

## ABOUT THE AUTHORS



Dr. D. Ramesh Kumar working as a Professor and Head in the Department of Civil Engineering at Mangalam College of Engineering Kuttayam, Kerala. He graduated in Civil Engineering at K.S.R College of Engineering, Tiruchengode, Namakkal, Tamil Nadu, India. He secured Post Graduate in Structural Engineering at VIT University, Vellore, Tamil Nadu, India. He secured Ph.D., in Civil Engineering at Anna University, Chennai, Tamil Nadu, India. He is in the field of Civil Engineering at Mangalam College Engineering, Kuttayam, Kerala, India. He is in teaching profession for more than 13 years. He has presented 15 papers in National and International Journals, Conference and Symposiums. His main area of interest includes Concrete Technology and Solid waste management.



Dr. P. Swaminathan working as an Associate Professor in the Department of Civil Engineering at Mangalam College of Engineering, Ettumanoor, Kerala. He graduated in Civil & Structural Engineering in Department of Civil & Structural Engineering at Annamalai University, Chidambaram, Tamil Nadu, India. He secured Master degree and Ph.D., in Department of Structural Engineering from the same University. He is in the field of Civil at Mangalam College of Engineering, Ettumanoor, Kerala, India. He is in teaching profession for more than Twelve years. He has presented more than 15 papers in National and International Journals, attended many Conferences and Symposiums. He also wrote a book in civil for the subject Construction Materials. His main area of interest includes Concrete Technology, Structural Analysis and Design of concrete Structures.



Dr. K. Arunkumar working as an Associate Professor in the Civil Engineering Department at Mangalam College of Engineering, Ettumanoor, Kerala. He graduated in Civil Engineering at Sengunthar Engineering College, Tiruchengode, Tamil Nadu, India. He secured Master of Structural Engineering in Civil Department at Kalasalingam University, Krishnankoil, Tamil Nadu, India. He secured Ph.D., in Civil Department at Kalasalingam Academy of Research and Education, Srivilliputhur, Tamil Nadu, India. He is in the field of Structural Engineering at Mangalam College of Engineering, Ettumanoor, Kerala, India. He is in teaching profession for more than 6.5 years. He has presented 30 papers in National and International Journals, Conference and Symposiums. His main area of interest includes Geopolymer Concrete, STAAD Pro software Analysis and Fibre Reinforced Concrete Technology.



Sreeranch Raghavu working as an Assistant Professor in the Civil Engineering Department at Mangalam College of Engineering. He graduated in Civil Engineering at Saintgits College of Engineering, Pathamuttom, Kerala, India. He secured Master of Engineering in Geotechnical Engineering at IES College of Engineering, Chittilappilly, Kerala, India. He is in teaching profession for more than 5.5 years. He has presented 5 papers in National and International Journals, Conference and Symposiums. His main area of interest includes Tunneling and Vibrations.

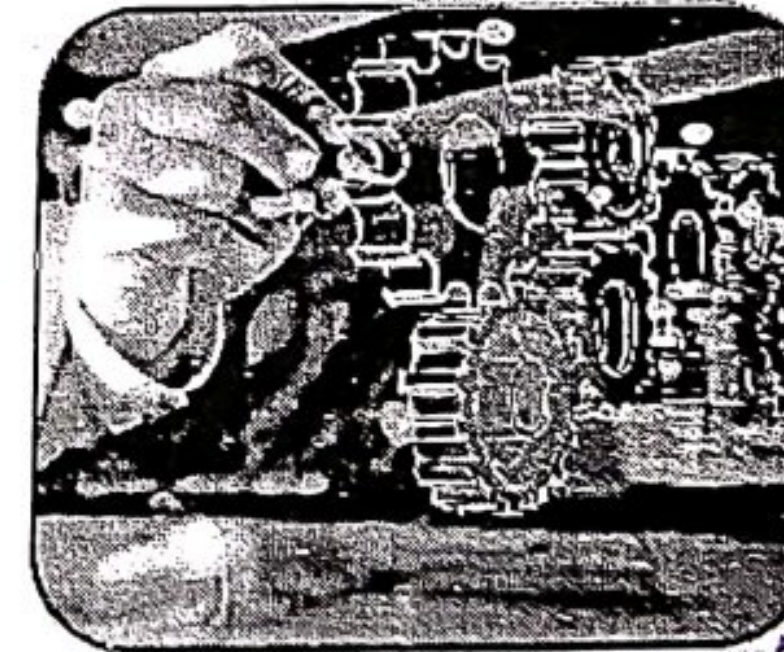


Abhijith Kumar A.N. working as an Assistant Professor in the Department of Civil Engineering, Mangalam College of Engineering, Ettumanoor. He is graduated in Engineering at Sadguru Swami Nithyananda Institute of Technology, Kanhangad, Kerala, India. He secured Master of Engineering in Geotechnical Engineering Department of IES College of Engineering, Trichur, India. He worked in Kochi Metro Rail Project work as Site Engineer for a period more than 2 years. He is in teaching profession for more than 4 years. He has presented 2 papers in National and International Journals, Conference and Symposiums. His main area of interest includes Geotechnical Engineering and Concrete Technology.

ENGINEERING MECHANICS



# ENGINEERING MECHANICS



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Dr. D. Ramesh Kumar | Dr. P. Swaminathan  
Dr. K. Arunkumar | Sreeranch Raghavu  
Abhijith Kumar A. N.



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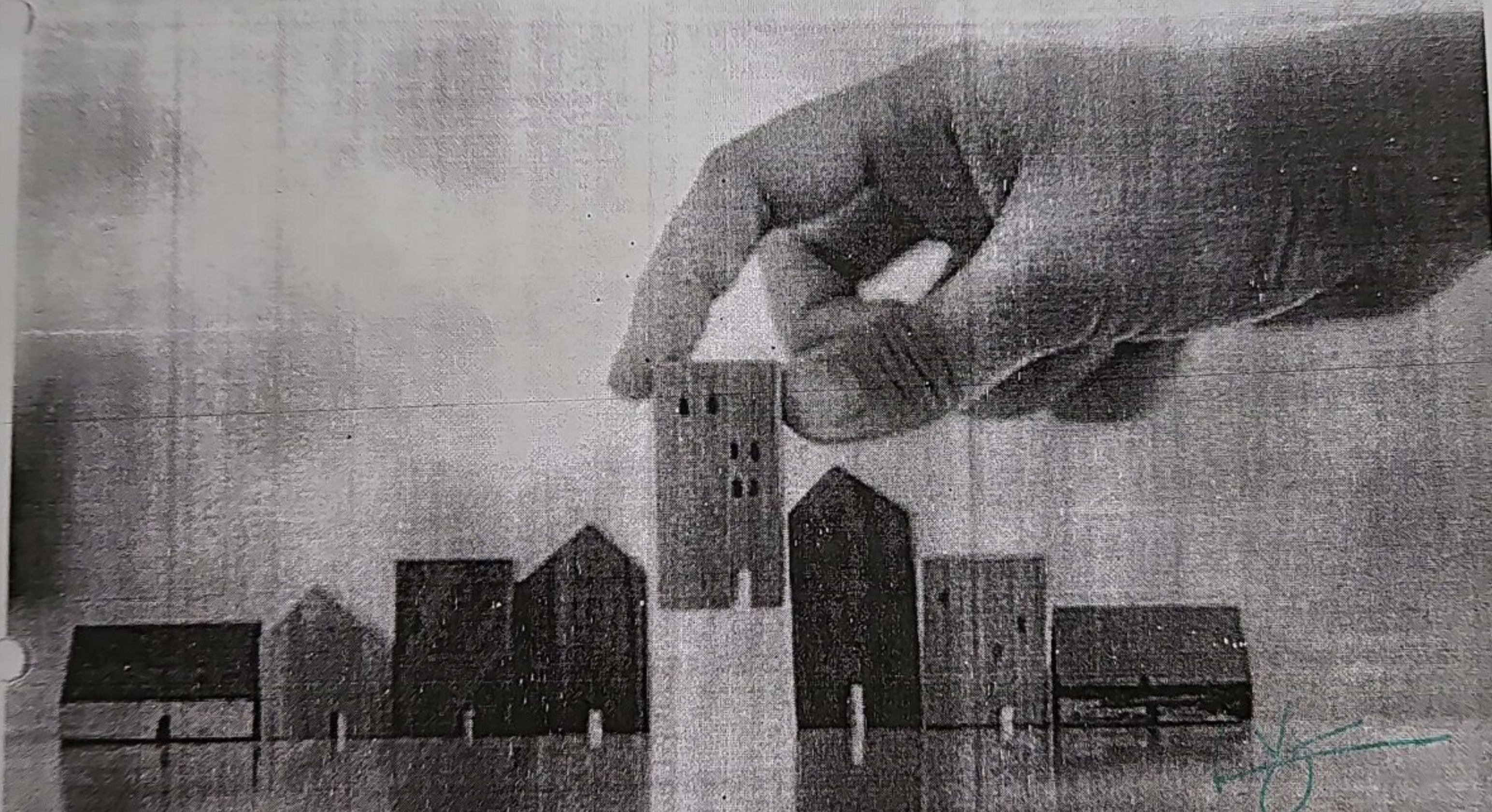
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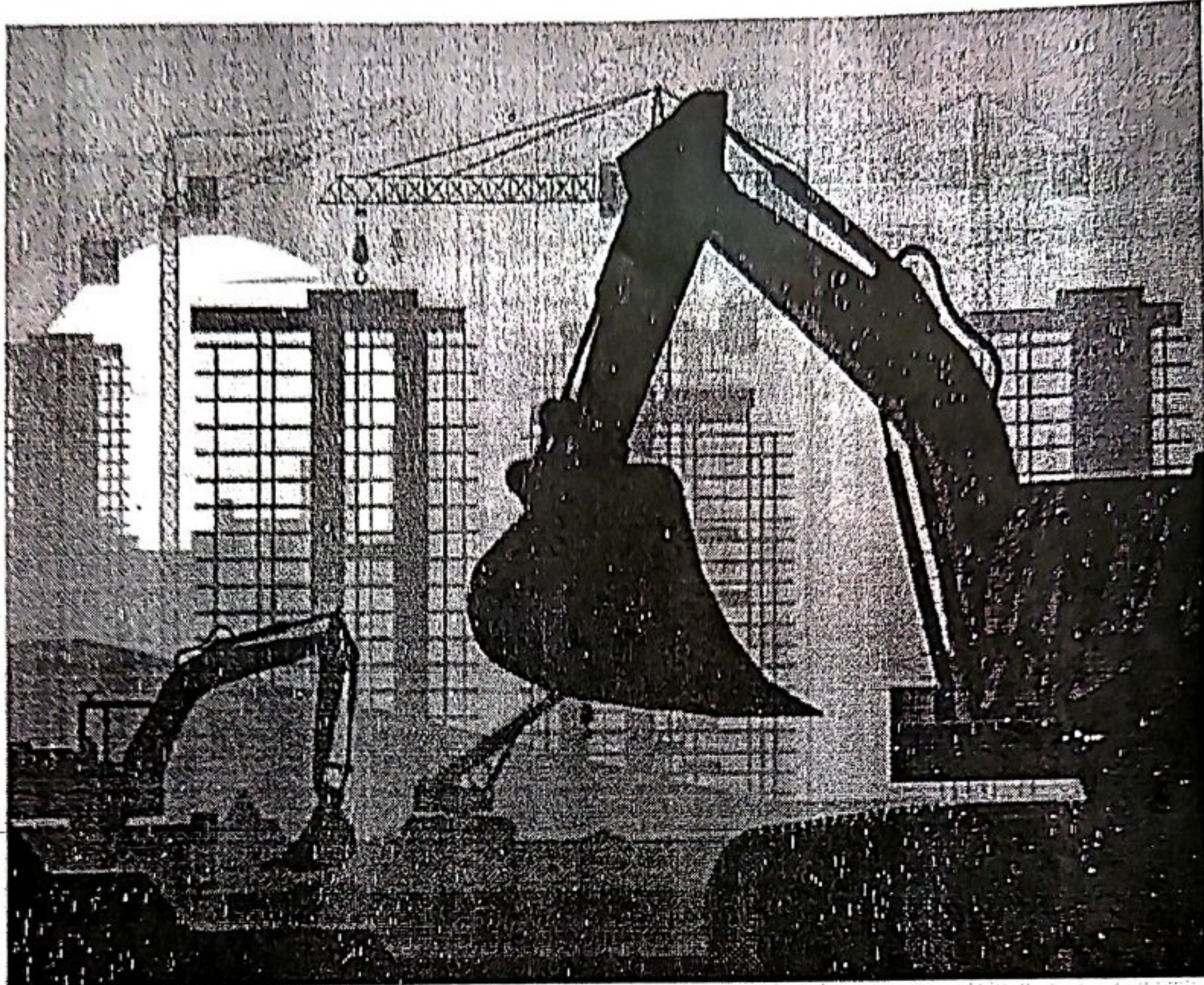
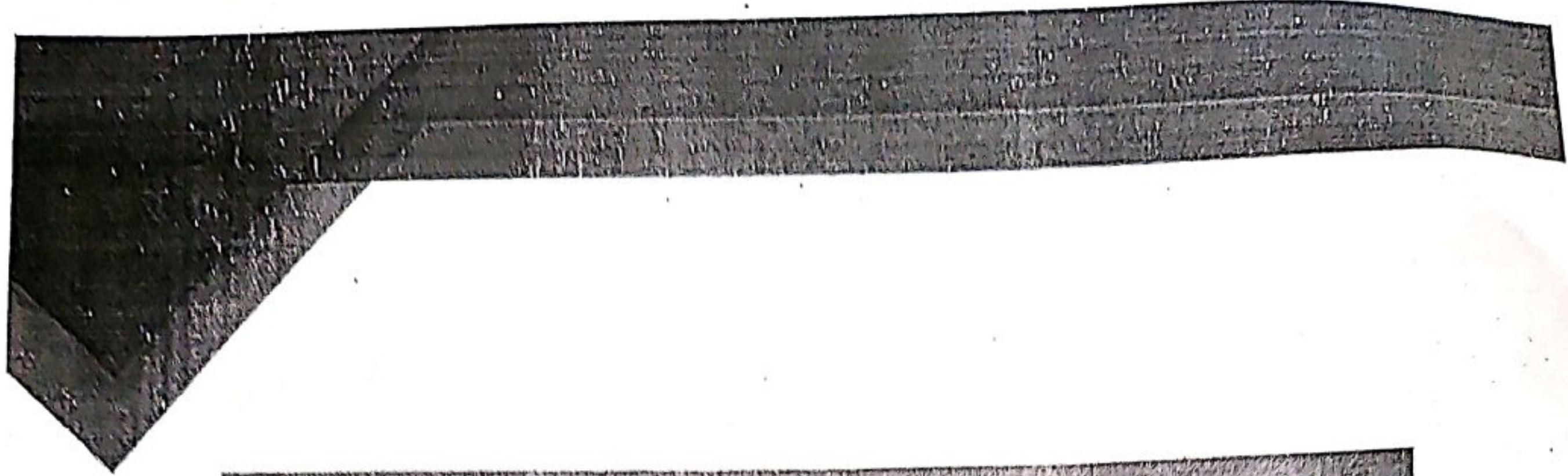
# TOWN & COUNTRY PLANNING



  
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# CONSTRUCTION METHODS AND EQUIPMENT

**GLADIA MATHEW**

**HARITHA M**

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Ettumanoor





## AUTHORS PROFILE



Dr. D. Ramesh Kumar working as a Professor and Head in the Department of Civil Engineering at Mangalam College of Engineering, Kottayam, Kerala. He graduated in Civil Engineering at K.S.R. College of Engineering, Tiruchengode, Namakkal, TamilNadu, India. He secured Post Graduate in Structural Engineering at VIT University, Vellore, TamilNadu, India. He secured Ph.D. in Civil Engineering at Anna University, Chennai, TamilNadu, India. He is in the field of Civil Engineering at Mangalam College Engineering, Kottayam, Kerala, India. He is in teaching profession for more than 13 years. He has presented 15 papers in National and International Journals, Conference and Symposia. His main area of interest includes Concrete Technology and Solid waste management.




Dr. P. Swaminathan working as an Associate Professor in the Department of Civil Engineering at Mangalam College of Engineering, Ettumanoor, Kerala. He graduated in Civil & Structural Engineering in Department of Civil & Structural Engineering at Annamalai University, Chidambaram, Tamil Nadu, India. He secured Master degree and Ph.D. in Department of Structural Engineering from the same University. He is in the field of Civil at Mangalam College of Engineering, Ettumanoor, Kerala, India. He is in teaching profession for more than Eleven years. He has presented more than 10 papers in National and International Journals, attended many Conferences and Symposia. His main area of interest includes Concrete Technology, Structural Analysis and Design of concrete Structures.



Dr. R. Senthilkumar working as an Associate Professor in the Civil Engineering Department at Mangalam College of Engineering, Ettumanoor. He graduated in Civil Engineering at College of Engineering, Guindy, Chennai, Tamilnadu, India. He secured Master of Technology in Offshore Structures, Department of Civil Engineering at National Institute of Technology Calicut, Kerala, India. He secured Ph.D. in Ocean Engineering at Indian Institute of Technology Madras, Chennai, Tamilnadu, India. He is in the field of Coastal/Civil Engineering at Mangalam College of Engineering, Ettumanoor, Kottayam, Kerala, India. He is in teaching profession for more than 15 years. He has presented more than 10 papers in National and International Journals, Conference and Symposia. His main area of interest includes Coastal Engineering/Civil Engineering and construction materials.



Mr. N. Nagarathinam working as a Head of the Department & Assistant Professor in the Civil Engineering Department at Nadar Saraswathi College of Engineering and Technology. He graduated in Engineering at Sardar Pappu College of Engineering, Thirunelveli, Tamilnadu, India. He secured Master of Engineering in Structural Engineering at University College of Engineering, Tiruchirappalli, Tamilnadu, India. He is Pursuing Ph.D. in Civil Engineering Department at PSNA College of Engineering and Technology, Dindigul, Tamilnadu, India. He is in the field of teaching and also a Building Design, Structural Consultant. He is in teaching profession for more than 10 years. He has presented 10 papers in National and International Journals, Conference and Symposia. He filed One International Patent in Patent Cooperation Treaty. His main area of interest includes Structural Design, Construction Materials & Techniques and Surveying.

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Dr. D. RAMESH KUMAR

Dr. P. SWAMINATHAN

Dr. R. SENTHILKUMAR

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# STRUCTURAL ANALYSIS AND DESIGN LAB MANUAL (STAAD LAB MANUAL)

(For 6<sup>th</sup> Semester Civil Engineering B.Tech. Students of KTU)

Dr. P Swaminathan *Ph.D., M.E.*  
Associate Professor,

Ms. Geethulal *M.Tech.*,

Assistant Professor,

Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, Kottayam

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Mangalam College of Engineering,  
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Silpa Caroline James *M.Tech.*

Assistant Professor, Civil Dept.  
Mangalam College of Engineering,  
Ettumanoor, Kottayam



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Assistant Professor, Civil Dept.  
Mangalam College of Engineering,  
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**Anju Raju** *M.Tech.*

Assistant Professor, Civil Dept.  
Mangalam College of Engineering,  
Ettumanoor, Kottayam

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# Incorporation of Waste Wood Ash and Polypropylene Fibre on the Production of Sustainable GPC



K. Arunkumar, M. Muthukannan, A. Suresh Kumar, A. Chithambar Ganesh, and R. Kanniga Devi

**Abstract** Geopolymer is an excellent binder material that belongs to the innovation of cement less concrete technology in the construction industry. The utilization of wastes in concrete has been growing well with incorporating in geopolymer concrete. Waste wood ash is the most spectacular waste material procured from all hotels. This study altered the fly ash with waste wood ash by varying the replacement percentages from 0 to 100% at 10% increment. The mechanical characterization was found to optimize the molarity of the alkaline activator, the solution to binder ratio, and the wood ash/fly ash ratio. The polypropylene fibre was added by 0–2% of volume fraction to improve the property of geopolymer in brittleness and crack resistance. In addition, the effects of adding polypropylene fibre on the mechanical properties of GPC were investigated. The research findings revealed the enhancement in compressive and tensile strength with 30% waste wood ash replacement. Further, the mechanical characters of GPC such as compressive strength, tensile strength, and flexural strengths were enhanced by 61%, 11%, and 12%, respectively, with the incorporation of 1% of polypropylene fibre. The research hypothesis focused on finding an alternate for fly ash, reducing alkaline activators quantity, and improving strength with PP fibre addition.

**Keywords** Geopolymer concrete · Waste wood ash · Polypropylene fibre · Sustainable GPC · Fly ash

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K. Arunkumar (✉)  
Department of Civil Engineering, Mangalam College of Engineering, Kerala, India  
e-mail: arunapcivil@gmail.com

A. Suresh Kumar · A. Chithambar Ganesh  
Sree Vidya Nikethan Engineering College, Tirupati, India

M. Muthukannan · R. Kanniga Devi  
Kalasalingam Academy of Research and Education, Krishnankoil, Tamil Nadu, India

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# Mix Design of DBM with RAP Aggregates

(Construction Materials)

Vijil A Jose

M.Tech student  
Department of Civil Engineering  
Mangalam college of engineering  
Kottayam India

Dr. P Swaminathan

Associate professor  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam India

**Abstract**— Recycling of asphalt pavements (RAP) is an economical, reasonable and environmentally friendly method material. In the face of rising asphalt prices, low availability of similar products, and extrusion to protect the environment, using RAP is superior to raw materials. So with this project, we can reduce the use of natural resources without compromising the specifications. Recycling the used aggregates with its properties can last for long years of life span of pavement. The main factor driving renewal in recent years is the product, including the price of asphalt and the absence of similar products. Therefore, recycling helps reduce costs, conserve scarce materials and lower labor costs. Thus recycling has an advantage of reducing the budget, protect limited material and decrease the amount of energy requisite.

By the time goes, new recycling innovations has been acquiring the word of Technology of different levels of construction. With the recycled materials with minimum content of binder contents can elaborate the usage of materials

**Keywords**- Asphalt, RAP, DBM, Mix Design, Binder Content, Marshall Stability

## I. INTRODUCTION

Reclaimed Asphalt Pavement (RAP) has been used as a valuable factor of new asphalt mix for many ages. Most RAP is produced from milling. RAP is milled from surviving pavement by producing to an appropriate size for using which used as a component for new asphalt mixture. Economically, there is an advantage for using RAP till these modules can be reused, thus can decrease the expenditure of purchasing and use less new virgin materials. In spite to economic benefits, the RAP usage has environmental positive. Recycling resource can lessens the reduction of consumption of non-renewable natural resources such as aggregates and asphalt binder. A RAP obtained from different purposes can have different asphalt binder content and properties, aggregate physical and gradation. Some of designers fractionate the RAP through one or more screens to have coarse and fine stockpiles, which will can increase the higher

percentage RAP use.

According to Federal Highway Administration, the graph shows the pavement condition, recycling and sustainability relationship.

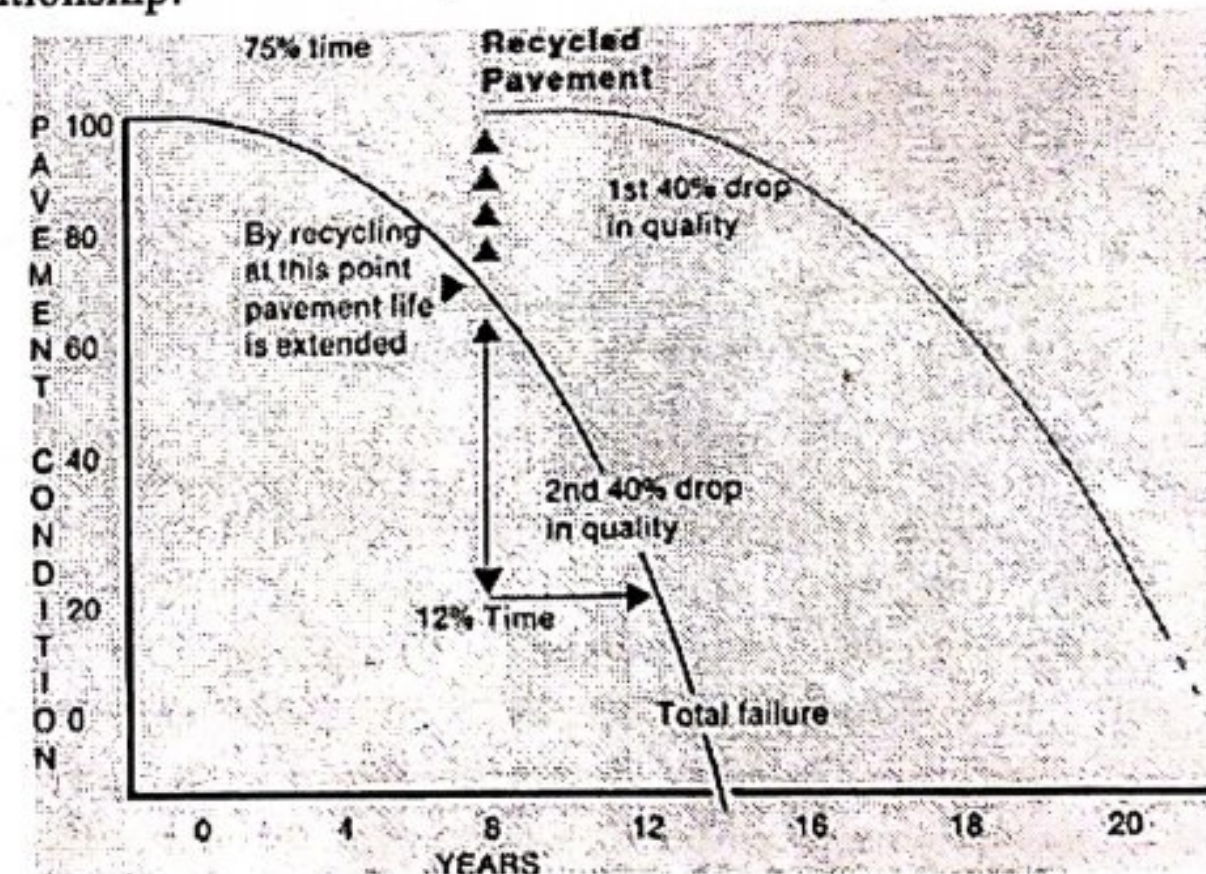


Fig No: 1 Graph showing Pavement condition, recycling and sustainability relationship

Recovered or reclaimed Asphalt Pavement (RAP) refers to asphalt and aggregate and paving contents of coarse aggregates and asphalt binder. These materials are formed from asphalt pavements which are removed for repair, resurfacing, or service. RAP consists of fine, fine grade aggregate and asphalt cement when properly crushed and analyzed.

Asphalt pavements are usually separated by milling or full depth exclusion. Milling takes place in removing the coating using a milling machine that can capture up to 50 mm of thickness in one go. The whole decision involves crushing and breaking the pavement using a truck horn and/or pneumatic pavement breakers. In the best example, crushed material is picked up by a front loader and loaded onto a truck and then transported to the main production area for processing. In this area, RAP is processed by processes such as crushing, screening, transport and stacking. Although most of the old asphalt pavement is reused.



# Study On Parking System And Its Analysis

Sneha Raju, Joyal Joseph, Tinu Joseph, Midhun.M  
 BTech Students  
 Department Of Civil Engineering  
 Mangalam College Of Engineering Ettumanoor  
 Kottayam, India

Dr.Swaminathan P  
 Professor  
 Department Of Civil Engineering Ettumanoor  
 Kottayam, India  
 E mail: swaminathan.p@mangalam.in

**Abstract**—The increasing rate of private car usage in the urban areas as a result of the fast-growing economy, derelict policies and subsidies are the main causes making car parking one of the main concerns for transport and traffic management all over the world. The coordination between parking policies and traffic management revealed how parking is becoming a barrier to the through-traffic operation. Also, it is responsible for the inefficient use of available resources, even the decisions are made on an ad-hoc basis while making policy. Hence, it is necessary to understand the parking choice behavior and actual demand of parking space.

**Keywords**—Transportation Engineering; Parking Demand And Capacity; Parking Characteristics; Parking Choice Behaviour; Policy Guideline; Planning And Management

## I. INTRODUCTION (Heading 1)

In developing countries around the world, the population of vehicles is increasing day by day. This is especially true for urban areas in those countries, where there is steep rise in human population. Cities usually provide a wide array of travel and transportation facilities including public transportation. But, the proportion of private modes among various travel options is increasing in urban areas which is leading to various problems like increased congestion and accidents. Increased income and improved socio-economic parameters contributes to the explosion in vehicle population in cities. In Ettumanoor city, the human population increased from 45000 to 1 lakh 2022. Subsequently, the vehicle growth in the city is from 2 lakh to over 5 lakh in the last 26 years. Parking could be considered as one of the inevitable aftereffects of traveling using private modes.

Parking is one of the least studied aspects of urban transportation. Parking is considered as the act of stopping and disengaging a vehicle and leaving it unoccupied. The provision of vehicle parking plays an important role in demand for traveling as well as basic functioning of the transport system. Increase in travel using private modes and reduction in public transport usage adds to parking demand. Addition of new parking supply facilities could attract more private vehicles. Thus, the most effective method to reduce the parking woes is to reduce the parking demand. In small cities like Ettumanoor, short distance trips account for about 60 % of total trips. changed to public transportation instead of traveling using private modes like personal cars and two-wheelers.

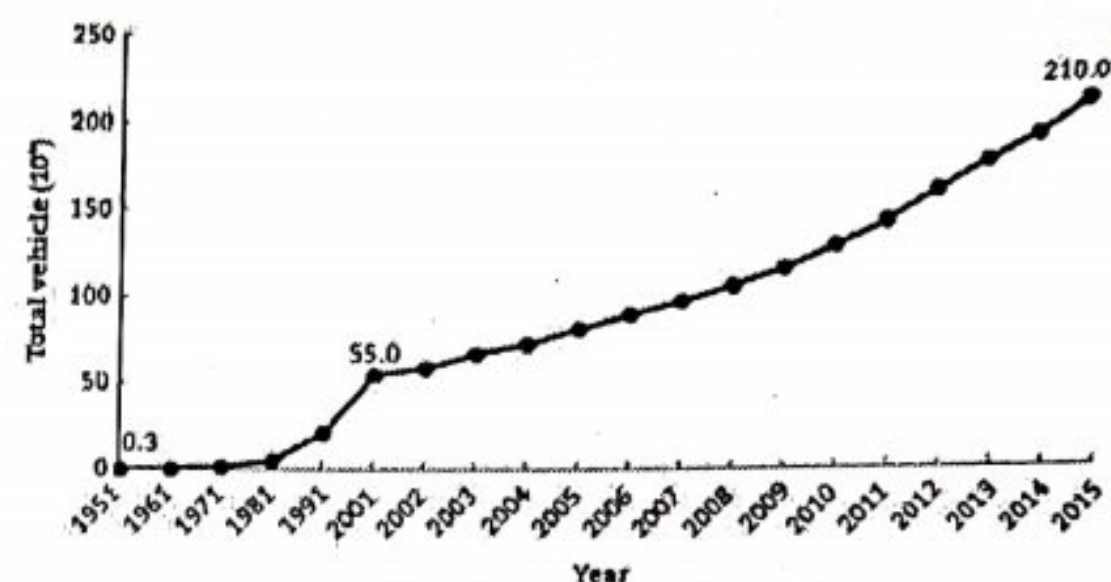


Fig. 1 - Vehicle growth in India (MORT&H, India, 2015).

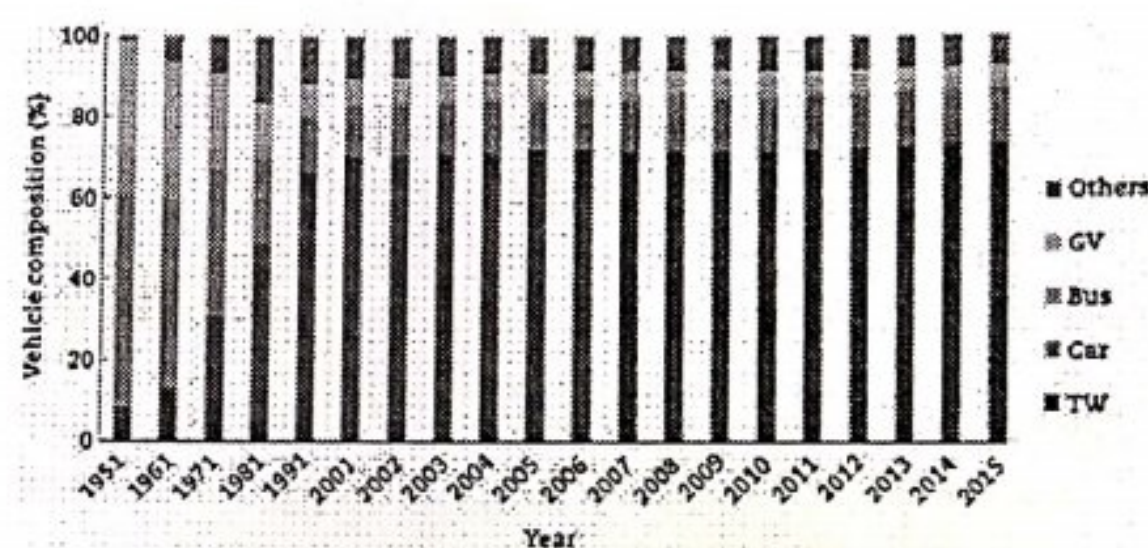



Fig. 2 - Composition of vehicle population (MORT&H, India, 2015).

## 1.2 NEED OF THE STUDY

Parking is an inevitable part of personal transportation. The demand for parking in urban areas is increasing day by day. This is because of increase in vehicle numbers, especially cars, which consume more space in comparison two-wheelers. In cities like Ettumanoori, two-wheelers accounts for about 60 % of total traffic, while cars are about 15-20 %. The decadal rise in the number of two-wheelers is 3-9%, but the rise in number of cars is 10-12% . This adds to the parking woes. As the number of cars increases, parking demand also increases. But, the on-street supply will remain more or less the same. This increases the gap between parking demand and parking supply. Study of this gap is important to evaluate the extent of parking problem prevailing in the area. This study could be used as an indicator of parking condition in urban regions in developing economies. Urban areas are in dire need of parking spaces. The most logical method to avoid parking problems is to reduce the parking demand. But this could be implemented only as a part of a long term plan. Short term plans are also needed, which includes addition of supply facilities.

  
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# FE Analysis on RC frame followed by column elimination using ANSYS

Ajin K Jiji  
M.Tech student  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam India

Er. Gokul PV  
Assistant professor  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam India

**Abstract**— A possible and economic method for changing the area is to remove the brick walls and rec pillars from the required framed constructions. If there no further reinforcing measures are taken, completely removing columns can cause accending collapse or intolerable deformations. In this work, only the 2 storey, 2 bay RC frame is taken into account, rather than the full structure. Costs associated with labour and installation can be decreased because FRP is lightweight. Compared to other building materials, FRP is a better heat insulator and can withstand higher temperatures. In the vicinity of the deleted column, contrast a number of bracing techniques, including the X, V, inverted V, forward, and backward. to assess the steel's ability to withstand vertical cyclic loading when the column is removed. to assess how different FRP varieties, including CFRP, BFRP, and GFRP, perform when utilised on beams. to assess the overall performance of the FRP sheets and suitable bracing on the lower story column. The RC frame is retrofitted when a column is removed using a number of techniques, and seismic performance is assessed while under cyclic loads. The bracing techniques used while constructing a truss system on top of an RC frame are contrasted. The FRP sheet jacketing strengthens the beam, and different FRP materials are contrasted. examining axial seismic loads.

**Keywords** – FRP Jacketting, Bracings, seismic behaviour, cyclic loading

## 1.INTRODUCTION

Many older structures in densely populated cities are unable to adapt to changes in use and the demand for more space as a result of societal and economic development. Removing columns and masonry walls from existing framed constructions is a practical and cost-effective way to create more space. However, removing a column could result in progressive collapse or intolerable deformations if there are no further reinforcing measures. Therefore, it is required to reinforce the upper beams and eliminate any columns that are next to the walls or adjacent columns. The stories above the removed columns can be refitted as truss systems to correct both, or the beams above the removed columns can be strengthened as underpinning beams (i.e., transfer girders). Different techniques have been developed in engineering practise to increase the flexural and shear resistance as well as the stiffness of the supporting beam, including section enlargement by increasing the RC cross section, external

prestressing or post-tensioning, and adding externally bonded plates or sheets, other great steel to fiber-reinforced polymer, and now fabric. Research has advanced on a variety of materials, including reinforced cementitious matrix composites and externally bonded plates, sheets, and strips. These materials are attached to the tension sides of structural components and have a high tensile strength to increase bearing capacity. Additionally, methods of enlarging the section via RC jacketing and employing a combination of steel angles and battens are frequently used if RC columns need to be improved in terms of both strength and stiffness. The latter technique bonds four steel angles to the RC column's rounded corners, and steel battens are externally welded to the angles at predetermined intervals to provide restricting and joint action if the angles are directly loaded.

By joining existing beams and structural parts, such as by adding vertical connections to produce a verandeel truss system or steel X-bracing to construct a standard truss, stories above a removed column can be transformed into a truss system.

Qun Gao, Jun Yu, Youhua Zhu, and Fangfang Wei (2020). With strengthened beams and columns at the renovated story and steel X-bracing at the second story, the seismic behaviour of a two-story, two-bay RC frame and a corresponding renovated RC frame is experimentally investigated in this journal under cyclic loading. The findings show that the renovated frame's lateral stiffness and peak capacity are significantly higher than those of the original frame, but its final deformation capacity is lower and its energy-dissipation capacity is comparable to that of the original frame..

Analysis was done by Issa et al. (2014) to determine how reinforced concrete columns with a steel jacket or fibre composite would react to an axial load. The two stages of this research are the first stage, which consists of experimental tests, and the second stage, which consists of theoretical and numerical analysis.

SamYoung Noh, Joseph A, and Yihai Bao (2017). A computational tool for assessing structural robustness against column loss is given in this article. The application of the concept to RC frame structures, employing a reduced-order modelling strategy for three-dimensional RC framing systems that incorporate the floor slabs, serves as an illustration of the methodology. The method is validated using comparisons with high-fidelity finite element model output. The reduced-order modelling approach is utilised to perform pushdown studies of prototype structures under scenarios of column loss, and an energy-based procedure is used to account for the dynamic impacts of abrupt column loss.



# SEISMIC ANALYSIS OF MULTISTORIED BUILDING HAVING DIAPHRAGM DISCONTINUITIES AND RE- ENTRANT CORNERS USING ETABS (Earthquake Analysis)

Amruta Murali<sup>1</sup>  
M.Tech Student  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam, India

Reni Kuruvilla<sup>2</sup>  
Assistant professor  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam, India

**Abstract**— The main reason for structural failure during an earthquake is irregularity. Currently, many buildings have irregular configurations in terms of both height and floor plan. These buildings may collapse due to devastating earthquakes in the future. The seismic behavior of structures is reduced due to structural irregularities. Earthquake damages usually occurs at weakened locations in multi-story frame buildings. Buildings with openings in slabs and changes in slab thickness are subject to damage due to the action of lateral loads. In every building structures, floor and roof system together serve as a horizontal diaphragm. They collect and transfer inertial forces to vertical elements of lateral load-resistant systems, i.e. columns and structural walls. These diaphragms also make sure that the vertical components act together under gravitational and earthquake loads. Diaphragm openings are intended for staircases, lighting, architectural elements, or manholes. While changes in slab thickness are caused by applied load, number of floors, type of support, quality of concrete, or span length. This work provides holes in the slabs at different locations such as the center, corners, and perimeter with square-shaped columned buildings. Three cases are randomly selected when analyzing the effect of slab thickness. They are the L-shaped variation, the same variation, and the outer thick inner thin variation. In addition to the discontinuity effect of re-entrant corners, it is also studied. The corners of the return inlet are provided with diaphragm openings. Shear walls will also become part of the entering corners to reduce the combined effect of entering corners and discontinuities. And all the parameters of the irregular building are compared with the regular building. Response spectrum analysis in ETABS software determines the seismic performance of multi-story buildings. This study attempts to determine the difference between a building with and without diaphragm discontinuities and also the effect when re-entrant corners are formed in the same building. The investigated parameters are storey drift and base shear.

**Keywords**—Irregularity, Diaphragm, Diaphragm discontinuities, story drift, Response spectrum analysis, ETAB, Re-entrant corners.

## I. INTRODUCTION

The diaphragm is a structural element that transfers the lateral loads to the vertical resistance members of the structure. If excessive openings are provided in a diaphragm, it leads to a flexible response of the diaphragm along with the concentration of forces and this causes load path deficiencies at the borders of the openings. In the floor plan, openings

in the diaphragms can significantly reduced the capacity of the plates. Discontinuities in diaphragm are caused by openings at various locations, cut-outs, adjacent floors at different levels, or changes in diaphragm thickness. The diaphragm of a structure often serves a dual function as a floor or roof system in a building or bridge deck that simultaneously carries seismic loads. Generally diaphragms are constructed by using plywood or composite metal plates. Openings for floor diaphragms are intended for staircases, shafts, or other architectural elements. The change in slab thickness is caused by the applied load, the number of floors, the type of support, the quality of the concrete, or the length of the span. Gravitational and earthquake loads moves in a continuous and smooth path through the horizontal and vertical elements of the structures and are transferred directly to the ground. In the plan, the holes in the diaphragms weaken the capacity of the plate. Discontinuities are present in both the plan and elevation of the structure. In this work, the effect of diaphragm discontinuities, re-entrant corners and the seismic behavior of buildings is processed. Response spectrum analysis in Etabs is used to find out the effect of diaphragm with and without diaphragm discontinuities and re-entrant corners.

In civil engineering, a diaphragm is a structural element used to transfer lateral loads to shear walls or frames. Wind and earthquake loads are usually considered as lateral loads. The two primary types of diaphragms are rigid and flexible. Flexible diaphragms resist lateral forces, and it is depend up on the area, regardless of the flexibility of the elements to which they transfer the forces. Rigid diaphragms transfer loads to frames or shear walls depending on their flexibility and location in the structure. The flexibility of the diaphragm affects the distribution of lateral forces on the vertical components of the transverse force elements in the structure. Re-entrant corners are defined as any inside corner that forms an angle of 180 degree or less. Diaphragm openings along with re-entrant corners will affect the structure severely during earthquake. The effect of re-entrant corners can be overcome by using shear walls. Shear wall is one of lateral resisting structure which is used commonly. Shear walls give high stiffness to the structure so that the structure become more stable. Applying shear walls helps to reduce the base



# STUDY OF STRUCTURAL BEHAVIOUR OF PT BEAM OF A MULTI-STORIED BUILDING UNDER SEISMIC LOAD

FEBIN ANTONY

Department of Civil Engineering  
Mangalam college of engineering  
Kottayam, India  
febinantony17@gmail.com

Ms: GEETHU LAL

Assistant professor  
Department of Civil Engineering  
Mangalam college of engineering  
Kottayam, India

**Abstract**— In case of RCC (Reinforced cement concrete) beam, usually the function of concrete is to take the compressive stresses and when it comes to steel the role is to take up the tensile stress. But we are not considering the mixture of concrete placed below neutral axis because of its fragile nature in tension resistance. Even though steel is provided for resist the tensile stress some minute cracks will form in the tension zone concrete. After a lot of research, it is found out that this problem can be eliminated by stressing both the steel and concrete, but this should be carried out before the load application. Pre tensioning process and post tensioning process are two different ways by which we can complete internal prestressing. In the process of pre-tensioning, before the casting of concrete using moulds, the tendons have to be tensioned first in between rigid anchor blocks cast which can be done on floor, pre-tensioning bed and also in columns. In post-tensioning the tensioning of concrete is carried out after casting of concrete. To fit the tendons concrete blocks are casted by incorporating ducts. Once the concrete attained enough strength, a jack is connected member's end face and thus the high-tensile wires are tensioned and anchored by wedges. Some space will be remined after this process and this can be filled by grouting. This PT beam and RC beam effect used in several storey building under seismic is studied assessed using ETABS 2017 and also the effect of bracings on the PT beam structure

**Keywords:** RC beam, PT beam, ETABS

## I. INTRODUCTION

Earthquake resisting reinforced concrete building design is a department deals with study of earthquakes because it has started in developed countries as well as in India. The damage

can be occurred due to different factors in an earthquake. On the last centuries India had undergone so many earthquake disasters in many places in different scales. As a matter of fact the percentage of areas that are prone to heavy earthquakes are above 50%. Due to the uncertainty in the calculation of earthquake time and intensity it is considered as one of the most dangerous disaster and the destruction will not be over by effecting buildings it will also lead to human loss. Country's north east part and Himalayan regions are subjected to high magnitude earthquake such as 8.0 and as per the study the main reason for this is Indian plate movement towards European plate and the amount by which it is happening is 50mm per year. Earthquake can't be eliminated from earth but by taking proper building construction technique it can be controlled to an extent.

In Asian countries one of the most used structures in industrial and residential building is RCC structures. PT beams are not used in buildings with small span length. Around 20 years ago we were suffered by the shortage of expertise people in the fields of prestressing but however this situation has improved a lot in these years and we are available with a lot of people and workshops to do this. One of the main reasons why the prestressed beams are economical is that, while we are using prestressed beam the depth of the beam can be reduced and in the same case if it is an ordinary beam as the span increases, we have to increase the depth of beams because of its limitations in deflection in structural engineering



# Flexural behavior of pairs of laminated unequal channel beams with different interfacial connections in corner-supported modular steel buildings Using ANSYS

**Febinmon Baby<sup>1</sup>**

**M.Tech student**

Dept. of civil engineering  
Mangalam college of  
engineering Kottayam India

**Ms. Anila Mary Jacob**

**Assistant professor**

**Dept. of civil  
engineering**

Mangalam college of engineering  
Kottayam India

**PRINCIPAL**  
**ANGALAM COLLEGE OF ENGINEERING**  
Ettumanoor

**Abstract:-** In the construction sector, modular building systems (MSBs) have grown at an exponential rate due to possible benefits such as quicker construction times, increased energy efficiency, and less reliance on favourable weather conditions. Increased embedded component production at MSB and size selection for each component would be advantageous for the modular joint design process. To evaluate the bending behaviour of channel beams with the proper size, MSB must take into account the necessity for light materials, a broader access area, transit facilities, fire safety regulations, and energy requirements associated to their use. Run a more thorough stability investigation to see how well the belts are positioned and opened. Analyse the effectiveness of various web ripple settings. The finite element method (FEM) is a well-liked method for the numerical solution of differential equations that arise in engineering and mathematical modelling. To compare bending performance, channel sections of various lengths are positioned. The development and assessment of five models. The outcomes are contrasted. The channel segment is then examined, paying particular attention to the corrugation and web holes. Four models with various diameters and two models with various corrugations are constructed and tested for this. Next, the model-derived load and deflection values are evaluated.

## INTRODUCTION

Modular building systems (MBS) have experienced accelerated expansion in the construction sector due to their potential benefits, which include quick construction, better energy efficiency, and decreased reliance on

favourable weather conditions compared to traditional construction processes. A deeper understanding of MBS performance in various contexts and scales is a goal shared by researchers and the building industry. Modular steel buildings are high-end prefabricated construction solutions that are frequently employed in urban development because they have the benefits of quicker construction, less environmental disruption, significantly cheaper prices, and superior quality. Corner modular steel buildings are becoming more and more popular because of their capacity to provide open spaces and transparent load transfer in the structural system, particularly for hospital and educational purposes. ONE. The corners of corner modular steel buildings are typically bolted and also welded by several 3D modules in order for a group of modules to bear external loads as an integrated system. In this modular design, independent double beams are created by building a short corner post at the connecting point and using the space between the floor and ceiling beams for a simpler post-to-post connection. Due to the distinctions between modular steel frames and traditional steel frames, corner modular steel buildings exhibit more complex structural behaviour than normal steel buildings, particularly as the number of building levels rises. Three pairs of layered non-uniform trough beams with various phase connections were employed in the corner-supported MSBLB-C, LB-C with four extra shear bolt connections, and LB-C-8B. Each pair had a unique interface. To better comprehend the flexural behaviour of laminated beams with an unequal channel, beam finite element models were created and validated using experimental results. Significantly superior to the



# SEISMIC ANALYSIS OF MULTISTORIED BUILDING OF REGULAR AND IRREGULAR PLAN CONFIGURATION WITH DIFFERENT BRACING SYSTEM USING ETABS

Anjaly Anilkumar<sup>1</sup>  
M.Tech student  
Dept. of Civil Engineering  
Kottayam, India

Ann Mary Jose<sup>2</sup>  
Assistant Professor  
Dept. of Civil Engineering  
Kottayam, India

**Abstract-** The goal of this project is to analyze ordinary and vertical irregular homes to understand the reaction of vertically abnormal homes using superior software program together with ETABS. ETABS is an included software program used for static analysis and layout of buildings. This paper deals with the take a look at of the conduct of buildings when subjected to horizontal loads together with seismic masses. The examine in particular makes a specialty of the effect of the shape of the structure on the resistance to these lateral hundreds. 3 one-of-a-kind configurations are taken into consideration on this look at, particularly: L-form, I-form and rectangular form. The response of vertically abnormal buildings with an everyday building is achieved by using thinking about the simple shear, displacement and bending moment of the buildings. Buildings which have irregular plan will without difficulty be concern to torsional effects because their center of gravity does no longer coincide with the center of gravity, as twisting can be advanced in the building. As for homes that have an abnormal peak and are positioned in seismic zones, it will be difficult to recognize the conduct of such vertically abnormal buildings.

A viable strategy to growth earthquake resistance is the usage of steel bracing structures with the aid of expanding its stiffness and stability, metallic bracing can growth the shape's resistance to lateral forces. The ability blessings of the usage of metallic braces are their high strength, stiffness, economic system, takes up less space and adds tons much less weight to the present structure. This challenge investigates the structural conduct of ordinary and abnormal building for reinforced and unreinforced situations underneath static and lateral loading. This examine may be used for the layout of latest irregular building systems and for the analysis of existing irregular building.

**Keywords-** Seismic loads, Configuration, Irregularity, Storey drift, Base shear, Response spectrum analysis, Bracing system.

## I. INTRODUCTION

Earthquakes are the most changeable and adverse of all herbal screw ups. Earthquakes have the eventuality to beget the most damage of all natural hazards. Due to the fact earthquake forces are arbitrary and changeable. They no longer handiest beget awesome damage in terms of mortal casualties, however also have a huge profitable effect at the affected area. Organizations approximately seismic pitfalls have brought about a growing mindfulness and call for construction designed to repel seismic forces. While a structure is subordinated to ground actions at some stage in an earthquake, it responds via wobbling.

Those floor moves beget the structure to joggle or shake in all 3 directions; the foremost route of shocks is vertical. At some point of an earthquake, structural damage generally starts off evolved at a factor of structural weak point present inside the shape structures. High- upward push RC structures are a special magnificence of systems with their very own special traits and conditions under the condition of earthquake, the behavior of a structure relies upon on several factors, stiffness, sufficient aspect strength, tension, simple and normal configurations. Structures with regular determine, with inconsistently disbursed mass and stiffness in plan and elevations, go through a lot decrease damage as compared to irregular configurations. Earthquake resistant layout of RC structures is an area of exploration as earthquake engineering has started not most effective in India but also in different superior nations. Harm to structures for some purpose or different throughout an earthquake.

Structure configuration can be described as ordinary or abnormal in phrases of structure size and shape, arrangement of structural rudiments and mass. The regular shape configuration is nearly symmetrical in plan and top about the axis and has an indeed distribution of the transverse force of the resisting structure in order that it gives a nonstop cargo path for each graveness and aspect loads. A shape it truly is unsymmetrical and has a discontinuity in figure, mass, or shipment- defying element is known as irregular. These irregularities can beget an unconditional influx of forces and interest of stress. Asymmetric association of mass and stiffness of rudiments can beget a massive torsional force where the center of graveness doesn't coincide with the middle of stiffness. India has witnessed numerous fundamental earthquake failures in the last century. Earthquake is the maximum dangerous and negative motive of destruction of structures and mortal lifestyles due to its unpredictability and enormous pressure. Building structures crumble at some stage in robust earthquakes and beget direct loss of mortal existence. Earthquake is an herbal miracle whose items cannot be unnoticed however can be minimized to a degree through espousing relevant structure designs. The main cause of this paper is to evaluate an everyday shape with an abnormal structure with recognize to earthquake, wind and crumble lading of the shape the usage of ETABS (reaction spectrum method).

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Ettumanoor



# RESPONSE OF MULTISTORIED BUILDING WITH DIFFERENT BRACING SYSTEMS UNDER SEISMIC CONDITIONS USING ETABS

Kiran P S<sup>1</sup>  
Mangalam College of Engineering, Ettumanoor  
Kottayam, India

Gökul P V<sup>2</sup>  
Assistant Professor  
Mangalam College of Engineering,  
Kottayam, India

Ettumanoor Kottayam, India

Vidya Mohan<sup>3</sup>  
Assistant Professor  
Mangalam College of Engineering, Ettumanoor  
Kottayam, India

**Abstract**— Earthquakes are one of the natural calamities that cause many damages to multi-storeyed structures. Many RC buildings need to retrofit to overcome the damages under earthquake loads. There are many ways to protect the buildings under these circumstances. Bracings systems are one of the horizontal load resisting systems which got structural importance. So bracing is the most effective method which can be incorporated to the RC buildings to reduce the seismic effects. In tall building structures, bracing has been used to stabilize the structure laterally. Different bracing systems are there to retrofit the building under seismic conditions. Among all, Steel bracing is the most efficient and economical method to resist lateral forces in a RC frame structure. Because, Steel bracing can improve the stiffness and strength of the RC building and can also reduce the deformation. In this study we have mainly focused on comparative study of a regular building and building with different bracing systems. Shape study and location study has also been done on building with bracing for comparison with regular RC building. X, V and inverted V bracing system is used for shape study. The comparative study is done under Response Spectrum method using ETABS Software. This study is mainly focused to determine which shape of bracing system is effective and also the best suited location for bracing to reduce the effect of seismic loading.

**Keywords**— regular buildings; bracing systems; response spectrum analysis; ETABS

## I. INTRODUCTION

Why seismic analysis is important? The seismic analysis allows us to monitor the response of a building during an earthquake, which enables us to obtain the additional forces or deformations that would generate because of lateral forces. Seismic design is an important process of structural analysis while designing a building, which is subjected to earthquake ground motions, such that the facility continues to function and serve its purpose even after an Earthquake. Seismic analysis is a subset of structural analysis and is the calculation of the response of a building (or nonbuilding) structure to

earthquakes. To prevent structural damage and also minimize non- structural damage underground shaking events are the objective of the seismic design of the structure. When the seismic wave's frequency approximates or is similar to the building's natural frequency, resonance takes place, and the buildings get affected. Therefore, the energy gets transmitted to the building at tremendous efficiency. - Small buildings are affected more by high-frequency waves. To create an adequate and proper seismic design, it is important to analyze the building's period, ductility, strength, stiffness, damping, etc. This analysis also helps determine which devices and strategies to employ for seismic design. These factors of seismic analysis include among others: soil condition, building heights, the relative difference between building's heights, the separation between adjacent buildings, lateral load resisting structural system, the peak ground acceleration of the earthquake at the location of the building etc .

Bracing system is capable of resisting lateral forces through the compression or tension of its brace members, which makes the system highly effective in resisting the lateral forces. In addition, the braced frame system's efficiency enhanced its ability to provide lateral stiffness and strengthen the structure. This research is mainly concerned with the following system: Bracings shape and its appropriate locations. There are various methods available for the evaluation of seismic performance of any structures.

In this study, the performance of RC building under lateral load resisting bracing systems is compared, including outer corners, the centre of outer sides and the inner core to determine the most favourable location for installing bracing systems in RC buildings.

Bracing is a construction method used to stabilize or stiffen the building structure against lateral loads. It enhances the ability of building structures to withstand lateral load due



# ACTIVE VIBRATION CONTROL OF LAMINATED COMPOSITE THIN PLATES USING A SMART MATERIAL

Richumon Salu<sup>1</sup>

<sup>1</sup>M.Tech Student

Department of Civil Engineering  
Mangalam College of Engineering  
Ettumanoor

Gokul P.V<sup>2</sup>

<sup>2</sup>Assistant Professor

Department of Civil Engineering  
Mangalam College of Engineering  
Ettumanoor

Silpa Caroline James<sup>3</sup>

<sup>3</sup>Assistant Professor

Department of Civil Engineering  
Mangalam College of Engineering  
Ettumanoor

PRINCIPAL  
MANGALAM COLLEGE OF ENGINEERING

**Abstract**— The aim of this paper is the vibration control of piezo-covered composite thin plates with surface reinforced or installed piezo-electric sensors and actuators by utilizing the limited component examination and LQR input control procedure". The consequences of the limited component investigation are utilized to plan a direct quadratic controller (LQR) controller with a dynamic state onlooker to accomplish the control. The control configuration starts with an inexact decreased modular model which can speak to the framework progression with the minimum framework modes. "A state space modular model of the brilliant structure which coordinates the host structure with reinforced piezoelectric sensors and actuators, is then used to plan the control framework.

**Keywords**— FE analysis, Thin composite plate, vibration control, LQR technique

## I. INTRODUCTION

A framework is named as 'keen' on the off chance that it is fit for perceiving an outside jolt and reacting to it inside a given time in foreordained way. Moreover it should have the capacity of recognizing its status and may ideally adjust its capacity to outer boosts or may give proper flag to the client. Brilliant structures that can monitor their own condition, recognize approaching disappointment, control, or recuperate harm and adjust to evolving condition. Due to their characteristic capacity of distinguishing the any adjustment in structure, shrewd materials, frameworks and structures are being utilized for SHM and NDE from recent decades.

## II. COMPONENTS OF SMART SYSTEM

### A. Sensors

A smart system must have embedded intrinsic sensors to recognize and measure the intensity of stimulus (stress or strain) or its effect on the structure .

### B. Actuators

"A smart system may additionally have embedded or bonded actuators, which respond to stimulus in predetermined manner."

### C. Control mechanism

"A smart system must have a mechanism for integrating and controlling the actions of the sensors and actuators."

## III. STYLING POTENTIAL APPLICATIONS OF SMART MATERIALS

One thought is to put containers or empty strands loaded with split fixing material into solid which if broke would break the fibre discharging the sealant. Optical filaments which change in light transmission because of stress are helpful sensors. They can be installed in concrete or joined to existing structures. Darker University and the University of Rhode Island explored the essentials and progression of inserted optical strands in concrete. Japanese scientists as of late created glass and carbon fibre strengthened solid which gives the pressure information by estimating the progressions in electrical protection in carbon strands .

## IV. NECESSITY OF MODELLING

The joining of savvy materials with the customary ones is a key viewpoint in the conduct of the structures and their displaying. Demonstrating ought to be to such an extent that firmness and inertial mass of the structure not affected by transducers or sensors. The above contemplations give a thought of the inspirations that drive the examination exertion in displaying keen structures, and the motivation behind why this is an extremely difficult and open research field. The displaying of full material nonlinearities and the demonstrating of full coupling between keen structures and liquids may be said as conceivable cases for future research.



# P-DELTA analysis on steel fiber reinforced concrete structure using ETABS

Jane Alexander  
M.Tech student  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam India

Er. Lulu K Makkar  
Assistant professor  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam India

**Abstract** — The intend of this research work is to introduce the application of SFRC (Steel Fiber Reinforced Concrete) as a structural material and the importance of P Delta analysis in highrise building, for this purpose first the previous research work was referred that have been done to obtain various important mechanical properties of SFRC which helps us to understand its behavior as a structural element. The material was simulated using software after the qualities were determined by experimental material testing study guidelines on SFRC. This study was conducted using ETABS 18.0.0. The P Delta study of a G+9 story RC frame structure was modified to use conventional M40 grade concrete, and the findings unmistakably demonstrated that the SFRC building model had outperformed it under seismic stress.

**Keywords** – Steel Fiber reinforced concrete, P-Delta effect, Linear Static Analysis, ETABS.

## 1.INTRODUCTION

Generally to calculate displacement, moments and design forces brought on by loads acting on a structure, structural designers employ linear static analysis, sometimes referred to as first order analysis. First order analysis is carried out by imagining minor deflection behavior, where the resulting forces, bending moments, and displacements do not account for the additional effect caused by the sudden changes in structure under vertical load before applying lateral loads. The structure experiences P-Delta effects when the structure elements are subjected to an axial load. In terms of deformation, it is one of the second order effects that correlates to the load applied to the structure. It is second order impact that is connected to the applied axial load and displacement. Every construction that has elements that are exposed to axial load experiences the nonlinear phenomenon known as P-Delta. Actually P-Delta is just one of several second-order effects. It is a "genuine effect" that is connected to a displacement (Delta) and the size of the applied axial load (P)

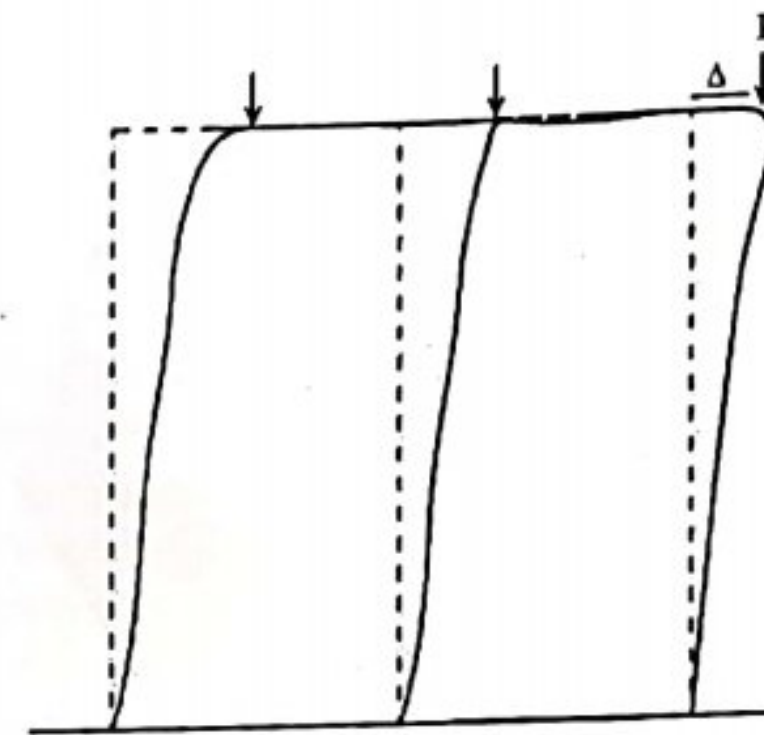


Fig 1: P- Delta

Steel fiber-reinforced concrete (SFRC) has become a practical way to provide ductility during both compressed post-peak softening behaviour and tensioned post-cracking behaviour. It has been discovered that using SFRC as a structural part also somewhat increases its ductility, which may make it a better material when subjected to seismic loads. Steel fiber reinforced concrete (SFRC) stands out for its high tensile strength, resilience to impact, resistance to fatigue, ductility under flexure, and capacity to stop cracks. Additionally, they lessen concrete's permeability, which reduces water leaking. It is true that such a building material has been investigated for the construction of pavement for more than 40 years. For the purpose of comparing the effectiveness of SFRC to conventional concrete, numerous experimental studies have been conducted in the past to gather information on the impact of steel fibre and its combination on workability, compressive strength, flexural strength, and non-destructive testing (NDT), such as rebound hammer. Steel Fiber comes in a wide variety of forms, although the most commonly used forms are conventionally straight, hooked, crimped, and coned. The modeling of SFRC in the current framework uses a variety of mechanical characteristics of steel fibres with hooked ends.

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ANGALAM COLLEGE OF ENGINEERING  
Kottayam



# SEISMIC BEHAVIOUR OF MULTISTORY BUILDING RESTING ON INCLINED GROUND USING ETABS

Noufal KT<sup>1</sup>  
Student,

Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, India

Lulu K Makkar<sup>2</sup>

Assistant Professor  
Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, India

Nimisha Annie Abraham<sup>3</sup>

Assistant professor  
Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, India

**Abstract**— A building with abnormality is considered within the arrange or as well as within the vertical abnormality of the building. The structural inconsistencies are considered as one of the most reasons for its disappointment. The auxiliary outlines having an amalgamation of assortments of abnormalities, such as stomach, mass, solidness, quality, torsional inconsistency, vertical, etc. Too, for the investigation of these sorts of structures, it is fundamental to carry out the energetic investigation to decide the maximum energetic reaction of the building. Since it would be extreme to urge the time history record for all the places beneath the ponder, it is feasible to go with Reaction Range Examination. In this project work, inconsistency in a building is said to be a building which is having inconsistency within the arrange of the building. i.e., arrange inconsistency. Here an unpredictable building of G+11 is analyzed for the seismic reaction. A case consider of G+11 building resting on ordinary ground and inclining ground of shifting inclines are being analyzed in this venture work. A G+11 RCC Step back building having each story of stature 3.6m with a even point of slant 20°, 30°, 40°, and 45° on the slanting ground and typical ground is analyzed in seismic zone V by Reaction Range strategy. The investigation is done as per IS 1893-2016, IS 456-2000, IS 875 (portion 3)-2015. The examination and demonstrating is done by utilizing ETABS 9 program. The seismic investigation is done by utilizing Reaction Range Examination strategy. By this investigation the energetic reaction properties like story diversion, story float and story shear can be found out.

**Keywords**— *Seismic Analysis, Response Spectrum Method, Step back building, Vertical Irregularity, Plan Irregularity, Dynamic analysis, Diaphragm irregularity, Sloping Ground, Seismic Zone V, IS 1893:2016, ETABS 9, Response Spectrum Analysis method, Storey deflection, Storey drift, Storey shear.*

## INTRODUCTION

Within the uneven districts buildings are for the most part built on slanting ground. When the uneven regions are beneath the seismic zones, these buildings are exceedingly uncovered to seismic tremors. The behavior of buildings within the course of seismic tremor depends primarily upon the allotment of

mass and firmness in both even and vertical planes of the buildings beneath ponder. In sloping locale both the vertical and level properties change with inconsistency and lopsidedly of the structure. At the show time, due to the shortage of plain ground numerous RCC buildings such as inns, private buildings, schools, colleges, healing centers etc. are for the most part developed on slope inclines having a few auxiliary abnormality. So, it is fundamental to explore the seismic execution of these buildings and the solidness of the ground where the building is to be constructed. In hilly districts, locally accessible ordinary fabric just, like the adobe, brunt brick, stone stone work and dressed stone stone work, timber fortified concrete, bamboo, etc., is utilized for the development of houses. Subsequently, the activity of buildings amid seismic tremor depends upon the allotment of mass and firmness in both even and vertical planes of the buildings, both of which shift in case of sloping zones buildings with inconsistency and asymmetry due to step back outline and step back & set back outline course of action of the buildings. Such developments in seismically powerless ranges makes them uncovered to more noteworthy shears and torsion as compared to conventional sort of development.

The buildings built in uneven locales are primarily built in stone work with mud mortar or cement mortar without fulfilling to seismic codal arrangements which have appeared hazardous and continued in misfortune of life and property when subjected to seismic tremor ground movements. The endless financial development and quick urbanization in sloping regions have sped up the genuine bequest advancement of the nation. Due to this tall populace thickness within the uneven locale has increased very quickly. Subsequently, there's celebrated and squeezing require for the development of multistorey buildings on uneven slopy districts in and around the cities of our nation. It is seen amid the past seismic tremors, buildings in sloping locales have finished tall degree of hurt driving to disintegrate in spite of the fact that they have been arranged for security of the inhabitants against common fiascos. Subsequently, whereas receiving the execution of multistorey buildings in these sloping and seismically inclined



# AN EXPERIMENTAL STUDY ON THE UTILIZATION OF WASTE MARBLE DUST POWDER IN MANUFACTURING OF M20 GRADE CONCRETE BLOCKS

Divya Anna Saju, Aparna Biju  
Aditya A, Ahammed Salman  
Mangalam College Of Engineering, Ettumanoor,  
Kottayam, India

Ms. Geethu Lal  
Assistant Professor  
Mangalam College Of Engineering, Ettumanoor,  
Kottayam, India

**Abstract**—Most environmental problems are mostly from wastes created from various industries. Global warming is mainly caused by the greenhouse gases mainly CO<sub>2</sub>. Marble dust powder (MPa) is a material which is growing industry that enables the concrete industry to generate financial benefits, optimize material use and construct systems that can be strong, durable and environmentally sensitive. MDP is obtained at a certain stage of mining from the original marble rock. The dumping of marble powder from the marble enterprise is one of the main reasons for the environmental problems and pollutions worldwide. The capacity utilization of marble dust powder can be an excellent advantage of the substitute in cementitious binder. For this reason, the reuse of this waste material can be targeted. Today, MDP helps in achieving economy by improving the properties of concrete and is an advanced opportunity for a concrete element to impart excessive strength by adding this MDP. In this experimental observation, the effect of marble dust powder in concrete on strength is presented. Concrete mixtures containing 0%, 5%, 10%, 15% and 20% marble dust powder were prepared to replace cement. The cubes were casted and the compressive strength and tensile strength of the different concrete mix specimens were tested. When the percentage of marble dust powder added increases the workability of the various mix specimens decreases. The use of powdered marble has other benefits such as it reduces the cost of construction, when used while mixing it with concrete for the construction of floors, whitewashing, other systems and it reduces the proportion of water-cement ratio.

**Keywords** - Cement, concrete, compressive strength, split tensile strength, water cement ratio, Marble dust powder.

## I. INTRODUCTION

One of the carbon dioxides emitting assets besides deforestation and burning of fossil fuels is the Cement manufacturing industry. The emission of greenhouse gases, which includes CO<sub>2</sub>, to the atmosphere creates global warming. The various greenhouse gases, CO<sub>2</sub> contributes about 65% of world warming. the worldwide cement enterprise contributes about 7% of greenhouse CO<sub>2</sub> emission to the earth's environment. On this have a look at marble dust powder are used as an alternative binder of cement in concrete and comparing the samples with various mix proportions of cement with MDP with conventional concrete. The marble manufacturing industries produce carbon dioxide emission which is a greenhouse gas which leads to global warming. Its purity effects for its shade and appearance. A huge amount of waste is generated and leaving those at once to environment causes intense problems. Feasibility of the usage of the marble dust powder as partial alternative of cement in concrete production as is studied on this project.

## II. OBJECTIVES

To examine the properties of marble dust powder with cement and the compressive and tensile strength alongside the variation in MDP. To take a look at the outcomes of marble dust powder on the different properties of concrete. To examine the possibility to incorporate MDP as filler in concrete. To discover the most desirable percentage for substitute of cement with MDP at which maximum strength is obtained.





## HUMAN HAIR FIBRE REINFORCED CONCRETE

Dr. G. Anand  
 Assistant Professor  
 Department of Civil Engineering  
 Mangalam College of Engineering,  
 Ettumanoor,  
 India

Mrs. Nimisha Annie Abraham  
 Assistant Professor  
 Department of Civil Engineering  
 Mangalam College of Engineering, Ettumanoor,  
 Kottayam, India  
 Email id: nimisha.abraham@mangalam.in

A sustainable and affordable solution for overcoming various types of inadequacies is provided by fibre reinforced concrete. Fibre helps concrete make up for its low tensile strength. Human hair is utilised here as a fibrous material. It is an inexpensive and non-biodegradable material. It also lessens environmental issues. Various percentages of human hair fibre, 0.5%, 1%, 1.5%, and 2% by weight of cement, were added in experiments on concrete cubes, beams, and cylinders of typical sizes. At 7, 14, and 28 days, the mechanical parameters are measured for changes in compressive strength, split tensile strength, and flexural strength and are compared to plain cement concrete.

*Fibre reinforced concrete, Human hair, Compressive strength, Split tensile strength, Flexural strength, Density, Non-biodegradable.*

### I. Introduction

Concrete is a typical building material. It is ductile and has high compressive strength. Fibrous material is present in fibre reinforced concrete, which improves structural integrity and is more and more significant. A fibre is a tiny particle of fibrous material with a specific set of properties. The quantity and proportion of the fibres have a considerable impact on the mechanical characteristics of the concrete, which are improved by their addition. Concrete's tensile strength is low thus fibres are added to increase it while also improving the durability of building materials. Concrete uses fibres to prevent cracking. Additionally, they lessen concrete's permeability, which in turn lessens water leakage. The fiber's aspect ratio is determined by the relationship between its length and diameter. Among various fibres, it has a distinct value. It was discovered that fibre reinforced concrete with a high aspect ratio performed better.

In concrete, hair is utilized as a fibre reinforcing material. Its strong tensile strength is comparable to copper wire of a comparable diameter. It is a cheap material that is non-degradable. By strengthening it, the mortar is kept from bulging. The presence of various types of human hair in different parts of our nation may be the result of environmental change as a waste product. Individual differences exist in terms of thickness and stiffness. It disrupts our ecosystem and causes several environmental problems. The environment is being negatively impacted by this. This study's major goal is to investigate if human hair can be used as a fibrous material to

enhance the mechanical properties of concrete. Various percentages of human hair fibre, 0.5%, 1%, 1.5%, and 2% by weight of cement, were added in experiments on concrete cubes, beams, and cylinders of typical sizes. At 7, 14, and 28 days, the mechanical parameters are measured for changes in compressive strength, split tensile strength, and flexural strength and are compared to plain cement concrete.

### II. Materials used

- 1. Cement:** Cement is mainly used as a binding ingredient in concrete mix. It gives high strength to structural elements. It has high resistance to cracking and shrinkage. The cement used here is Ordinary Portland Cement (OPC) having grade 33 and the specific gravity of the cement is 3.06.
- 2. Fine aggregate:** Any naturally occurring sand fragments that are taken from the soil by mining are considered fine aggregates. These are particles that are retained in a 0.075mm sieve after passing through a 4.75mm sieve. It helps to make concrete mix more compact. The fine aggregate used here is sand and is obtained from grading zone III.
- 3. Coarse aggregate:** A coarse aggregate is a particle with a diameter greater than 0.19 inches, which commonly ranges from 3/8 to 1.5 inches. Examples of coarse aggregates, which are granular and uneven materials used to produce concrete, include sand, gravel, or crushed stone. It provides a strong connection between cement paste and finer material. It provides durable and stable building material.
- 4. Human hair:** Human hair is used as a fibre here and is of length 60mm. Hair improves the performance of concrete by improving its mechanical properties. It has high tensile strength and is also easily available. The hair is collected from different saloons in Kottayam. It is treated before adding to the concrete specimen (Separating, washing, drying and sorting).



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 Ettumanoor



# EXPERIMENTAL INVESTIGATION ON THE REUSE OF POLYPROPYLENE FIBERS FOR ADVANCING ON CONCRETE STRENGTH PROPERTIES

Akshara Nair, Blitto M Kuruvilla  
Cyril George  
B. Tech Students  
Dept of civil engineering  
Mangalam college of engineering  
Ettumanoor, Kottayam India

Aksharamol G Raj  
Assistant professor  
Mangalam college of engineering  
Ettumanoor, Kottayam India

**Abstract**—covid 19 pandemic resulted in the enormous growth in the use, production and disposal of PPE, face mask, gloves, face shield etc... plastic pollution to the environment is a major concern that is increasing due to the negligence of the waste management by human. After covid-19 health pandemic it created an extra pressure on the regular waste management system personal protective equipment. PPE is the main medical waste generated during the pandemic. It led to the inappropriate waste management. PPE kits are made of polypropylene plastic that are non biodegradable like any other plastic which take 20 to 30 years and thus it is essential to develop a reusing approach of polypropylene in the various ways. In this paper we discuss the study procedure to utilize the polypropylene waste to effectively reuse in the concrete mix. The main objective of the study was to investigate the effectiveness of polypropylene in concrete mix to modified the mechanical properties. The different properties such as tensile, compression, flexural strength is compared with conventional concrete mix. The PPE were added by the volume of 0%, 5%, 1%, 1.5%, 2% and 2.5%. It is observed that PPE waste composite has better performance as compared to conventional concrete mix. This study is expected to enhance a new sustainable approach to utilization of polypropylene waste to concrete mix in the construction sector

**Keywords**-Concrete, Compressions strength, Split tensile strength, Flexural strength, PPE

## I. INTRODUCTION

Plastic has become a major threat to natural Ecosystem. The global massive production of plastic is more than million tons and it limit the capabilities of waste management. After covid 19 outbreak consumption of plastic as personal protective equipment are vulnerable and contagious. during the corona virus health pandemic PPE personal protective equipment is used by the health care professionals and workers for the prevention against the virus. The use of PPE has emerged as a most preventive control measure to keep the covid 19 transmission. PPE consist of polymers and materials like polypropylene which are plastic which take years to be degraded. The enormous

usage of PPE will lead to massive generation of waste due to its single usage. one of the innovative way of managing waste of polypropylene from PPE is utilization along with the existing construction material. it is way of ecofriendly approach because the major problem occur in contagious waste produced after the single usage of PPE which is the root cause of severe environmental problems and health threat. Therefore, it is essential to integrate and reuse the plastic waste like polypropylene converted to product with relatively longer life time. In this work PPE waste been used as a material along with commonly used concrete construction mix. various strength and durability properties were assessed and result are compared with existing concrete mix. Nowadays sustainable development is a highly concern. It is approachable method adopted to benefit the polypropylene fibers by reusing it in construction material by applied to concrete mix to improve the mechanical properties as well as converting the brittle to ductile nature

## II. OBJECTIVE

The objective of our study is to compare the compressive strength, flexural strength and tensional strength of conventional concrete mix and the effect of concrete mix made by utilization of polypropylene fibers and their impact on the concrete properties

## III. MATERIALS

**1. Cement:** OPC grade 53 cement was used for the experimental work as per The following test were conducted on the cement as per IS standard Given in the table 1.



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# DEVELOPMENT OF CONCRETE BRICK USING RECYCLED PLASTIC AND GLASS WASTE

Akhil Mathai Varkey, Amaan Sajan,  
Aparna B Prasad  
B.Tech students  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam India

Athira Jacob  
Assistant professor  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam India

**Abstract**— The management of garbage is a critical issue in the modern world, particularly with regard to plastic and glass waste. Thousands of tonnes of plastic and glass are thrown in the trash every day, yet there aren't enough treatment and recycling options. Every day, a significant amount of plastic is thrown away or burned, contaminating the ecosystem and the atmosphere. Plastic trash buildup in the environment poses a threat to both plant and animal life. Recycling plastic and glass garbage after their useful lives are through while generating economic value and causing the least amount of environmental harm is the secret to their sustainable management in a circular economy. Bricks are a common building material used to make masonry structures like walls and pavement. Numerous research has been conducted on concrete that has been saturated with waste plastic and glass fiber, with positive outcomes and many benefits. Numerous testing have been carried out to manufacture eco bricks, including compression tests and water absorption tests.

**Keywords**—bricks; compression testing; water absorption testing

## 1.INTRODUCTION

One of the oldest and most common building materials is brick. Depending on their size, color, texture, origin, materials utilized, and forming process, the many varieties of bricks available on the market are employed. Bricks are an important component of industrial production processes in addition to being utilized in the construction of buildings. Plastic is a versatile, sturdy, and fairly priced material. These characteristics have led to the development of numerous products that are advantageous to society in terms of economic activity, employment, and level of living. Utilizing these waste materials is one way to address ecological and environmental problems. A such substance is glass, which is produced from raw materials like sand. Despite the fact that most glass debris is recycled in order to manufacture new glass products. Non-biodegradable and useful resource glass takes up valuable landfill space. In order to lessen the amount of glass waste

dumped in landfills, alternative recycling techniques must be investigated. The use of plastic and glass in such materials not only promotes their utilisation but also decreases the cost of making concrete and has other indirect advantages, including cheaper landfill costs, energy savings, and environmental protection from potential pollution consequences. Only a very small portion of it is recycled, most likely as a result of a lack of funding or a low level of interest in recycled plastic garbage. As a result, the majority of it is often burned or deposited in landfills. Such actions have a damaging impact on the environment at a time when the globe is concentrating its efforts on combating pollution and environmental challenges like global warming.

## 2.OBJECTIVE


To contrast the compressive strength and water absorption of standard concrete brick with bricks constructed using glass and polypropylene waste.

## 3.MATERIALS

**1.Cement:** OPC grade 53 cement was used for the experimental work. According to IS standards, the cement was put through the following tests.

TABLE 1: Test on the cement

Sl. no	Tests	Result
1	Fineness	9%
2	Standard consistency	32%
3	Initial setting time	Less than 30 minutes
4	Final setting time	10 hrs
5	Specific gravity	3.06

  
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# RUBBERIZED GEOPOLYMER CONCRETE

Sanjay P Kailas, Sreelakshmi Suresh  
Siju Varghese Biju, Sebin Sabu  
B.Tech Students  
Department of Civil Engineering,  
Mangalam College of Engineering, Ettumanoor  
Kottayam, India

Dr. Arun Kumar  
Professor  
Department of Civil Engineering,  
Mangalam College of Engineering Ettumanoor  
Kottayam, India  
Email id: arun.kumar@mangalam.in

**Abstract:** This experimental study deals with the optimization of rubberized geopolymer concrete replacing crumb rubber waste as replacement of coarse aggregate (CA) partially in varying proportions (5%, 10%, 15%, 20%, 25%). In this experimental study, properties of concrete like workability and mechanical properties of hardened geopolymer concrete such as compression strength, Tensile strength and flexural strength were analysed to determine the strength parameters of rubberized geopolymer concrete mix. Nowadays, the construction field is addressing the issue of integrating sustainability into the production processes for the past few years. This was done by using solid waste materials as aggregates in concrete or by looking for more environmentally friendly raw materials. Incorporating used tyre rubber into geopolymer concrete to replace natural aggregate is one of the potential uses for the material. To reduce the greenhouse gas emission caused by ordinary portland cement, the cement is fully replaced by combination of cementitious materials like ggbs and pozzolanic materials such as flyash that have been alkali activated. To protect the construction field from the depletion of natural resources, natural sand is replaced by manufacturing sand. The paper focuses to develop a process to not only eliminates the binder like Ordinary Portland Cement, but also eliminates water curing and consumes diminished quantity of natural Sand - a product of restricted natural resources. The mix design is calculated, casted and tested at 7 days and 28 days. Obtained results were calculated and analyzed that there is a reduction in strength parameter by the increment in rubber crumb content. From 5%-25%, 15% of rubber crumbs in geopolymer shows the optimum mix when differentiate to conventional portland cement concrete mix. Our project aims to bring out an advanced concrete material that is sustainable, economical, eco-friendly after all meeting the strength criterias for the construction industry.

**Keywords:** Rubberized geopolymer concrete, Geopolymer concrete, Rubber tyre crumbs, Flyash, Ground Granulated Blast-furnace Slag (GGBS), Alkaline Activator solution.

## I. INTRODUCTION

In field of construction, concrete are the most extensively utilized building material and the primary component of the concrete is Portland cement. Carbon dioxide (CO<sub>2</sub>) emissions from cement manufacturing contributes considerably to atmosphere's green-house gases emission. A tonne of CO<sub>2</sub> is thought to be discharged into the surroundings for every tonne OPC production. The annual global cement output is 2.6 billion tonnes. It takes a lot of limestone to make cement, and that supply is now quickly running out. In addition, a significant amount of fossil fuel is used to the production of limestone. Alternatives to OPC are continually researched to

address this issue. But a significant amount of it still poses a threat to the environment.

In order to preserve natural resources and work towards using substitute materials that don't consume a lot of energy as the leading future demands the use of sustainable and environmentally friendly construction materials and methods, while nevertheless supporting the same anticipated structure performances & constructional purposes. The main adhesive & binder in building combinations is often cement. Without sacrificing the necessary cementitious qualities, using wastes and substitute binder materials in the optimisation of materials like concrete will create reduction in greenhouse gas formation. These substitute binders emphasize combining basic components and fuel obtained from waste. The switch to employing geopolymer concrete as alternative to regular Portland-cement-concrete is one of the alternatives that has been offered that outperforms traditional concrete. Davidovits found that some primary calcinated kaolinite ( flyash, ggbs, metakaolin etc), calcinated clays, may then used with alkaline solution to activated to produce products that are similar to hardened ceramics at temperatures below 100°C. Because of this finding, geopolymerization has advanced. J. Davidovits' development & research and leads for production of 1st geopolymer cement in the 1980s, that were based on slag. Rockbased geopolymer mix, flyash-based geopolymer mix, ferrosialate based geopolymer cement mix, and Slag based geopolymer cement were the few models for the geopolymer concrete kinds. To improve sustainability, this method was created to produce sustainabled concrete & less cement masonry utilising reprocessed resources, According to research, manufacturing geopolymer concrete creates CO<sub>2</sub> release which were 5x lesser than of normal cement concrete. Fly ash were among the top ingredients used to make geopolymer concrete. The advanced strength attaining property of fly-ash geo-polymer concretes showed delayed growth on addition to a reduction in the heat- of-hydration of concrete, by which it minimises thermal crack action. Fly ash configuration were particularly affluent in silicon & aluminium elements. Yet there are other techniques to accelerate the growth of strength, like employing high-temperature curing or using slag elements. The steam curing during the use of flyash can be partially substitute by adding slag content such as GGBS.

Ground-granulated blast-furnace-slag were the waste material produced from industry deals with steel. The use of hydroxides & nitrates of sodium solution by alkaline liquids retort with GGBS & fly ash for generating bonding gel polymer with aggregates for make GPC. Non-metallic



# AN EXPERIMENTAL STUDY ON THE USE OF PLASTIC WASTE IN PAVER BLOCKS

Ivin Jacob, Jimil Thomas,  
Riswan Rasheed P.T, V Aadithy  
B.Tech Students  
Civil Engineering Department  
Mangalam college of engineering  
Kottayam, India

Ms. Anila Mary Jacob  
Associate professor  
Mangalam college of engineering  
Kottayam, India

**Abstract**-Daily plastic waste disposal is a necessity for solid waste management. As a result, this study looked into the possibility of using plastic waste to create paver blocks for a pedestrian walkway. A trial mix was used to develop paver blocks made of recycled plastic in order to determine the best way to make paver blocks. The goal of this project is to study the properties of pavement blocks-made from recycled waste plastic. Pavement blocks are ideal for straightforward laying and finishing on pathways as well as streets. Here, the design considerations for pavement blocks incorporating waste plastic bags and the strength characteristics of pavement blocks made of waste plastic are presented. The environment and modern society will benefit from it. Utilising plastic in construction fields with minimal additions is the main goal.

**Keywords:** Plastic paver blocks, Plastic waste.

## I. INTRODUCTION

Municipal Solid Waste (MSW) includes plastic as one of its major constituents, and efforts to recycle plastic waste have led to extensive research projects, like those in concrete blocks. Plastic waste was also looked into for its potential to replace aggregate or cement to create concrete blocks with value-added performance in

addition to sustainability. The properties of the concrete can be slightly or significantly altered by the addition of recycled plastic. Recycling wastes can help cut down on the production of solid waste, as well as pollution and other risks. Making composite materials, for instance, is a creative way to get rid of plastic waste.

All over the world, concrete is a common building material. The three most typical components of concrete are cement, sand, and coarse aggregate. Concrete is extremely useful, but as time goes on, it is running out, making it necessary to look for alternatives.

In India, pavement technology has been used for parking lots and footpaths for many years, and it now serves a variety of purposes. This project conducts tests on properties like compression and oven performance. The raw materials used in this paver block are more readily available and affordable than those used in conventional paver blocks, including cement and readily available aggregates.

Karma Tempa, Nimesh Chettri, Gautam Thapa, Phurba, Cheki Gyeltshen, Dawa Norbu, Dikshika Gurung (2022)- an experimental investigation was carried out to recycle plastic waste as a substitute to cement as a binding constituent. Also, it reduces carbon footprint and reduces environmental pollution and health hazards. The maximum mass loss of 70.33



# Prediction of Optimum Geopolymer Concrete Mix With Various Methods

Aleena Alan , Arathi S ,  
Bikku Biju , Febina V Shaji  
B.Tech Students  
Department of Civil Engineering  
Mangalam College of Engineering  
Kottayam India

Dr. K Arunkumar  
Associate Professor  
Department of Civil Engineering  
Mangalam College of Engineering  
Kottayam India

**Abstract**— By chemically activating industrial waste byproducts including Bottom Ash, Flyash, GGBS, Wood Ash, Metakaolin, and others using alkali activator solutions, Geopolymer Concrete (GPC) has been created. It should be noted that the binding substance contains a suitable amount of aluminium silicate. The potential for the geopolymer concrete to replace OPC concrete is greater. The binders, such as GGBS and wood ash, are employed for the geopolymer mix at varied ratios from 0% to 100% as part of this experimental inquiry. Alkali-binder ratio, alkali activator component ratio, and concentrations are just a few of the GPC factors that are used in different combinations. According to the findings, the mixture should contain 0.55 alkali to every 70 percent GGBS and 30 percent wood ash at a 14M concentration for achieving maximum values for strength properties. We may infer that GGBS has a significant role in the higher values of the strength characteristics of the geopolymer mix. Due to the low cost of these byproducts, geopolymer concrete's widespread use will result in a very lucrative construction material that is also environmentally friendly.

**Keywords:** Geopolymer concrete, Sodium silicate, Sodium hydroxide, Wood ash, Ground Granulated Blast Furnace Slag, varying parameters

## 1. INTRODUCTION

The cement acquires the position of being the most utilized product in widespread in all over the world. When combined with water, fine and coarse aggregate, and other binder materials, liquid cement is primarily used as the binding agent in concrete. This is so that the cement, when mixed with other concrete ingredients, may function very effectively as a binder material. The cement may provide the structural component formed of cement concrete with high workability, fresh concrete qualities, and mechanical properties. When producing clinker, an intermediary product in the cement manufacturing process, carbon dioxide emissions are released into the environment. Carbon dioxide is released into the atmosphere as a result of the excessive production of cement in every corner of the globe, which may speed up the greenhouse effect and eventually result in global warming. According to research and publications, it is clear that the manufacture of cement on a global scale contributes significantly to the increased rate of CO<sub>2</sub> in the atmosphere. In other words,

excessive cement production is to blame for 8% of the world's CO<sub>2</sub> emissions. Therefore, finding an alternative to cement as a binder ingredient is important. As an equivalent for Portland cement concrete, geopolymer concrete is now popular in the construction sector in general. Making applications for precursor materials with an alumina silicate composition as well as an alkali activator solution allows for the production of geopolymer concrete. This study focus attention on green approach that can be implemented by exchanging any current materials with a different option materials that might deliver the same efficient functions.

## 2. OBJECTIVE

For achieving the optimum proportional mix of GGBS - Wood ash geopolymer concrete at varying percentage proportions of binders, varying molar concentrations of activator solution with varying ratios and at varying ratios of activator to binder ratios by means of mechanical properties.

## 3. MATERIALS

**1. Ground Granulated Blast Furnace Slag:** Ground Granulated Blast Furnace Slag (GGBS) which is a byproduct that is obtained during the steel and iron manufacturing process. It is used as a major binding material which consist of silica and alumina content.

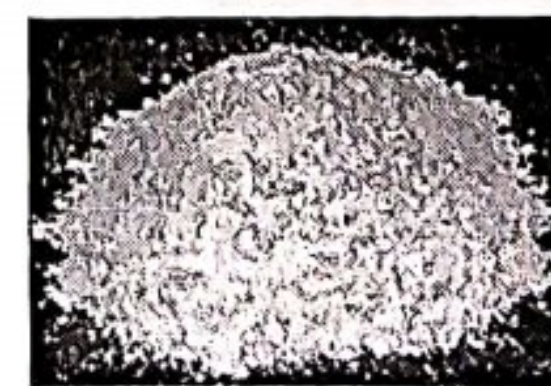


Figure 1 : GGBS

Table 1: Properties of GGBS

No	Properties	Value
1	Colour	Off white
2	Specific gravity	2.83
3	Fineness	7%
4	Bulk Density	1220 Kg/m <sup>3</sup>



# PARTIAL REPLACEMENT OF FINE AGGREGATE USING WASTE TYRE RUBBER IN CONCRETE

Aiswarya P, Ajith V  
Arathy Raj R, Avani S  
Mangalam College Of Engineering  
Ettumanoor, Kottayam India

Richu Varghese George  
Assistant Professor  
Mangalam College Of Engineering  
Ettumanoor, Kottayam India

**Abstract**— The use of waste tyre disposal is crucial for environmental issues. It is suggested that rubber granules might serve as a lightweight alternative to fine aggregate. These waste products can be employed to enhance the ductility and fracture resistance of concrete, among other mechanical attributes. The compressive and tensile strengths of concrete containing rubber granules are examined during periods of 7 days, 14 days, and 28 days. These mixes were compared to natural concrete, and the behaviour of the rubber granules in the concrete was observed. This concrete mixer treats waste rubber with a replacement proportion of fine aggregate. Rubber granules were substituted with natural fine aggregate in amounts of 5%, 10%, 15%, 20%, and 25%. The suggested approach stimulates the use of recycled rubber in concrete and is simple to implement by the precast industry to produce precast concrete goods that contribute to environmentally friendly and sustainable buildings.

**Keywords:** Rubber concrete Compressive strength Compressed rubber concrete

## I. INTRODUCTION

One of the major problems facing the entire planet is the excessive dumping of trash. Because waste tyres take a very long time to disintegrate, even after extensive usage, their disposal is a serious issue. Rubber products may also be made using waste rubber as a raw material. Cement, coarse aggregate, and fine aggregate are used to create concrete. Due to the high demand for concrete as a building material, it is necessary to use substitute materials that may be obtained from recycled or waste materials in order to protect the natural coarse aggregate.

Rubber is inexpensive compared to other components of concrete and is easily accessible in the form of old tyres. Waste tyre disposal and burning are exceedingly complex and polluting processes. Concrete that has been rubberized can be used to make lighter concrete. Cement is a material that is widely used in building. The use of tyre granules as a partial replacement for fine aggregate in concrete is one of the various methods suggested for using used tyres.

## MATERIALS

The cement used for the paper is Portland pozzolana cement and coarse & fine aggregate are recently used along with rubber granules. The reference grade of concrete used is M35 grade rubber granules is a recycled rubber produced from automotive and truck scrap tires higher content of waste tyre crumb rubber particles used in concrete increases workability of concrete and produces the lightweight concrete here fine aggregate is partially replaced using rubber granules. The percentage replacement of natural fine aggregate with rubber granules was 5%, 10%, 15%, 20% and 25%.

TABLE 1 : Test on the cement

SI no	Name of the test	Result
1	Fineness	9%
2	Standard consistency	32%
3	Initial setting time	Less than 30 minutes
4	Final setting time	10 hrs
5	Specific gravity	

TABLE 2 : Test on fine aggregate

SI no	Name of the test	Result
1	Specific gravity	2.65
2	Particle size distribution	Zone 3, Fineness modulus 2.76, Uniformity coefficient 2.5
3	Bulking of sand	Max bulking 35.2%, Water content at max bulking 7%
4	Water absorption	1.25%

TABLE 3: Test on coarse aggregate

SI no	Name of the test	Result
1	Specific gravity	2.65
2	Grain size analysis	Fineness modulus 5



# Experimental Study on Physical Properties of Bitumen Using Waste Engine oil And Waste Cooking Oil

Athira Haridas<sup>1</sup>

Student,

Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, India

Chichu Babu<sup>2</sup>

Student,

Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, India

Geethu Subash<sup>3</sup>

Student,

Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, India

Vidya Mohan<sup>4</sup>

Assistant Professor

Department of Civil Engineering,  
Mangalam College of Engineering,  
Ettumanoor, India

**Abstract**— Amount of Waste engine oil (WEO) and Waste cooking oil (WCO) has been increased in large quantities as a result of growth in automobile and increase in today's lifestyle. As waste oil disposal is heavy task in the current society as it leads to many environmental issues. The generic structure of bitumen is similar that of the waste oil, so it can be used in highway construction to decrease the hardening effect of reclaimed flexible pavement materials. Through this experiment, five different ratios of Waste engine oil and Waste cooking oil is blended with VG40 bitumen and bituminous tests like Penetration test, Viscosity test, Softening point test, Ductility test were performed. The physical properties of bitumen is improved when treated with this waste oils. According to this test results, 3% of WEO and WCO gives the optimum results. Mixing of high amount of bitumen shows a varying change of trend in case of bitumen grade.

**Keywords**—Waste engine oil; waste cooking oil; Bitumen

## I. INTRODUCTION

The development of automobiles and the rise in living standards in society have resulted in massive productions of waste cooking oil (WCO) and waste engine oil (WEO). The amount of WEO being produced globally is rises along with the number of automobiles on the road. Continuous engine operation causes the oil's performance destroy with time, making it harder and harder to recycle used engine oil (WEO) into new vehicle oil. Engine oils are petroleum remains, such as used motor oil from garage, as it reflects many physical and chemical properties of bitumen. Additionally, as food production has increased in response to a rise in population, there is a significant increase in the amount of kitchen waste produced. We are aware that one of the most often used kitchen supplies is cooking oil, which may be made from a variety of materials including plant and vegetable oils, animal fats, and a number of other sources. Waste cooking oil (WCO) can be collected from many sources, mainly from frying shops after frying and cooking process when various eatable

vegetable oils, animal oils, and palm oil are utilized. Due to their ability to destroy rivers and other natural resources, WEO and WCO have become significant environmental contaminants. The rightful removal of this waste oil is crucial since it could make existing regional and national environmental issues worse. The waste oil is huge threat to the environment so that it is treated before the disposal into rivers or streams. From the survey done by International Energy Agency, India uses 102 billion liters of fuel annually and uses 23 million tons of edible oil. WEO burning will release lots of pollutants that are airborne in atmosphere and may cause lung related diseases in the society and have detrimental effects on their health. After four batches of frying, food business operators (FBOs) are obligated to dump the cooking oil, because it increases the health issues.

According to research, the comparable molecular structures to bitumen, WEO and WCO have the potential to be employed in road building to reduce the impact of hardening on recycled flexible pavement materials after being reused. Asphaltenes, aromatics, resins, and saturates are the four fractions which make up bitumen, a result of distilling the petroleum product. The most plentiful element is water-soluble, followed by aromatics and resins. The two general groupings that are most frequently observed are maltenes and asphaltenes, which can be used to categorise the compounds. Asphaltenes are made up of resins and saturated and aromatic compounds, whereas maltenes, which are also soluble in n-heptane, are made up of resins and saturated and aromatic compounds. Asphaltenes are the components that are dark in colour, insoluble in n-heptane, and have the highest potential and molecular weight.

Here five different ratios of Waste engine oil and Waste cooking oil is blended with VG40 bitumen and different bituminous tests like Penetration test, Viscosity test, Ductility test, Softening point test were performed. The use of waste oil in bitumen increases the physical properties of the bitumen. Therefore, properly turning waste material qualities into ecologically conscious products can be achieved through the



# Dairy Waste Water Treatment by using Natural Coagulants

Namrata S Naragundakar  
Department of Civil Engineering,  
Jain Institute of Technology, Davanagere.

Naghma-N  
Department of Civil Engineering  
Jain Institute of Technology, Davanagere.

Mohan Naik B  
Department of Civil Engineering,  
Jain Institute of Technology, Davanagere

Padmavathi V  
Department of Civil Engineering,  
Jain Institute of Technology, Davanagere.

Basanth Kumar U  
Department of Civil Engineering  
Jain Institute of Technology, Davanagere.

**Abstract**— The dairy industry uses massive amounts of water to process raw milk for dairy products and generates roughly 3L of waste water per 1L of processed milk. The waste water discharge from this dairy industry contains a high concentration of organic material such as fats, carbohydrates, grease, protein, etc. Due to pollutants available in dairy waste water, if it is not properly treated then it may cause serious environmental issues. The present study focuses to treat Dairy Waste water with environment friendly natural coagulants like Moringa Oleifera, Neem leaves, Saw dust, Custard Apple seeds are in powdered form resulting an effective natural agent that is modification for highly turbid and untreated pathogenic water. Various doses of natural coagulants are evaluated for the efficiency of dairy wastewater treatment. On comparison various parameters like of TDS, chloride, pH, turbidity obtained for each coagulant. It was observed that moringa Oleifera seed powder showed best results with effect of pH varies as 9.08 – 4.42, TDS varies from 5.02 – 4.38 ppm, turbidity varies from 162 – 44.6 NTU are experimental found out with the extension. By varying dosage of coagulant that is Moringa oleifera seeds is recommended as eco friendly non toxic coagulant for dairy waste water treatment.

## 1. INTRODUCTION

Water is key substance for natural and human activities. Water is tasteless, odorless and nearly colorless chemical substance which is the main constituent of earth's streams, lakes and oceans. Which are used for drinking, industrial water supply, irrigation, water recreation for many other uses including being safety returned to environment. Dairy market volume world wide USD 489.74 billion. Global cow milk production volume per year 600 million metric tonnes. With 60% of the world population, Asia accounts for only 22% of global milk production. The total world production is more than 530 million tonnes for a population of about 400 billion amounts to an average annual per capita availability of 100Kg.

India is rank 1st in milk manufacturing contribution 23 in step with cent of world milk manufacturing. Milk manufacturing withinside the us of a has evolved at a

composite annal boom charge of approximately 6.2 percentage attain 209.ninety six million tonnes in 2020-21 from 146.31 million tonnes in 2014-15. However, over 3% near five million tonnes of milk get wasted because of unreliable power supply.

Karnataka daily produces of an estimated milk of 1.6 crore liters of milk, of which about 1.2 crore liters is "marketable supply". KMF procures about 80 lakh liters, which translates to almost 70% of the milk produced. Before the introduction of the incentive scheme, KMF procured roughly 50% of the milk products in the state such as ice-cream, peda, ghee, butter, and so on. With the lock down in place, barring ghee and butter, there is no market for the rest of its bouquet of products, resulting in stocking up of unconverted milk. At present, 13484 dairy co-operative societies are functioning, with in the limit of 14 district milk federations, 23.78 lakh formers are enrolled as members, out of which 8.37 lakh formers are active members. The first of the dairy cooperative that make up KMF started in 1955 in kudige, Kodagu district. KMF was founded in 1974 has Karnataka dairy development co-operation (KDDC) to implement a dairy development project run by the World Bank.

## 2. OBJECTIVES

To study the characteristics of dairy waste water.

1. Preparation of natural coagulants like Moringa Oleifera seeds, Custard Apple, Neem Leaves, Saw Dust into powder form.
2. Using different dosage of natural coagulants for dairy waste water treatment for removal of pH, turbidity, Chloride, TDS test.
3. Determination of optimum dosage of coagulants.
4. To check the suitability of treated water for irrigation and used for other purposes.

## 3. MATERIALS AND METHODOLOGY

Dairy waste water collected from the Bhati dairy industry in Davanagere. The physio - chemical characteristics of samples were analyzed. Samples of dairy effluent were collected in clean containers of 5



# STRENGTH ASSESSMENT OF AN EXISTING BUILDING USING ULTRASONIC PULSE VELOCITY METER

Robin Scaria, Pooja Pramod, Nirmalan Thomas,  
Sangeeth Santhosh  
B.Tech students  
Dept. of civil engineering  
Mangalam college of engineering

Gokul P.V  
Assistant Professor  
Dept. of civil engineering  
Mangalam college of engineering  
Kottayam, India

**Abstract**—Ultrasonic Pulse Velocity (UPV) meter is a widely used non-destructive testing technique for assessing the strength of concrete and other construction materials. The UPV method involves sending ultrasonic waves through the material using a transducer and measuring the time taken for the waves to travel between two points. The velocity of the waves is directly related to the mechanical properties of the material, such as compressive strength, elasticity, and tensile strength. This paper provides an overview of the UPV method and its applications in the construction industry for assessing the strength and quality of concrete structures. The paper discusses the advantages of the UPV method, including its fast, accurate, and reliable results, and its non-destructive nature. The paper also covers the limitations and potential sources of errors associated with the UPV method, along with the methods to minimize these errors. The paper highlights the importance of UPV testing in ensuring the structural integrity and safety of concrete structures. UPV testing can be used to detect early signs of damage and deterioration, allowing for timely maintenance and repairs. The UPV method is an essential tool for engineers and construction professionals in assessing the strength and quality of concrete structures and ensuring their longevity and safety. In conclusion, the UPV method is an effective and widely used non-destructive testing technique for assessing the strength of concrete and other construction materials. This paper provides a comprehensive overview of the UPV method and its applications in the construction industry, highlighting its importance in ensuring the structural integrity and safety of concrete structures.

**Keywords**— UPV, Concrete, Transducer, Structural integrity

## I. INTRODUCTION

Assessing the strength and integrity of existing buildings is of paramount importance for ensuring their structural stability and safety. Traditional methods of strength evaluation often involve destructive testing, which can be time-consuming, expensive, and disruptive to the building occupants. In recent years, non-destructive testing techniques have gained significant prominence, with the Ultrasonic Pulse Velocity (UPV) meter emerging as a powerful tool for assessing the strength of construction materials, particularly concrete.

The UPV method utilizes the propagation of ultrasonic waves through a material to determine its mechanical properties, such as compressive strength, elasticity, and tensile

strength. By measuring the velocity of these ultrasonic waves, the UPV meter provides valuable insights into the quality and strength of concrete without causing any damage to the structure. This non-destructive approach offers numerous advantages, including fast testing, minimal disruption to building occupants, and the ability to assess large areas or multiple locations within a structure. In this journal, we present a comprehensive study on the application of the UPV method for strength assessment of existing buildings. The aim of this research is to demonstrate the efficacy and reliability of UPV testing in evaluating the structural integrity of buildings, identifying potential weaknesses, and facilitating informed decision-making regarding maintenance, repair, or retrofitting strategies. By harnessing the power of non-destructive testing, this study seeks to contribute to the advancement of building assessment practices, promoting efficient and effective methods for ensuring the safety and longevity of existing structures.

Overall, the utilization of the UPV meter for strength assessment of existing buildings offers significant potential to enhance structural evaluation practices, enabling proactive maintenance and intervention strategies. By providing reliable and non-invasive data on the material properties, the UPV method empowers engineers and building professionals with valuable information for making informed decisions regarding the structural integrity of buildings. This research aims to highlight the benefits and applications of the UPV technique and contribute to the body of knowledge in the field of non-destructive testing and building assessment.

## II. OBJECTIVES

The objective of assessing the strength of existing buildings using an ultrasonic pulse velocity meter is to evaluate their structural integrity and identify potential weaknesses. By measuring the velocity of ultrasonic waves passing through concrete or masonry, the assessment aims to determine the overall condition of the building, detect areas of deterioration or weakness, and provide a basis for informed decisions on maintenance or repair strategies. This helps ensure the safety and longevity of the building by quantifying material properties, monitoring deterioration over time, and facilitating decision-making for necessary intervention.





# EXPERIMENTAL METHOD TO TREAT WASTEWATER IN REFERENCE WITH CONSTRUCTED WETLAND

Binisha Saira Philip, Akhil Thilak,  
Abina Akber, Smruthy Mohan  
Mangalam College Of Engineering, Ettumanoor,  
Kottayam, India

Ms Gladia Mathew  
Assistant Professor  
Mangalam College of Engineering, Ettumanoor,  
Kottayam, India

**Abstract**— Constructed wetlands (CW) are a technology for eliminating contaminants from wastewater that is ecologically beneficial and has been used to treat municipal wastewater, wastewater from oil refineries, drainage from agricultural operations, acid mine drainage, etc. There have been a rather large number of advancements in the microbiology discipline, which is expanding quickly. With an emphasis on recent developments in the last three decades, this book provides a comprehensive assessment of important CW elements, including the many types of CW, contaminants and their removal processes, degradation routes, difficulties and possibilities, materials, applications, and theory. Additionally, an effort has been made to predict future developments in the field of CW and to encourage these developments by framing significant unresolved CW challenges.

**Keywords**— constructed wetland; wastewater; plants; microorganisms; remediation; degradation

## 1. Introduction

Environmental awareness has grown over the past ten years and concerned political entities from all over the world have made treating environmental degradation and contamination their top priority. The efficacy of the degrading process and the method's cost are typically considered when choosing an appropriate environmental remediation technique for a particular kind of waste. The environmental effect of the chosen remediation strategy is of particular significance since, in certain cases, the daughter product of the degradation process is more harmful than the initial contamination. Wetlands are often defined by the soaking of soil over an extended period. Anaerobic conditions emerge. Wetlands are classified into two types: natural fresh and salt-water wetlands and manmade wetlands. Wetlands built for Contaminant remediation incorporate complex inclusive processes including water, substrate (soil), plants, animals, microbes, and the environment. Constructed wetlands used a variety

of remediation approaches, including biodegradation, phytoremediation, and natural attenuation. Wetland processes include physical processes such as filtration and sedimentation, chemical processes such as adsorption and precipitation, and biological activities such as biodegradation and plant assimilation. The great majority of wetlands have a dense population of vascular plants.

High-density vegetation slows water flow, creates microenvironments, and provides sorption sites for pollutants as well as attachment sites for microbes [5]. As plants die and fall into the water, the plant portions above the water produce new sorption and exchange sites. Furthermore, plant debris is an excellent source of organic carbon as well as nutrients (nitrogen and phosphorus) for microorganism metabolism. Wetlands have relatively low oxygen concentrations owing to soil saturation. As a result, the vegetation in wetlands is restricted to species (vascular plants) that can flourish in low oxygen environments.

Constructed wetlands have been utilised to treat wastewater all around the world. For example, CWs have been utilised in Europe since the second part of the past century; Germany was the first country to deploy CWs in Europe. CWs are also in use in several other countries, including the United Kingdom, Austria, Slovenia, Switzerland, and Denmark. Some African countries, including South Africa, Tanzania, Kenya, and Seychelles, have used CWs. According to certain figures, the cost of subsurface CWs for wastewater treatment in Africa is approximately US \$5 per person, as opposed to mechanical wastewater treatment (activated sludge system), which costs around US \$50 per person. According to a recent research, the overall cost (including sludge operation, maintenance, and disposal)

## 2. OBJECTIVES

To analyze the characteristics of wastewater. To treat wastewater using constructed wetland coupled with various substrates and macrophytes.

To find the removal efficiency of pollutants. To test quality of wastewater by using constructed wetlands for other beneficial uses.

  
PRINCIPAL





# SUSTAINABLE TRAFFIC SIGNAL IMPROVEMENT IN PARAKANDAM JUNCTION

Krishnapriya B , Sandra S ,

Varsha B

B Tech Students

Department of civil engineering

Mangalam college of engineering

Kottayam, India

Geethu Lal

Associate professor

Department of civil engineering

Mangalam college of engineering

Kottayam ,India

**Abstract**—Traffic jams and fatal car accidents are just two of the significant social issues brought on by the spectacular increase in the number of motor vehicles on the road. The distressing human misery and the serious economic loss caused by the road accidents demand the alertness of society and call for the solution of the problem. It is therefore necessary to give increasing awareness to operational characteristics of highway transportation and study the needs of better geometric design, capacity, intersections and traffic signs and signals, parking facilities, design of bus stands and street lighting.

**Keywords:** geometric design, capacity, intersection

## I. INTRODUCTION

The constant growth in traffic flow and the resulting congestion at intersections have been a challenge to transportation engineers in recent years. Parakandam being one of the dominant developing junction in Kottayam district faces a major problem – traffic congestion. Three major roads come and meet at central junction are the roads from Pala, Ettumanoor, Ernakulam, and Kottayam. Since proper traffic signal can control accidents and delay and can lead to systematic movement of traffic. The work generally includes engineering survey, traffic study, planning & design of traffic signal to develop existing road to lane width required as per standards.

## II. SCOPE AND OBJECTIVE

The traffic signs emphasise reducing the traffic load on the current road network using various travel demand management strategies. Congestion should

be reduced, traffic signals should work better, and intersection geometry should be improved.

The main objective of the study is to redesign the traffic signal through traffic engineering, management and control measures for Parakandam junction. Towards achieving that, broad objective of study is as follows,

(i) To develop ideas for traffic improvement based on scientific analysis.

(ii) To analyse adequacy of the improvement of junction.

(iii) To carry out traffic survey such as traffic volume count, pedestrian survey within the study area.

(iv) To workout appropriate regulatory and engineering measures for improving function of traffic signal and junction.

(v) To identify existing issues affecting smooth traffic flow.

(vi) To analyse of pedestrian movement at junction.

(vii) To analyse of traffic movement at junction

## III. LITERATURE REVIEW

*Allen geo Varghese, (2022)* studied the traffic congestion problems at kacheripadi junction. The traffic survey includes the pedestrian and traffic volume studies. As the number of vehicles on the road increased, traffic flow became less safe. The problem of traffic accidents and congestion in urban





# EFFECT OF POLYPROPYLENE FIBER ,COIR AND NON WOVEN GEOTEXTILE ON SUBGRADE SOIL.

Poojamol P. R , Varsha Madhu , Varun Vluodkumar ,  
 Vysluavi G Nath  
 B.Tech Students  
 Dept.of Civil Engineering  
 Mangalam college of engineering , Ettumanoor  
 Kottayam , India

Abhijithkumar A.N  
 Assistant Professor  
 Dept.of Civil Engineering  
 Mangalam college of engineering, Ettumanoor  
 Kottayam , India

**Abstract**—Road should be constructed on strong soil deposits and the behaviour of the road surface depends on the strength of the fill material and the subgrade below it. The performance of a road largely depends on properties of subgrade soil. In order to improve the performance of road on such soil coir textile has scope as reinforcement. The main objective is to increase stability or strength of soil and to reduce the construction cost. Subgrade soil supports the pavement and also serves as a foundation to carry load. For this an appropriate CBR value is required for subgrade soil in order to ensure adequate strength to support the imposed traffic load regardless of adverse conditions such as high rainfall, flooding. In this project polypropylene fibres of varying percentages added to the total weight of soil and CBR test should be conduct

Increase the energy of the soil, makes the process extra environment friendly, and additionally reduces the general value of erosion. Among all the natural sources, presently coir fibre is turning into greater popular as a reinforced fabric because of its clean availability, exact wearing resistance, and longer durability. India is the biggest producer of coir which is a flexible natural fibre extracted from the husk of coconut in a considerable quantity. The software of polypropylene fibers can be taken as an answer for several geotechnical engineering troubles because of their availability, low price and durability. Reinforcing flexible pavements the use of distinct forms of geosynthetics is a technique which are extensively used to increase the sturdiness, lessen the upkeep fees and guarantee the high performance in the course of the provider existence.

## INTRODUCTION

Roads are the essential component for the social as well as economic upliftment of a country.. Around 20% of land area of our country is covered with the kind of soils having low shear strength and California Bearing Ratio (CBR) values. The pavement which is constructed over such soils deteriorates significantly under heavy wheel load which leads to substantial enhancement in maintenance and construction costs. To overcome such situations the soil reinforcement techniques have to be resorted to as alternative and removal of soil might lead to heavy monetary liability. On this work, an attempt was made to have a look at the outcomes of non-woven synthetic geotextile at the energy conduct of the soil. The geotextile was placed as multiple layers from the top of mould at exceptional depths in soil subgrade. Geotextiles are ease of use those fabric used in geotechnical applications, which includes avenue and railway embankments, earth dikes, and coastal protection structures, designed to perform one or more basic capabilities consisting of filtration, drainage, separation of soil layers, reinforcement, or stabilization. It protects from migration of small gravels & sand aggregates. A geotextiles crafted from artificial or herbal fibers related to soil thin portions. It improves soil characteristics consisting of Friction or motion restraint, aid of masses and modifications in bearing failure aircraft. It's miles necessary to construct pavements on unfastened soil or expansive soil, for making roads on a massive . Moreover, these unfastened and expansive soils can be modified by using using herbal resources which makes the soil more durable.

## OBJECTIVE

To determine the engineering properties of soil, Increase the durability and strength of road pavement, To enhance load carrying capacity and improve the performance of unpaved roads, To investigate role of geotextile in road construction and to compare the cost effectiveness, Maintaining the integrity of the Specifications

## MATERIALS

### 1. SOIL

The laterite soil is formed under conditions of high temperature and heavy rainfall with alternate wet and dry periods, which leads to leaching of soil. The subgrade should possess sufficient stability under adverse climatic and loading conditions.

TABLE I. PROPERTIES OF SOIL

Properties	Values
Specific Gravity	1.96
Liquid Limit	75.43
Plastic Limit	35.29
Shrinkage Limit	
California Bearing Ratio	8
Maximum Dry Density	
Optimum Moisture Content	



## EXPERIMENTAL STUDY ON MODIFIED BITUMEN USING LDPE AND CRUMB RUBBER

Mehruniza K N, Megha Meenu Unni

Minnu P Prasad, Midhun Sethu

Students: Dept of Civil Engineering

Mangalam College of Engineering Ettumanoor

Kottayam, Kerala, India

Ann Mary Jose

Asst. Professor

Dept of Civil Engineering

Mangalam College of Engineering Ettumanoor

Kottayam, Kerala, India

**Abstract**—Low density polyethylene (LDPE) and crumb rubber (CR), both recycled from used tyres, were combined in order to produce a plastic-elastomer admixture. For the purpose of strengthening the base bitumen binder's characteristics, two waste materials—LDPE and CR—were used. A mixture of molten bitumen and CR powder with particle sizes less than 0.7 mm was used. The weight of LDPE, CR, and an LDPE/CR combination was used in the same way to produce the various compositions. When compared to base bitumen, these modified mixtures perform better in terms of penetration, softening point, and viscosity. In 2023, 157 million tonnes of polyethylene is expected to be produced annually throughout the world. These statistics demonstrate that polyethylene is the most widely used and consumed polymer worldwide. Bitumen can be modified to improve pavement performance at a low cost and with ease of access by utilising crumb rubber. Since these modified bituminous binders cover aggregates better than base bitumen over base bitumen alone, it is expected that using them in pavement will result in a durable pavement surface.

**Keywords:** Bitumen; LDPE; Crumb rubber

### I. INTRODUCTION

The network of roads have a major role in the development of an area. The paving industry makes extensive use of bituminous binders. Mineral aggregate and bituminous binders are used to create the bituminous pavement. Due to an increase in traffic volume, conventional binders cannot maintain asphaltic pavement's present performance standards. Bitumen is modified using crumb rubber and low density polyethylene. The study analyses the usage of crumb rubber and low density polyethylene (LDPE) for bitumen modification.

Today, disposing of plastic garbage has become a major issue. Its improper disposal results in issues including water pollution and soil pollution. The

mechanical properties of bitumen can be significantly modified by adding polymers, which can modify it. These non-biodegradable materials are utilised in bituminous pavements. In highways, bituminous mixes considerably improve the stability, strength, fatigue life, and other desired features of bituminous concrete mix, even under unfavourable conditions of water logging. As a result, compared to the use of regular bitumen, it is expected that the life of the pavement surfacing course using the modified bitumen will also significantly increase. By shredding remaining plastic items from daily life, plastic pellets are created. The difficulties with pollution and disposal can be effectively solved by using these materials in the construction of highway roads. Crumb rubber is the substance that results when worn tyres are properly crushed.

### II. LITERATURE REVIEW

According to Professor Lokesh Kumar's 2022 study, "Effect of LDPE/CR admixture on the properties of bituminous binder used in paving applications," using modified bituminous binders that include Low Density Polyethylene (LDPE) and crumb rubber in pavement ends in a durable pavement surface due to these modified binders coat aggregates and gravel better than base bitumen does. According to the study, pavement built with this modified bituminous binder performs better in terms of durability, resistance to rutting and cracking, temperature sensitivity, and fatigue resistance.

A comprehensive evaluation of binder is done by Angelo Filonzi, Satyavati Komaragiri, K Lakshmi Roja, and Anand Sreeram (2021). The main goal of this research was to assess LDPE's potential as a modifier for use in asphalt mixtures. The rheological and performance-related



# Design and Analysis of High Rise buildings using ETABS

Jenita Kuriakose, Sreya Shaji, Roshan Daniel, Jithu  
Sreekumar

B.Tech students

Dept. of Civil Engineering  
Mangalam College of Engineering  
Kottayam India

Mr. Richu George Varghese

Associate Professor

Dept. Civil Engineering  
Mangalam College of Engineering  
Kottayam India

PRINCIPAL  
MANGALAM COLLEGE OF ENGINEERING

*Abstract : Civil engineering is a broad area in which buildings are planned and designed to meet specific needs. As we can see that many developments and changes happening in the sector of construction and everyday new commercial and residential building projects are initiated. As a result, thorough planning is required before beginning construction so that the work may be completed in a cost-effective manner while still meeting the needs of the users. The ETABS is an engineering software that helps in modelling, designing and calculating loads while making a structure. It is a very useful software in civil engineering field and provide a vast method to ease out the work of engineers. It analysis the structure in terms of static and dynamic loading conditions. The structure is analyzed in terms of static and dynamic loads. Today, there is a large scope in this subject, which allows many people to work in the respective field.*

*Ernakulam is a fast-growing metropolitan area. With this increasing growth comes problems of population density, overpopulation and lack of land availability. To overcome this problem the most effective solution found out was high rise buildings. There are different types loading that act on a high rise building like wind load, earthquake load, live load, dead load etc.*

*In this we are focusing on wind load analysis on high rise buildings.*

**Keywords : ETABS, Wind And Seismic Analysis**

## I. INTRODUCTION

Civil engineering is a broad area in which buildings are planned and designed to meet specific needs. As we can see, there are numerous advances and changes taking place in the construction industry, and new commercial and residential building projects are being begun on a daily basis. As a result, thorough planning is required before beginning construction so that the work may be completed in a cost-effective manner while still meeting the needs of the users. The ETABS is an engineering software that helps in modelling, designing and calculating loads while making a structure. It is a very useful software in civil engineering field and provide a vast method to ease out the work of engineers. It analysis the structure in based on static and dynamic loads. Today there is a huge scope in this field and it gives the opportunity to many people to work in this respective field.

Ernakulam is a fast-growing metropolitan area. With this increasing growth comes problems of population density, overpopulation and lack of land availability. To overcome this problem the most effective solution found out was high rise buildings. There are different types of loading that act on a high rise building like wind load, earthquake load, live load, dead load etc. In this, we are focusing on wind load analysis on tall rise buildings.

## II. METHODOLOGY

The major focus of civil engineering is structural design. The design of the basic components and members of a building, such as Slabs, Beams, Columns, and Footings, is the most fundamental in structural engineering.



# Design of a Residential Building Using STAAD

Silpa Caroline James  
 Assistant Professor  
 Mangalam College of Engineering

**Abstract**— Residential building is one of the major work which shows the social progress of the county. For fulfilling the requirements of the community new techniques and methods are being developed daily. Engineers are the one who is responsible for planning, designing and executing the work on time. Structural Design involves the investigation on stability, strength and rigidity of structures. A structural Engineer designs a structure based on the loading conditions including dead load, live load and seismic or wind load.

**Keywords**— Analysis, Design, STAAD Pro, Residential Building

## I. INTRODUCTION

A multi-storey, multi-panelled frame is a complicated statically intermediate structure. Design of a 3storey reinforced concrete building is taken as the project. There are total 17 number of columns. The design is done using software the software STAAD Pro. This software computes the loads, moments, shear forces, deflection etc.

Residential requirement accommodation depends up on the income, status and classes of people. A poor man may be satisfied with a single room house but a highly rich family needs a luxurious building. A standard residential building of bungalow type will have drawing room, dining room, guest room, kitchen, store, dressing room, bath room, front verandah, stair etc., while for other house the number of rooms may be reduced according to the requirements. Here the building considered is a 3 storey residential building of bungalow type .

## II. REQUIREMENTS

Requirements of the building are:

**Ground floor:** Sitout, Drawing room, Dining room, Kitchen, Guest bed room, Store, Toilet, Work area, Servants room, Porch.

**First floor:** Living room, Balcony, Three bath attached bedrooms along with dressing room

**Second floor:** Living room, Library, One bath attached bedroom along with dressing room, Balcony

Staircase and lift room connecting all the three floors are also required.

## III. BUILDING PLAN

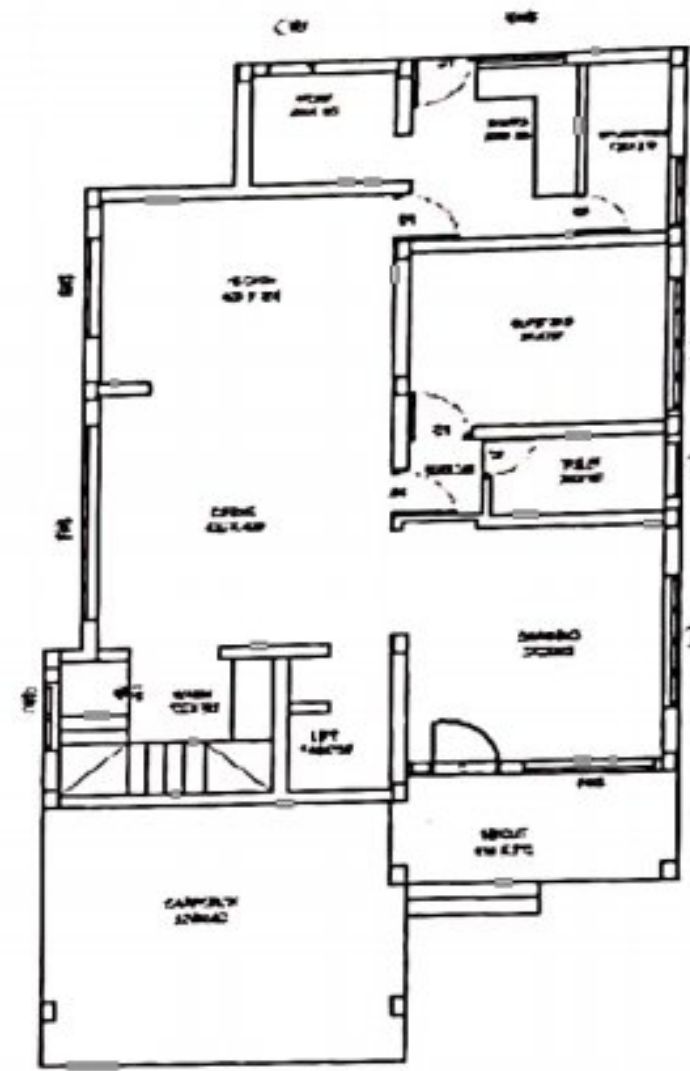


Fig.1. Building Plan - Ground Floor

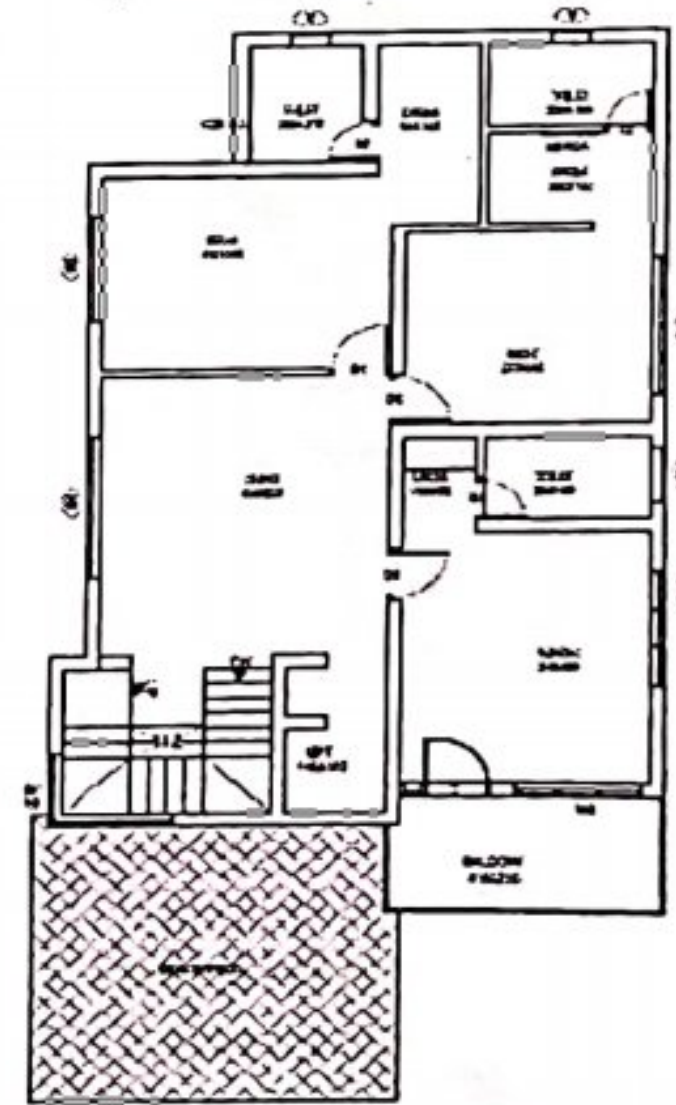


Fig. 2. Building Plan - First Floor

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 MANGALAM COLLEGE OF ENGINEERING  
 Ettumanoor



Aswathy sugu  
Department of civil engineering  
Mangalam College of Engineering  
Kottayam  
Emailid: aswathysuguengg@gmail.com

Dr. N P Rajamane  
Head CACR  
SRM Institute of Science and  
Technology  
Kattankulathur, Tamilnadu

**Abstract—** Geopolymer is a class of aluminosilicate binding materials synthesized by thermal activation of solid aluminosilicate base materials such as fly ash, GGBS etc with an alkali metal hydroxide and silicate solution. The present program investigates the impact of sodium oxides and silicate di oxide content of alkaline activated solution on the cs of high volume fly ash based geopolymer concrete. The solutions 1:2:7, 1:4:5 and 1:7:2 were prepared and used for casting of standard cubes of size 100X100mm and cylinders of size 100X200mm. The result shows that as the sodium oxide and silicate dioxide content increases the rate of reaction also increases and the compressive strength of geopolymer concrete is correspondingly increasing. Also it is found that, the geopolymers that are cured at a high temperature of 80°C possess high compressive strength than the room temperature curing

**Keywords—** Geopolymer, reaction generating liquid, silicatedioxide, sodium oxide

### 1. INTRODUCTION

Cement is used as the binding agent of concrete in world wide. But the manufacturing of cement will result in the emission of CO<sub>2</sub> resulting from the calcinations of lime stone in to the atmosphere which will result in to serious environmental issues. In such regard, geopolymer concrete can be considered as potential applicant material. The name geopolymer was the first time coined by Devidovits[1]. In geopolymer concrete, cement is replaced by fly ash and ground- granulated blast furnace (GGBS) and an reaction generating liquid (RGL) which is a mixture of sodium hydroxide and sodium silicate will replace the water. This reaction generating liquid is prepared by mixing sodium oxides, silicate di oxide and water with certain proportion. This paper investigates about this proportion of RGL and the effect of sodium oxides and silicate di oxide in geopolymer concrete with 80% fly ash and 20% GGBS.

### 2. SCOPE OF THE PRESENT STUDY

The geopolymer mix is mainly consisted to four ingredients

- 1) Geopolymer Source Material (GSM)

Powderly ingredient of the mix such as fly ash, GGBS etc

- 2) Fine Aggregate in the form of M Sand
- 3) Coarse Aggregate
- 4) The liquid component known as the Reaction Generating Liquid (RGL)

The geopolymer source material (GSM) of the concrete mix was prepared by mixing fly ash and GGBS in the ratio of 4:1. Thus the binder portion is having 80% fly ash and 20% GGBS. This proportion are based on the extensive work on geopolymer at SRM university at ambient temperature curing, thereby avoiding the necessity fact keeping the moulds of GPC mix in the oven as reported by many research works in the literature[2].

The three numbers of RGL prepared with varying chemical composition. The rate of RGL used RGL/GSM ie, liquid/binder was arrived 0.65 based on the trial mixes to achieve the satisfactory workability of the mixes.

The compressive strength was required at 7 and 14 days using the cubes of size 100 X100mm and the split tensile strength were measured using cylinders of size 100 X 200mm. The test data was analysed understanding the chemical composition of RGL and the strength characteristics.

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### 3. LITERATURE REVIEW

GajjalaRamya, D SVSMRK Chekravarthy[3]: In this study, the development of geopolymer concrete was carried by using fly ash and GGBS river sand and



# Sparse Long Short-Term Memory Approach for Energy-Efficient Adaptive Cluster Fuzzy-based Controller in Wireless Sensor Network

Dr. K. Ramanan  
Associate Professor

Dept. of ECE  
NPR College of Engineering and  
Technology  
Dindigul, India  
ramana3483@gmail.com

Dr. C. Sahaya Kingsly  
Associate Professor

Department of Computer Science and  
Engineering  
Mangalam College of Engineering  
Ettumanoor, Kottayam, India  
kingsly2k7@gmail.com

Dr. D. David Neels Ponkumar  
Professor, Dept. of ECE

Vel Tech Rangarajan Dr. Sagunthala  
R&D Institute of Science and  
Technology  
Chennai, India  
david25671@gmail.com

S. P. Ramesh

Assistant Professor, Department of  
Computer Science and Engineering  
AMET University  
Chennai, Tamil Nadu, India  
spramesh.me@gmail.com

G. Vinoth Rajkumar

Assistant Professor  
Department of ECE  
JP College of Engineering  
Tenkasi, Tamil Nadu, India  
vinorj88@gmail.com

Dr. M. Vargheese

Professor, Department of CSE  
PSN College of Engineering and  
Technology  
Tirunelveli, Tamil Nadu, India  
nellaivargheese@gmail.com

**Abstract**— Wireless Sensor Network (WSN) gadgets began with limited-scope WSNs and have expanded to larger-scope and Internet of Things -based WSNs. Clustering increases WSN activity. Before picking Cluster Heads (CHs), Nodes are clustered. Nodes in a clustered WSN, transmit CH environmental variables. Current sink-selection approaches presume unlimited data transfer. Multiple CHs using the same instance, might create complications. Insufficient drop-off space causes package loss. Sinks should have airy, less-restrictive regulators. SIS reduces sink nodes. Looser regulators choose the CH. R-recommendations are used to standardize. Reductions standardize regulators. These methods reduce energy, residual energy, First Node Dead, Half Nodes Dead, Last Node Dead, packet loss, and latency. Good throughput, latency, reliability, packet loss, durability, power consumption, and end-to-end delay are accomplished. The objective of this work is to examine the accessible clustering systems for further developing sensor network execution due to different plan limits and streamlining philosophies.

**Keywords**— Wireless Sensor Network, Cluster Heads, Sink Selection, First Node Dead, Half Nodes Dead, Last Node Dead.

## I. INTRODUCTION

As of late, WSN has gotten a lot of academic attention. This growing interest necessitated a comprehensive report that would provide scholars with a thorough comprehension of the request's subject. A Wireless Sensor Network (WSN) is a particularly designated organization made up of a couple of sensor devices that work together to carry out certain tasks, such as determining the current weather, making judgments, and transferring the observed data to the appropriate target. Since its inception, WSN innovation has been an integral aspect of the IoT, given that a stand for associating with exchanging data across various devices to make clients' climate executives.

Handsets, sensors, power supply, and microcontrollers are the four main components of each WSN sensor node. The sensors' job is to collect continuous measurements of the fundamental boundaries, while the handling unit examines the data and transfers it to the Base Station (BS) using the correspondence component via a sole bounce otherwise intermediary node [1]. WSNs contain benefited military observation, well-being checking, rural, calamity the board,

and other continuous observing tasks [2][3]. WSNs are typically sent to locations that are difficult to reach by humans. The organization's energy use and adjustment is a fascinating aspect of the WSN study.

Analysts have been looking for creative techniques to better increase the energy equilibrium and productivity of WSNs [4] because, node power sources are limited and non-battery powered. Because sensor batteries have a finite lifespan, efforts are being made to extend the life of these sensors by developing energy-efficient steering rules. In a WSN, steering is a tiresome movement, but it is the distinguishing feature that distinguishes WSNs from other specially constituted remote organizations. Energy-efficient steering components are essentially designed for a sensible node to send detected information commencing the Sensor Node (SN) to the BS, whose determination extends the organization's administration existence. WSN antenna nodes are clustered regularly, and this clustering process is employed to ensure the organization's agility. It also ensures optimal asset utilization and control of limited company assets, resulting in energy savings and organizational stability [5].

In sensor networks, clustering tactics are used on the way to make certain well-organized asset use and decrease announcement disbursement, lowering the system's total power consumption and reducing SN blockage [6]. According to [7], cluster directing is used to decrease information broadcast rates by leveraging the Cluster Head's (CH) data pooling approach. This method reduces the SN's energy requirement by reducing correspondence-related energy usage. Another reason to use clustering is to improve load balancing and, as a result, the organization's administration life. Clustering hopes to extend the organization's life by adjusting the CHs' obligations.

This study examines available clustering solutions for improving sensor node execution due to plan limits and streamlining philosophies.



# Wireless IoT Security Management Enhancement and Optimization using Various Elements

Dr. C. Sahaya Kingsly  
Associate Professor

Department of Computer Science and  
Engineering  
Mangalam College of Engineering  
Ettumanoor, Kottayam, India  
kingsly2k7@gmail.com

Ms. Neema George  
Assistant Professor

Department of Computer Science and  
Engineering  
Mangalam College of Engineering  
Ettumanoor, Kottayam, India  
neema.george@mangalam.in

Ms. Neema Joseph  
Assistant Professor

Department of Computer Science and  
Engineering  
Mangalam College of Engineering  
Ettumanoor, Kottayam, India  
nestofneemas@gmail.com

Dr. K. Johnpeter  
Professor

Department of Computer Science and  
Engineering  
Mangalam College of Engineering  
Ettumanoor, Kottayam, India  
kjohnpeter@gmail.com

Ms. Sruthy K. Joseph  
Assistant Professor

Department of Computer Science and  
Engineering  
Mangalam College of Engineering  
Ettumanoor, Kottayam, India  
sruthy.joseph@mangalam.in

K. A. Mohamed Riyazudeen  
Research Scholar, Research

Department of Computer Science  
Sadakathullah Appa College,  
Manonjiam Sundaranar University  
Tirunelveli, Tamil Nadu, India  
mriyaz001@gmail.com

**Abstract**— The old security measures are failing because of the exponential rate at which the technology environment is expanding, effectively outdating modern technologies. Similarly, to that, Industry 4.0 needs modern, smart solutions to improve security and productivity. This assertion should be taken into consideration since traditional security methods cannot always safeguard rapidly created information and numbers. This is true because both the technology being targeted and the active and passive attack methods are developing quickly. The Internet of Things (IoT) will have 75 billion connected devices by 2025, which will undoubtedly produce massive amounts of data that must be safeguarded and protected at all costs as it travels around the globe. Failure to do so may result in undesirable circumstances. IoT is a part of Industry 4.0, hence an Industry 4.0 solution would be the ideal option for addressing the numerous IoT difficulties. To determine the optimal criteria for securing IoT, this article compares many elements of the fourth technological revolution, including Cloud Technology, Data Science, Cognitive Domains, and Blockchain. In addition, this study also suggests a hybrid method for enhancing and maximizing the security angle of IoT. Using the hybrid work id POW with Watch dog Mechanism added this work.

**Keywords**—Internet of Things, Cloud Technology, Hybrid, Data Science

## I. INTRODUCTION

The Internet of Things (IoT) is a nexus of related technologies that is expected to reach its aim of 75 billion linked devices by 2025 [1]. A vast array of devices translates into a vast array of data that has to be safeguarded [2]. Contemporary and or SMART solutions are needed since the traditional methods of IoT protection are no longer effective [3]. Industry 4.0, which was introduced in 2011, comprises Cyber-Physical Systems and IoT. (Working on Algorithms). The Work Force of Machinery (Industrial), Electric Technologies (Engineering), and Computers (Digital Revolution) were the components of 1.0. [1765], 2.0. [1870], and 3.0. [1969] Industrial Revolutions, respectively [4]. Cloud technology, cognitive information technology, cryptocurrency, malware networks, etc. are some of the many parts of this business. The basic phrase, cloud computing, refers to any split of hosting services provided

through the Internet or other forms of cyberspace. IaaS, PaaS, and SaaS are the three cornerstones of the cloud [5]. In Modern Scenarios, several different services also serve as the foundation of the cloud. For instance, the terms Backend as a Service (BaaS) and Analytics as a Service (AaaS) are used interchangeably [6] and [7]. The use of digital models to simulate the human brain's complex cognitive function is the next parameter, or cognitive computing [8].

Particularly, cognitive computing mimics a human being's personality. By adhering to the machine learning principles and their subcategories, it enhances the decision-making process [9] and [10]. Blockchain, a network of peer-to-peer devices, has been dubbed the Next Measure of Industry 4.0 [11]. The three fundamental tenets of blockchain are immutability, decentralization, and transparency. The last one is Cyber-Physical Systems, which involve the operation of Intelligent Systems and is verified by pre-defined algorithmic rules [12]. An Intelligent Agent in Artificial Intelligence (AI) has two key traits: a system that imitates humans and a system that behaves and thinks logically [13]. This paper focuses on identifying the best industry 4.0 IoT security solution. For a proper analysis of the topic, all these Industry 4.0 Parameters are shown and contrasted in the following subsections.

## II. INDUSTRY 4.0 ELEMENTS

Industry 4.0 is a broad automation transition incorporating several technologies that have the potential to serve as the key response to many Internet of Things security concerns. This section illustrates the Research Background for each of these solutions.

### A. Internet of Things

The Internet of Things is a network of interconnected nodes for exchanging data and documents through the Internet [14]. In today's technology age, it refers to a system that functions with electronic things. It can carry out tasks either with or without the assistance of human beings. The creation of a smart toaster marked the start of the Internet of Things. Since then, the IoT has achieved several landmarks in terms of popularity. A related IoT nexus is anticipated to have over 75 billion nodes by 2025. This privacy,



# Evaluation of Wireless Sensor Networks Module using IoT Approach

I. Anand

Department of Networking and Communications  
School of Computing  
SRM Institute of Science and Technology  
Kattankulathur  
anand.i@srmsm.edu.in

Dr Padmalal S.  
Professor

Department of Computer Science and Engineering  
Manipal College of Engineering  
Uthamanur, Kottayam Dist  
Kerala  
spalal71@gmail.com

Dr I. Sreelika

Associate professor  
Department of Computer Science and Business Systems  
Pamunthi Engineering College,  
Chennai  
issreelika@gmail.com

Dr R. Juhana

Professor, Department of Information Technology, Kerala KAM College of Engineering and Technology,  
Chennai, India  
juhana.r16@gmail.com

PS Naveen Kumar  
Assistant professor

Department of CSE-DATA SCIENCE  
St. Ann's college of engineering and technology, Churala AP  
naveenmtech28@gmail.com

Gayatri Parasa

Assistant Professor, Department of Computer Science and Engineering, Kanuru Lakshminah Education Foundation, Vaidhyanagar, Coimbatore, Andhra Pradesh, India  
gayatriparasa20@gmail.com

**Abstract:** - Microcomputers and medical devices with signal transceivers that operate on a specific radio display constitute the backbone of wireless sensor networks (WSNs) that monitor environmental conditions (temperature, pressure, light, vibration levels, location). It is widely used in WAN sensor networks because of its flexible design and low setup fees. The u200b touch network allows for the connection of up to 65,000 devices, while the Intelligent sensors on other wireless networks are used to transfer data ports and assign wireless networks. Since the price of wireless solutions has been decreasing, and their functional capabilities have been growing, they are gradually replacing wired ones in telemetry data gathering systems and long-distance detecting communication. A deep learning model was used in this investigation to prevent the sensor nodes from manipulating data. Sensor nodes include a lot of parameters and estimations. If these projected data values are altered, network performance will suffer, and the node's lifetime will be reduced. Data security became a priority when the sensor nodes were distributed. This new method is 98.82% more efficient than the previous one.

**Keywords:** WSN, WAN, U200b touch networks, Data Security.

## 1. INTRODUCTION

WSNs are very organized at this point [1]. Ten to fifteen years from now, universal Internet access to WSNs with built-in security is a reasonable expectation. It is noticed when the Internet is converted into a real-world network [2]. The potential uses for this technology are many, spanning fields as diverse as medicine, ecology, transportation, the armed forces, the entertainment industry, homeland security, crisis management, and smart cities [3].

ZigBee is the backbone of many modern wireless networks. Expansions in these areas, along with others such as product development, human security requirements, resource management, and the practical application of product-material values, are all part of the

present advances. As the technology behind semiconductors has improved, new theoretical and practical questions about the use of emotional networks in commercial and community settings have emerged [4]-[6].

Use as parts of technologies that save energy and resources, keep tabs on the state of the environment, evaluate industrial property, manage a firm property, and more.

Although sensor networks have been around for some time, the notion of building one has yet to be fully enforced and defined across various software and hardware (platform) solutions. The current state of emotional network development is highly dependent on the particular requirements of the industrial issue [8]. Developers interested in a technologically relevant search for potential manufacturers are paying close attention to the rapid advances in architecture, software, and hardware implementation technology.

The term "sensor network" has seen widespread usage recently. It operates independently, automatically adjusts to any changes, is resilient to the loss of any single part, requires no upkeep, and may be used without any special hardware being set up. Various sensors may be used at each terminal in a sensor network to control the radio receiver, the microcomputer, and the surrounding environment. Several tasks are carried out, including taking readings from instruments, processing raw data, and establishing a link to a remote data system. Telecommunication 802.15.4/Gb "sensor networks" (also known as Telecommunication 802.15.4/Gb WSN - Wireless Sensor Network) are one of the latest methods for developing distributed self-regulatory error-tolerant systems of resource management and operations monitoring. Wireless technology is the only option for monitoring and managing problems that significantly impact the sensors' working lifetime in wireless sensor



# A Survey for the Early Detection and Classification of Malignant Skin Cancer Using Various Techniques



Jinu P. Sainudeen and N. Meenakshi

**Abstract** The unrepaired DNA in skin cells causes skin cancer disease which leads to mutations or genetic defects in the skin. This disease will be widely spread in other parts of the body which can be cured in the initial stages. So, the early deterrence of this disease is a vital factor. This skin cancer has increased the mortality rate, and the treatment is highly expensive. Researchers have undergone several techniques for skin lesion detection based upon parameters of skin such as symmetry, color, size, and shape. These parameters are useful for distinguishing non-melanoma cancer from melanoma cancer. This paper gives a detailed study of the early detection of skin cancer with the aid of image processing, machine learning, and deep learning techniques.

**Keywords** Skin cancer detection · Convolutional neural networks · Deep learning · Transfer learning

## 1 Introduction

Skin cancer is the abnormal growth of cells in the skin which may invade into other parts of the body. Majority of the disease is caused due to the exposure of UV radiation. Other causes include sunburn, previous history of melanoma, people living in geographic locations, eczema, psoriasis, xeroderma pigmentation, and over exposure to particular chemicals. The unrepaired DNA in skin cells causes skin cancer which leads to the mutations or genetic defects in the skin. Mainly, the arrival of skin cancer is from the moles on the skin which leads to the inflammation around epidermal layer. It will cause drastic increase in the temperature.

J. P. Sainudeen (✉) · N. Meenakshi  
Information Technology, Hindustan University, Chennai, India  
e-mail: jinups@gmail.com

N. Meenakshi  
e-mail: nmeenakshi@hindustanuniv.ac.in

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# Satellite Image Fusion for Obtaining High Resolution Images Using Deep Neural Network

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A Nisam Rahman ; Vikas Tripathiy ; Ayan Das Gupta ; Biju Paul ; Manju T Kurian ; Vinodh P Vijayan **All Authors**

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**Abstract:**  
 Due to its critical function in a wide range of applications, scene categorization of high-resolution remote sensing (RS) photos has drawn increasing attention. A technique for spatiotemporal fusion using deep neural networks (DNNs) with a large amount of remote sensing data as the application background. An innovative multispectral image fusion architecture is proposed in this paper. The proposed method for fusing satellite images entails two phases, each using two neural networks. In the first stage, an adaptively weighted injection-based joints detailed approach to remotely sensed image fusion is discussed. Multispectral (MS) and panchromatic (PAN) images are used to extract spatial features using a wavelet transform. In contrast to the conventional detail injection technique, dictionary learning from the sub-images themselves is used to construct the primary joint details by sparsely representing the extracted features. To minimize spectrum distortions in the fused images while keeping spatial information, we implemented a unique loss function for this DNN. This network is known as the 'Spectral Reimbursement Network (SRN).' Finally, using three datasets, full-reference, and limited-reference criterion, the proposed strategy is compared against several state-of-the-art methods. Experiment findings demonstrate that the suggested technique can compete in both spatial and spectral parameters.

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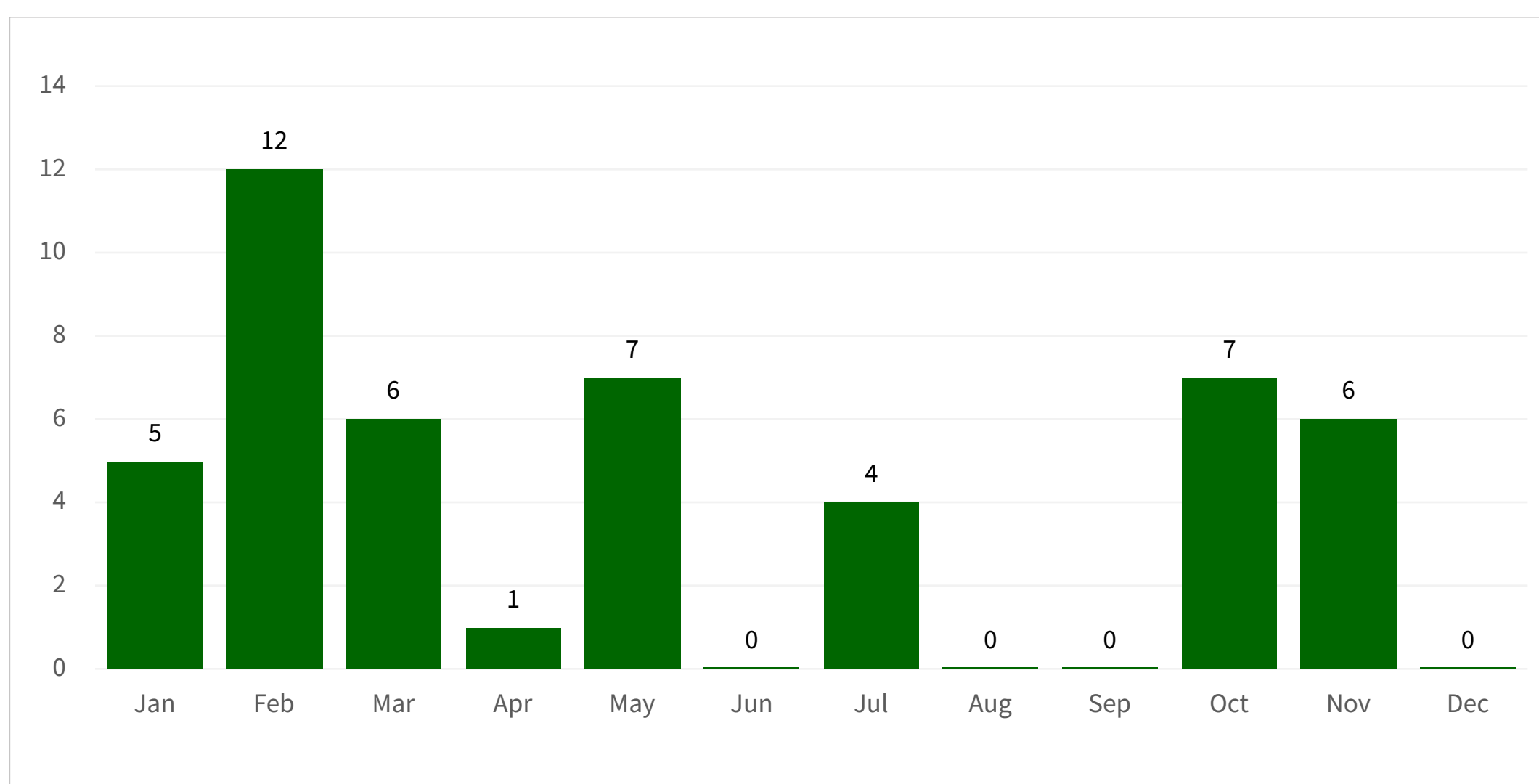
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## Author's Profile



Dr. Vinodh P Vijayan, Principal, Mangalam College of Engineering, Kottayam, India has completed Bachelors Degree in Electronics and Communication Engineering, Post graduation in Computer Science Engineering from Anna University, Chennai, Ph.D in Computer Science & Engineering from Vels Institute of Science, Technology and Advanced studies (VISTAS), Chennai. He has many years of experience in teaching Undergraduate program and Post graduate programs of M G University and APJ KTU He was an Adjunct professor for IGNOU post graduate programs and visiting faculty for BITS Pilani's Post Graduate programs. He has published many papers with SCI, SCIE & Scopus indexed International Journals. Recently TWO patent also published in his credit. He has served as author/reviewer for many technical publications. His research area includes Soft Computing, AI, Bio-inspired computing, Computer Networks, IoT etc



Dr. Sankata Bhanjan Prusty obtained his B. Tech degree in Electronics and Telecommunication Engineering from Orissa Engineering College, Bhubaneswar, Odisha, India in 2008. He received both M.Tech. and Ph.D degrees in Electronics and Communication Engineering from National Institute of Technology, Rourkela, Odisha, India in the year 2012 and 2017, respectively. He is a member of IEEE and has published several research papers in National and International Journals. Presently, he is serving as an Associate Professor in the School of Electronics and Communication Engineering, REVA University, Bangalore. His research interests are focused in the broad areas of nonlinear control, adaptive approximation based control, model predictive control, Internet of Things and Electronic Warfare



Dr. A. Vijaya Kumar, currently working as an Associate Professor in Computer Science department at School of Arts and Science, Vinayaka Mission's Research Foundation, Aarupada Veedu Campus, Chennai, Tamilnadu, India. He is having 20+Years of Teaching and Learning Experience in various Academic institutions. He is a cherished teacher with ability to train and counsel the Students. He is also a Certified Soft Skill Trainer. He received B.Sc., M.Sc., and M.Phil degree in Computer Science from Bharadhidasan University TamilNadu, India in 1998, 2001 and 2004 respectively, M.Tech. in Computer Science & Engineering from SRM University, TamilNadu, India in 2016 and Ph.D in Computer Science from Bharathiar University, TamilNadu, India in April 2022. He has qualified SET 2016. He has presented many research papers in Scopus index journals, National & International Conference. His research areas are Image processing, Video Processing, and Artificial Intelligence



Dr. M. Madijagan, completed his B.E. Computer Science and Engineering from University of Madras, Master Degree from BITS Pilani, Rajasthan, India also completed his Ph.D. Degree from BITS Pilani, Rajasthan, India in the year 2009. Presently he is working as an Associate Professor in School of Computer Science and Engineering, VIT, Vellore, Tamilnadu. He is having more than 26 years of Teaching experience in various Institutions and Universities like VIT, BITS Pilani. In BITS Pilani he was Professor In-Charge ICT & Network Infrastructure requirement Analyst and he was one of Architect in implementing the BITS Connect 2.0 Project (CISCO Tele presence Systems). He published more than 25 papers in International & National Journals and presented in International Conferences got Best Papers Award. He authored Books and Book chapters which is indexed by Scopus Elsevier. He is having more than a dozens of Indian & Australian patents which were published and granted. His current research area are Human Brain Computing Interface (BCI), Artificial Intelligence, Deep Learning, Cyber Physical Security (CPS), IIoT and ICT Healthcare.

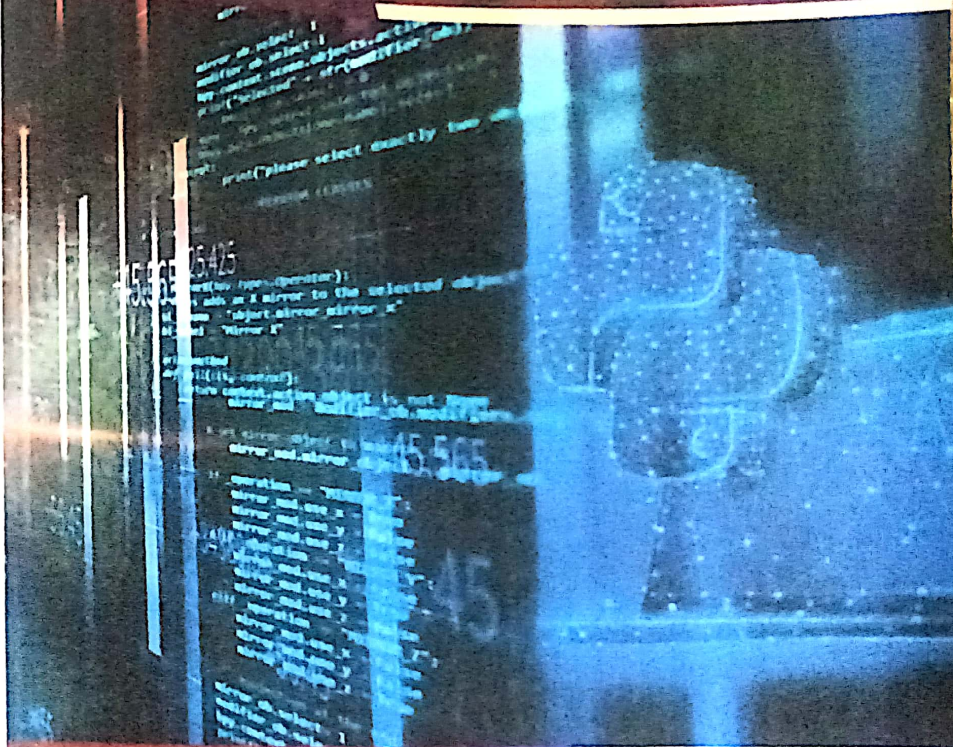
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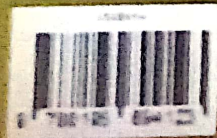
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## About the Authors



**Dr.P.A.Abdul Saleem**, D.E.C.E., B.E., M.E., Ph.D. is currently working as a Professor in the Department of Computer Science and Engineering (Data Science), CVR College of Engineering, Ibrahimpatnam, RR Dist. Telangana State. India. He has acquired 30 years of Experience in the Industries as well as in Engineering Colleges. He has gained more Technical as well as Administrative Knowledge by taking various designations like Engineer, lecturer, AP, Professor, HOD, Principal and Director. He has completed his B.E.(1993) as well as M.E.(2002) from University of Madras and Ph.D.(2013) from University of Allahabad. He has published around 36+ research articles in different Journals and has 5 patents. His research area includes MANET, WSNET, Cloud Computing, Artificial Intelligence and Machine Learning.

**Dr.Rakesh Nayak** is author four books, presently working as a Professor in the Department of Computer Science and Engineering at O P Jindal University, Raigarh, Chhattisgarh. He received his Master degree in Computer Applications from Indira Gandhi National Open University in the year 2007 and M.Tech (CSE) from Acharya Nagarjuna University in 2010 and his Ph.D. degree in Computer Science from Behrampur University in 2013. Prior to joining the computer science department in 2022, he has worked as a Professor in CSE in Vaagdevi Engineering College Warangal, Sri Vasavi Engineering College, Tadepalligudem, Sr. Lecturer in Mathematics for around Eight Years in various Engineering/MCA colleges. He has more than 22 years of teaching and administrative field in the technical level institutions. He has guided 11 M.Tech Students. He has many publications in international journals/conferences to his credit.



**Dr.S.Padmala** is currently working as Professor in the Department of Computer Engineering, Mangalam college of Engineering, Kottayam District, Kerala. He Completed B.Sc computer science and M.C.A from Madurai Kamaraj University, Madurai. He received the Master Degree M.Tech (Computer and Information Technology), Master of Philosophy(M.Phil) and Ph.D degree in computer and Information Technology from Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu. He has 23 years of experience (10 years in the post of Principal) in teaching and administrative field in the technical level institutions. He has published a number of papers in national, international journals and patents. His research interests include Image Processing, Networking, Network security and Cloud computing.

**Ajith Sundaram** has nearly 15 plus years of experience which includes over 12 years in General Administration, Classroom Management, Curriculum Development, Teaching and Student Management and 3 years in industry where he was involved in recruitment and implementation of information system. A Computer Science Engineering graduate got post graduate degrees in Business Administration from Madras University and Masters in Information Technology from University of Nottingham in UK. Took his PhD in HR and his second PhD in Information System.



**Dr.Vidyullatha Pellakuri** is an Associate Professor of Department of Computer Science & Engineering at Koneru Lakshmaiah Education and Foundation, Guntur, Andhra Pradesh. She completed her graduation in S.V University, Tirupathi and Master of Technology in computer science from JNTU-A. She pursued her PhD from Department of Computer Science & Engineering, KL University, Guntur, AP. Her research and publication interests include Data Science and Artificial Intelligence techniques. Her present research interests focus on image analysis, Big Data Analytics and IoT. Her research has been chronicled in over 30 journal publications and International conferences. She is a life time member of IAENG, IACSIT, SDIWC, CST and NITTS. She is having national patents on Machine Learning & IoT.



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To ensure public safety, railroad transportation needs to be constantly inspected and promptly maintained. Traditional manual inspections are expensive and time-consuming, but the accuracy of flaw identification depends on the inspector's skill and productivity. Railway track inspection using robots is an innovative technology that has revolutionized the way railway tracks are inspected. It involves the use of autonomous robots that are designed to inspect and monitor railway tracks. The robots are equipped with ultrasonic sensors that enable them to detect any kind of defect or damage to the tracks. They are programmed to move along the track and detect potential defects or damages. This technology has improved the safety standards of railway tracks by helping the operators to detect and repair any defects in a timely manner. It has also helped reduce the need for manual track inspection, thus reducing the costs associated with it. Furthermore, the use of robots for track inspection has also helped in reducing the risk of human error during the inspection process.

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**Abstract:** The performance and efficiency of the integrated circuit are impacted by power optimization, making it a crucial component in VLSI design. The operational expenses, battery life, and environmental effect of electronic devices are all impacted by power consumption, which is a crucial factor in VLSI design. The majority of recent research concentrate on simulations or laboratory trials, which could not truly reflect the difficulties and limitations of actual IoT implementations. Large-scale field tests of IoT devices using various power management techniques may be used in future studies to provide more accurate assessment of their efficacy and viability. This literature study paves stone to further research works in power optimization in VLSI circuits.

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J. K. Kurian

Electronics and Communication Department, Mangalam College of Engineering, Ettumanoor Kerala, India

#### Authors

J. K. Kurian  
Electronics and Communication Department, Mangalam College of Engineering, Ettumanoor Kerala, India

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##### Abstract:

The ALU is an essential operational unit found in every processor, serving as the core component of the CPU. It performs most of the fundamental operations, including logical and arithmetic operations. In this paper, an 8-bit Arithmetic Logic Unit (ALU) is developed using swing restored M-GDI technique and compared with the previous M-GDI technique. The M-GDI technique is area and power efficient technology but the output swing is not obtained fully. To solve this problem a swing restored M-GDI technique applied to previous circuits. The ALU is responsible for performing logic operations (AND, OR, XOR) and arithmetic operations (ADDER, SUBTRACTOR, MAGNITUDE COMPARTOR) using three logic gates: AND, OR, and XOR. The output of the ALU is determined by the input select line and given to the multiplexer. The average power, number of transistors, and delay are the key factors used to evaluate the performance of the ALU, which is implemented in the software CADENCE VIRTUOSO.

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ANGALAM COLLEGE OF ENGINEERING  
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Electronics and  
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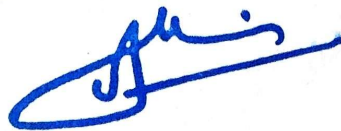
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Professor & Head  
Electronics and Communication Engineering  
Mangalam College of Engineering  
Kottayam, India - 686 631



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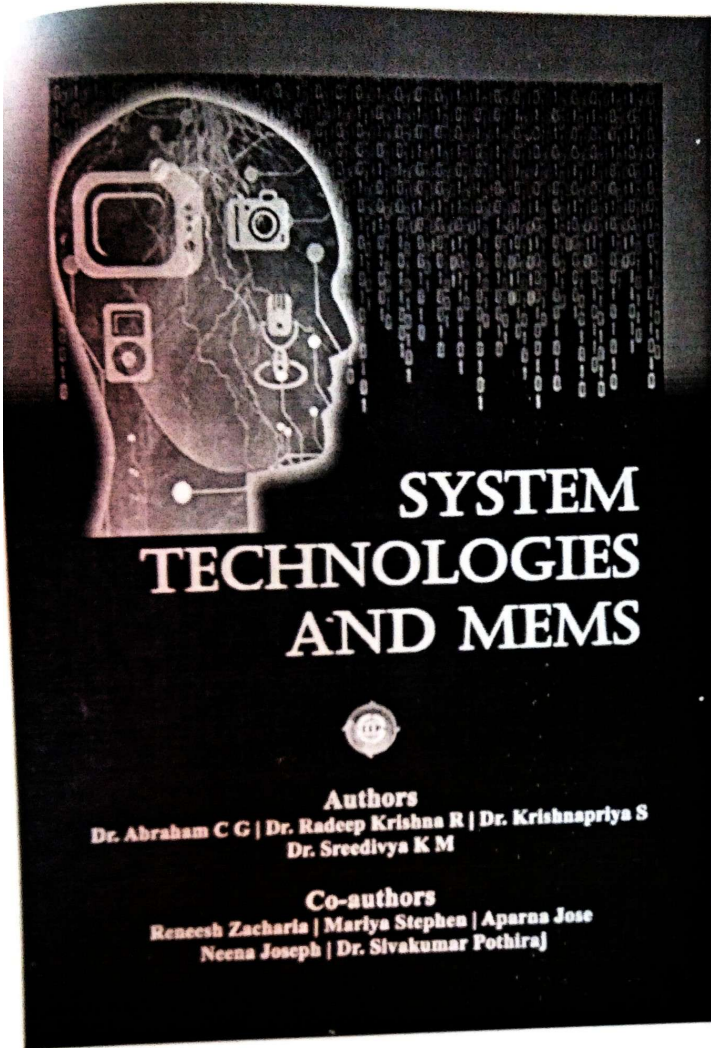


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Electronics and Communication Engineering  
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Kottayam, India - 686 631



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## Authors

Dr. Abraham C G | Dr. Radeep Krishna R | Dr. Krishnapriya S  
Dr. Sreedivya K M

## Co-authors

Reneesh Zacharia | Mariya Stephen | Aparna Jose  
Neena Joseph | Dr. Sivakumar Pothiraj

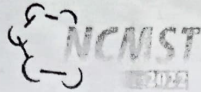
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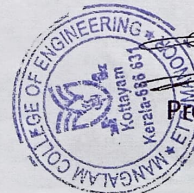
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# A NEW MPPT TECHNIQUE FOR PV SYSTEMS UNDER PARTIALLY SHADED CONDITIONS

Dr. Bincy K. Jose<sup>1</sup>

<sup>1</sup>Electrical & Eletronics department, Mangalam College of Engineering, Ettumanoor, Kottayam, India  
\*bincykjose84@gmail.com

**Keywords:** PHOTOVOLTAIC SYSTEMS, GLOBAL PEAK POWER POINT, SHADING FACTOR, PARTIAL SHADING CONDITIONS, SOLAR ARRAY SIMULATOR.

## Abstract

An empirical maximum power point algorithm for photovoltaic systems is presented in this research. It is challenging to determine the running voltage proportionate to maximum power point changes with alteration in solar irradiance and temperature in photo voltaic systems owing to the non linearity of the voltage-current characteristics, especially in the case of partial shading conditions. This method calculates the voltage at the peak power point in accordance with the local climate. The operating point is subsequently driven to the global peak power point using voltage tracking. This approach is straightforward and requires fewer sensors.

## 1 Introduction

Due to the reduction of fossil fuels and the growth of the greenhouse effect, the demand for renewable sources has grown throughout time. This sources include wind, solar, wave, tidal and biomass etc. Photovoltaic has become popular among the renewable energy sources because of advancement in power electronic techniques, its availability and being maintenance and pollution free [1]. Photovoltaic sources will have major contribution to power generation in future years as the installation of photovoltaic sources is globally increasing year by year. The photovoltaic system's output power mainly varies with the temperature and irradiance level. Partial shading in photovoltaic system occurs due to clouds, buildings and other adjacent objects, some part of the module may obtain less intensity of sunlight. Therefore, under various conditions, the peak power point varies. Thus peak power point control is difficult process for efficient PV applications.

Various methods for locating MPP have been established throughout the last three decades [2]-[11]. These approaches may vary regarding the quantity of sensors used, sensor reliability, complexity, cost, and tracking operation of various climatic circumstances. These techniques include the fractional current (FSCC) method, the fractional open circuit voltage (FOCV) method, the perturbation and observation (P&O) method, the incremental conductance (IC) method, the look-up table method, the artificial neural network method and the fuzzy logic method. In the event of partially shaded situations, traditional approaches like P&O, incremental conductance, and the hill climbing method may fail to detect the global maximum power point (GMPP). Few researchers have suggested a few changes in order to solve the problem with conventional strategies.

In the fractional short circuit current approach, it is assumed that the current  $I_{sc}$  and the current at the peak power point  $I_m$  under various climatic conditions have a linear relationship. One of the easiest offline techniques is this one.

But it requires additional switch for shorting the PV panel. In this method, the computation of  $I_{sc}$  demands periodic isolation of the photovoltaic panel which makes in power loss generation during such times. This method is not suitable for partially shaded conditions. In ripple correlation control method, driving the power change to zero by correlating the temporal derivative of the PV array's fluctuating voltage or current. Computational burden and proper selection of scale factor are the major disadvantages with this technique. Particle swarm optimization based methods have been reported in [12]. Fuzzy based controllers there have successfully used to track the peak power point of solar energy. These outcome show better performance in terms of the monitoring effectiveness and speed. Even so these technique require large memory and powerful micro controllers for performing the computations. This results in an automatic increase in the price of the photovoltaic system. The recommended MPPT algorithm in [13] determines the possible GMPP based on the PV array's open-circuit voltage before using the P&O-based MPPT algorithm to track the GMPP. Although this technique performs well for dynamic tracking, it may not be appropriate for GMPP in complex partial shading situations. With less monitoring time in [14]-[16], the GMPP was estimated, although it required extensive knowledge of the construction of the PV array. In the context of actual engineering methods, these values are challenging to measure or anticipate. In [17], where  $V_{oc}$  is the open circuit voltage of every photovoltaic module in the array, it is assumed that the peaks occur at whole number multiples of  $0.8V_{oc}$ . The search might be limited to the areas around these regions rather than scanning the MPP over the entire voltage range of the  $P-V$  curve. However, this approach has only been tested for modest PV systems in the literature.

Thus there is a need of an MPPT algorithm which can overcome the aforesaid demerits of the the most recent methods. The proposal should have features of simplicity, reduced computation and reduced cost. These need to be

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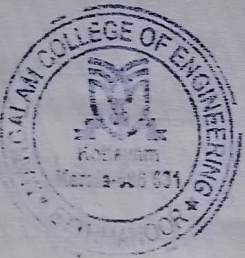
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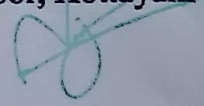


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Ms. Shoma Mani *M.Tech.*

Assistant Professor, EEE Dept.  
Mangalam College of Engineering,  
Ettumanoor, Kottayam



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Ms. Jolly George *M.Tech.*

Assistant Professor, Electrical Dept.  
Mangalam College of Engineering,  
Ettumanoor, Kottayam

Ms. Shoma Mani *M.Tech.*

Assistant Professor, Electrical Dept.  
Mangalam College of Engineering,  
Ettumanoor, Kottayam

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*Divya Jose M.Tech.*

Assistant Professor, Dept. of Electrical & Electronics  
Mangalam College of Engineering,  
Ettumanoor, Kottayam

*Jeneesh Scaria M.Tech.*

Assistant Professor, Dept. of Electrical & Electronics  
Mangalam College of Engineering,  
Ettumanoor, Kottayam

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## ABOUT AUTHORS



**Dr. Saurabh Tege**

Dr. Saurabh has received his Ph.D in Mechanical Engineering, completed Post graduation in Industrial Engineering and Management from Devi Ahilya University Indore, working as an academician and Associate Professor in Geetanjali Institute Udaipur from 2013, his main interests are production engineering and management, industrial engineering and technology management.



**Dr. Jayaraman. R**

Currently working as Professor at Vinayaka Missions Kirupananda Variyar Engineering College, Salem, Tamil Nadu. He holds a Bachelor degree in Mechanical Engineering from Bangalore University, Master's degree in Manufacturing Engineering from Vinayaka Missions Research Foundation Deemed University, Salem and PhD in Manufacturing Engineering from Anna University, Chennai. He has published many papers in National and International Journals. He has organised conferences, workshops and seminars. He has over 27 years of teaching experience in teaching graduate and post graduate level. He has guided graduate and post graduate level projects. He is a Research supervisor at VMRF Deemed University Salem.



**Dr. Rabi. J**

Currently working as Associate Professor at Mangalam College of Engineering, Kottayam, Kerala. He holds Bachelor's degree in Production Engineering from Bangalore University, Master's degree in Machine Design from Bharath University Chennai and PhD in Manufacturing Engineering from Anna University Chennai. He has many Research publications in National and International Journals to his credit. He is a life member in the Institution of Engineers India. He has more than 25 years of teaching experience in teaching under graduate and post graduate levels and has guided graduate and post graduate level projects. He has good experience in organising various conferences, workshops, seminars and symposiums.



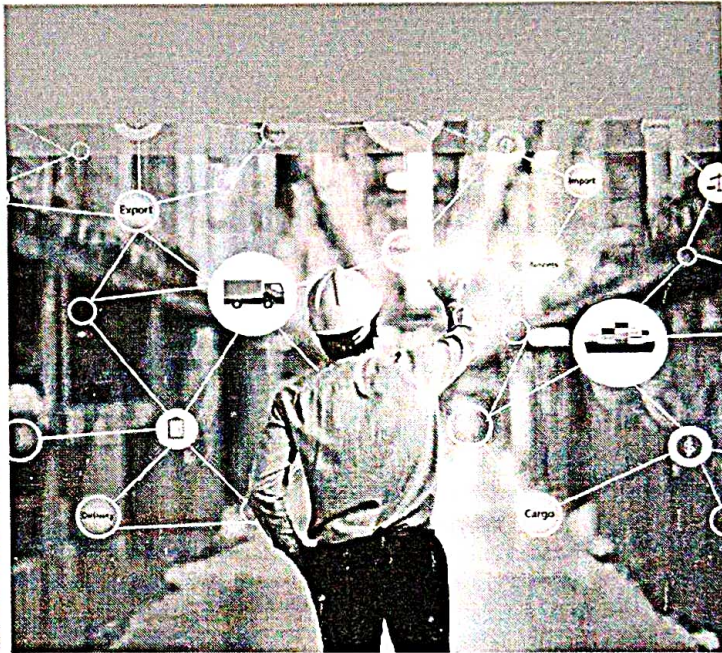
**Prof. Satish G. J.**

Prof. Satish G. J. completed his M.Tech in Production Engineering Systems Technology from University B.D.T. College of Engineering, Davangere, Karnataka, India by securing the First rank at the university level. For the last ten years, he has been working as Assistant Professor in the School of Mechanical Engineering, KLE Technological University, Hubballi, Karnataka, India, handling UG and PG courses. He has research interests in Industrial Production, Engineering Education, Energy Management and Sustainable Development. He has published more than 30 articles in reputed International Journals and conferences related to his research interests. Recently, he has started to work on the areas of ERP and PLM.

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Ettumanoor





**About the Authors**



Dr. K. Pratheesh is serving as a Professor and Head of the department at Mangalam College of Engineering, Kottayam-686631. He is having more than two decades of experience in academic, administration, research and innovations. He completed his Ph.D. degree from Department of Mechanical Engineering, National Institute of Technology-Calicut one of the premier institutes of India and having his M. Tech and B. Tech from premier Government Institute of Kerala. His research interests include solidification of alloys, Structure-property correlations of Al alloys, qualitative metallography and advanced manufacturing technologies. He is a seasoned researcher with number of quality publications and Ph.D. supervisor at APJ Abdul Kalam Technological University, Kerala.

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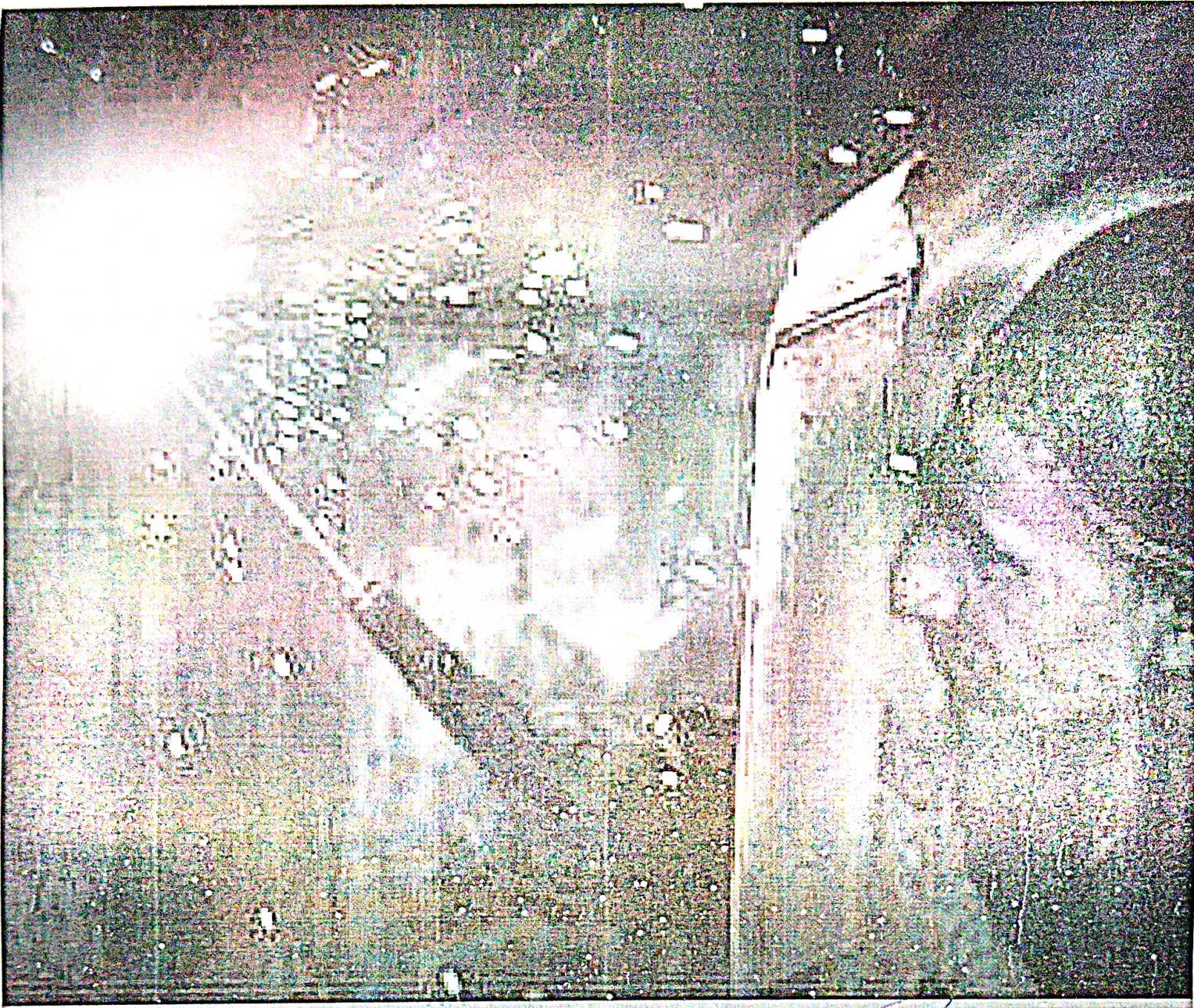
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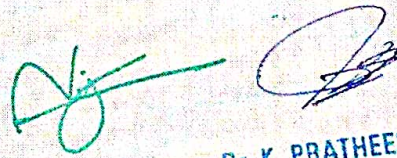
Professor,

Aeronautical Engineering Department  
Nehru Institute of Engineering and Technology  
Coimbatore

Dr. RABI J M.E., Ph.D.

Associate Professor,

Mechanical Engineering Department  
Mangalam College of Engineering,  
Kottayam, Kerala



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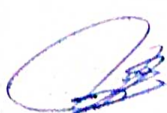
Dr. K. Pratheesh is serving as a Professor and Head of the department at Mangalam College of Engineering, Kottayam-686631. He is having more than two decades of experience in academic, administration, research and innovations. He completed his Ph.D. degree from Department of Mechanical Engineering, National Institute of Technology-Calicut one of the premier institutes of India and having his M. Tech and B. Tech from premier Government institutes of Kerala. His research interests includes solidification of alloys, Structure property correlations of Al alloys, qualitative metallography and advanced manufacturing technologies. He is a renowned researcher with number of quality publications and Ph.D. supervisor at APJ Abdul Kalam Technological University, Kerala.

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Head of Department  
Department of Mechanical Engineering



  
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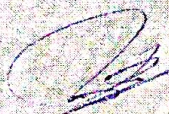
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# Selecting the Optimum Tool for Driving Performance Evaluation by Assessing the Ergonomic Methods—An Overview



Arun Chand , H. Mannikandan , and A. B. Bhasi

**Abstract** Ergonomic analysis of the driving environment is very essential for enhancing productivity and reducing musculoskeletal disorders (MSDs) of drivers. The proposed driver distraction model for heavy vehicles examines the influence of environmental, psychological, and vehicle design factors on driver performance. The main ergonomic risk factors include long driving hours, poor human–machine interface, incorrect driving posture, vibration due to bad road conditions, driver sleepiness and age. To evaluate the effect of these factors on driving performance which leads to MSDs, different ergonomic methods/techniques are available. Selecting a single tool from these methods is quite difficult due to the heterogeneity of driver ergonomic parameters. To find the optimum tool, different features of the ergonomic methods were identified and compared. Integration of these tools used for ergonomic analysis was an outcome of the advancements in machine learning technology which resulted in digital human modelling (DHM). DHM combines computer-aided design, human factors management, and risk evaluation.

**Keywords** Human factors · Musculoskeletal disorders · Driver fatigue · Ergonomic tools · Digital human modelling

Dr. K. PRATHEESH  
Head of Department  
Department of Mechanical Engineering

## 1 Introduction

Subsequent paragraphs, however, are indented. Driver ergonomics have been identified as a source of concern that contributes significantly to traffic accidents. Driver fatigue is a function of ergonomic issues related to driving. Fatigue is a state of exhaustion caused by extended periods of driving, tedious road conditions, and a poor environment or the driver's features [1]. Driver fatigue caused by ergonomic issues also leads to a reluctance to drive and a complete withdrawal of attention

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A. Chand (✉) · A. B. Bhasi  
School of Engineering, CUSAT, Kochi, Kerala, India  
e-mail: arunchand@cusat.ac.in

H. Mannikandan  
SCMS School of Engineering and Technology, Kochi, Kerala, India



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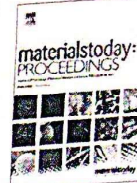
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# Thermal and magnetic properties study of NiCo<sub>2</sub>O<sub>4</sub>/graphene and NiFe<sub>2</sub>O<sub>4</sub>/graphene

Manuel George<sup>a,\*</sup>, K. Pratheesh<sup>a</sup>, Akash Mohanty<sup>b</sup>, Nakul Suresh<sup>a</sup>, Tijo Varghese<sup>a</sup>, Richard Sunny<sup>a</sup>, S. Narayanan<sup>a</sup>

<sup>a</sup> Department of Mechanical Engineering, Mangalam College of Engineering, Ettumanoor, Kerala, India  
<sup>b</sup> SMEC, VIT Vellore, TN, India

Dr. K. PRATHEESH  
 Head of Department

Department of Mechanical Engineering

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## ABSTRACT

The article explores thermal stability studies and magnetization properties of spinel ferrites with graphene. Different spinel ferrites such as CoFe<sub>2</sub>O<sub>4</sub>, Ni<sub>0.25</sub>Zn<sub>0.75</sub>Fe<sub>2</sub>O<sub>4</sub>, NiFe<sub>2</sub>O<sub>4</sub>, NiCoFe<sub>2</sub>O<sub>4</sub> were prepared by a co-precipitation method, followed by sintering at 900 °C, 1200 °C, 1450 °C, and graphene was prepared by Hummers method. The magnetic polarization after particle bonding was found higher for sintered powder samples. The saturation magnetization (Ms) of 50.57 emu/g for NiCoFe<sub>2</sub>O<sub>4</sub> powder and 63.1 emu/g for CoFe<sub>2</sub>O<sub>4</sub> specimen sintered at 1200 and 1400 °C. This could be by the weakening of spin canting with a variation in the increase of sintering temperature. The addition of graphene to nickel-cobalt improved the saturation magnetization from 40.8 to 43.8 emu/g with an increase in graphene content 5 to 20 wt%. An increase in magnetization of 6.8 % was gained by the influence of graphene. While nickel-ferrite with 26 mg graphene without sintering gained the Ms value as 30.79 emu/g. Thermal stability enhanced upon the increase in graphene concentration for NiCo and NiFe due to higher crystallite size as a higher stage 2 slope than stage 1 of DTG denoting a faster crystallite growth.  
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## 1. Introduction

Spinel ferrites are widely studied magnetite for their superior chemical stability and exceptional magnetic and electrical characteristics [1]. Different synthesis routes such as hydrothermal, co-precipitation, sol-gel techniques are adopted for particles synthesis along with different sintering temperatures. Spinel ferrites are a class of chemically and thermally stable materials suitable for a wide variety of applications [2]. Nickel substituted cobalt ferrites suits in supercapacitors with high energy efficiency, sensors, energy storage, and catalysts [3]. Mohamed et al. [4] studied crystalline, pure cobalt ferrite powders and attained a maximum saturation magnetization of 76.1 emu/g with the single-phase at Fe<sup>3+</sup>/Co<sup>2+</sup> molar ratio 1.818 and annealing temperature of 600 °C for 2 h using tartaric acid precursor. Velhal et al. [5] obtained a maximum saturation magnetization with 0.4 Ni substituted cobalt ferrite, of 92.87 emu/g at 30 K.

Liu et al. [6] studied the microstructure and magnetic properties of Ni<sub>0.5</sub>Zn<sub>0.5</sub>Fe<sub>2</sub>O<sub>4</sub> nanoparticles by the rapid combustion process. Gao et al. [7] synthesized NiFe<sub>2</sub>O<sub>4</sub> by sol-gel method, and Curie temperature increased from 849 to 859 K. The highest saturation magnetization of 70 emu/g at 298 K and the highest specific heating rate of 1.6 K/s. Yan and Hu [8] observed a monotonous increase in permeability of both microwave and conventionally sintered samples with increasing sintering temperature. An agglomeration of nanoparticles was observed due to their magnetic properties, [9] where ease in magnetizing the material was the reason. Matsushita et al. [10] got a hysteresis loss when the magnetic material Ni<sub>0.22</sub>Zn<sub>0.78</sub>Co<sub>0.02</sub>Fe<sub>2.782x-2y</sub>O<sub>4</sub> films is going through a cycling state and Ms of the material was independent of the Co content y. The enclosed area within the hysteresis curve, which is the measure of the energy lost in the core material during that cycle. Madani et al. [11] found out the pH in the starting solution affects the combustion process, and then determines the particle size of the synthesized powder. Goodarz et al. [12] obtained a larger saturation magnetization when calcined at a slower heating rate where a complete crystallization occurred. Sangmanee and Maensiri

\* Corresponding author.  
 E-mail address: [manuel.george@mangalam.in](mailto:manuel.george@mangalam.in) (M. George).



[13] showed that saturation magnetization (Ms) increases for cobalt ferrite from 9.7 to 56.5 emu/g with decreasing the heating rate of calcination at 5 °C/min heating rate calcined at 773 K. The Ms value increases for larger particle sizes and decreases for smaller sizes. Fe<sub>2</sub>O<sub>3</sub> got poor electrical conductivity, low specific capacity, and poor cycling stability, which limits its commercial application. But the development of composite material based on Fe<sub>2</sub>O<sub>3</sub> and graphene enhances the electrochemical performance of Fe<sub>2</sub>O<sub>3</sub> [14].

Ferrites find applications in battery electrodes, solar cells, sensors, while it lacks in attaining better conductivity and surface area that is essential in the development of better electrode materials. The ferrites combining with carbonaceous materials improve the electrochemical performance of the ferrite electrode material as certain carbonaceous materials like graphene, CNTs got superior conductivity and surface area [15].

Samee Gadwal et al. [29] studied the growth of cobalt by developing the concept of locally varying strain preferably nucleating on some favourable nucleation sites. This provides a perspective for engineering a nanocrystalline cobalt system with profound spatial ordering in which the textural morphologies and magnetic properties can be tailored. Lokhande et al. [30] synthesized PVA/Ni(OH)<sub>2</sub> nanocomposite by adding nickel hydroxide in PVA. The flame retardancy property improved because at high temperature Ni(OH)<sub>2</sub> decomposes and release water which dilute combustible gases. Lokhande et al. [31] developed a film on the nickel substrate demonstrated superior electric conductivity and higher surface area which resulted in rapid electron transfer and more active mass deposition. Vertical nanorods grown on the rGO sheet was found to maximize electrode performance. Chavan et al. [32] synthesised battery-type electrode Ni(OH)<sub>2</sub>/Ni tested as an electrode for supercapacitor which exhibited superior electrochemical performance. The excellent electrochemical performance is due to materials unique nanostructure where thin nanosheets build the nanobelt-like structure. Lokhande et al. [33] studied presence of highly conductive reduced graphene oxide enhances the charge transfer process and facilitates electrolyte diffusion without aggregation of active material. From the result, discussion attributes that Ni(OH)<sub>2</sub>/rGO composite has better electrochemical performance than pure Ni(OH)<sub>2</sub> and which indicates that composite material is a promising candidate for supercapacitor electrode.

Thus, in this paper, the influence of magnetic particles such as CoFe<sub>2</sub>O<sub>4</sub>, Ni<sub>0.25</sub>Zn<sub>0.75</sub>Fe<sub>2</sub>O<sub>4</sub>, NiFe<sub>2</sub>O<sub>4</sub>, NiCoFe<sub>2</sub>O<sub>4</sub> with graphene on thermal and magnetic properties was studied.

## 2. Experimental

### 2.1. Materials

Table 1 shows the list of chemicals used in this research work.

### 2.2. Synthesis of graphene

Graphene oxide was synthesized by modified Hummer's method. Initially, 3 g of graphite powder dispersed into conc. H<sub>2</sub>SO<sub>4</sub> to H<sub>3</sub>PO<sub>4</sub> solution (9:1 ratio), was kept on a magnetic stirrer. Then, 18 g of KMnO<sub>4</sub> was added to the solution pinch-wise. This solution was heated to 55 °C for 12 h. Further, the solution was kept in the ice bath to quench the reaction. Followed by the addition of 400 ml distilled water (DW) and 3 ml of 30 % H<sub>2</sub>O<sub>2</sub> into the solution. The residue material was washed with 30 % HCl + DW solution and dried out at 40 °C in the vacuum oven.

**Table 1**  
List of chemicals used.

Material	Manufacturer
Graphite flakes	Alfa Aesar,
Concentrated sulfuric acid (H <sub>2</sub> SO <sub>4</sub> )	SD fine Ltd.
Phosphoric acid (H <sub>3</sub> PO <sub>4</sub> )	SD fine Ltd.
Hydrochloric acid (HCl)	SD fine Ltd.
Hydrogen peroxide (H <sub>2</sub> O <sub>2</sub> )	SD fine Ltd.
Potassium permanganate (KMnO <sub>4</sub> )	SD fine Ltd.
Ethanol	SD fine Ltd.
N, N dimethylformamide (DMF)	SD fine Ltd.
Polyvinylpyrrolidone (PVP)	Sigma Aldrich, India
Nickel Nitrate (AR) Ni(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	SD fine Ltd.
Cobaltous Nitrate hexahydrate (AR) Co(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	SD fine Ltd.
Zinc Nitrate (AR) Zn(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	SD fine Ltd.
Ferric Nitrate (AR) Fe(NO <sub>3</sub> ) <sub>3</sub> ·9H <sub>2</sub> O	SD fine Ltd.
NaOH pellets	Nice chemicals Ltd., Kochi

### 2.3. Synthesis of magnetic particles

#### 2.3.1. Preparation of CoFe<sub>2</sub>O<sub>4</sub>, NiCoFe<sub>2</sub>O<sub>4</sub>, NiZnFe<sub>2</sub>O<sub>4</sub>

The magnetic nanoparticles were prepared by the coprecipitation method. Cobalt nitrate (0.5 M) and Ferric nitrate (1.0 M) mixture solution was fed into a 100 ml NaOH solution by maintaining a constant pH value with constant stirring. Nickel nitrate (0.1 mM), cobaltous nitrate (0.1 mM), iron nitrate (0.2 mM) were dissolved in distilled water and stirred for 3 h continuously. NaOH was added to maintain the pH to 12. 0.2 mmol of iron (III) nitrate, 0.025 mmol of nickel nitrate, and 0.075 mM zinc nitrate, and the solution stirred for 2 h. NaOH solution is added to maintain pH to 12. All the precipitates were then filtered out and washed with distilled water several times. Further, the precipitates were dried at 110 °C for 12 h.

#### 2.3.2. Preparation of NiCo<sub>2</sub>O<sub>4</sub>/Graphene and NiFe<sub>2</sub>O<sub>4</sub>/graphene

Nickel nitrate (2 mM), cobaltous nitrate (4 mM), were dispersed in deionized water. Graphene was added in 5 and 10 wt% mass ratios [27,28]. This was kept in the autoclave for 12 h @ 160 °C. The mixture was washed with ethanol and deionized water to get the precipitate. Finally, the precipitate was annealed at 60 °C for 12 h to obtain NiCo<sub>2</sub>O<sub>4</sub>/graphene powder.

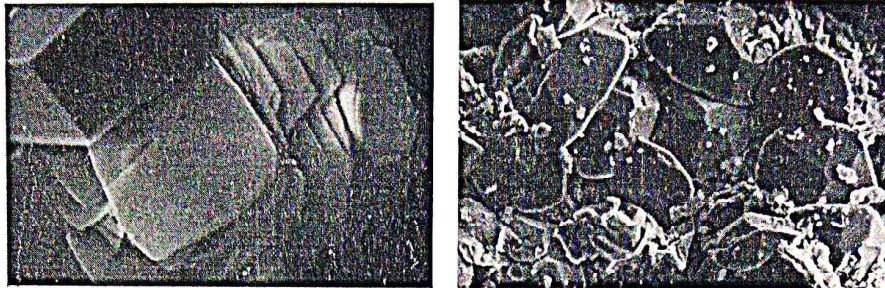
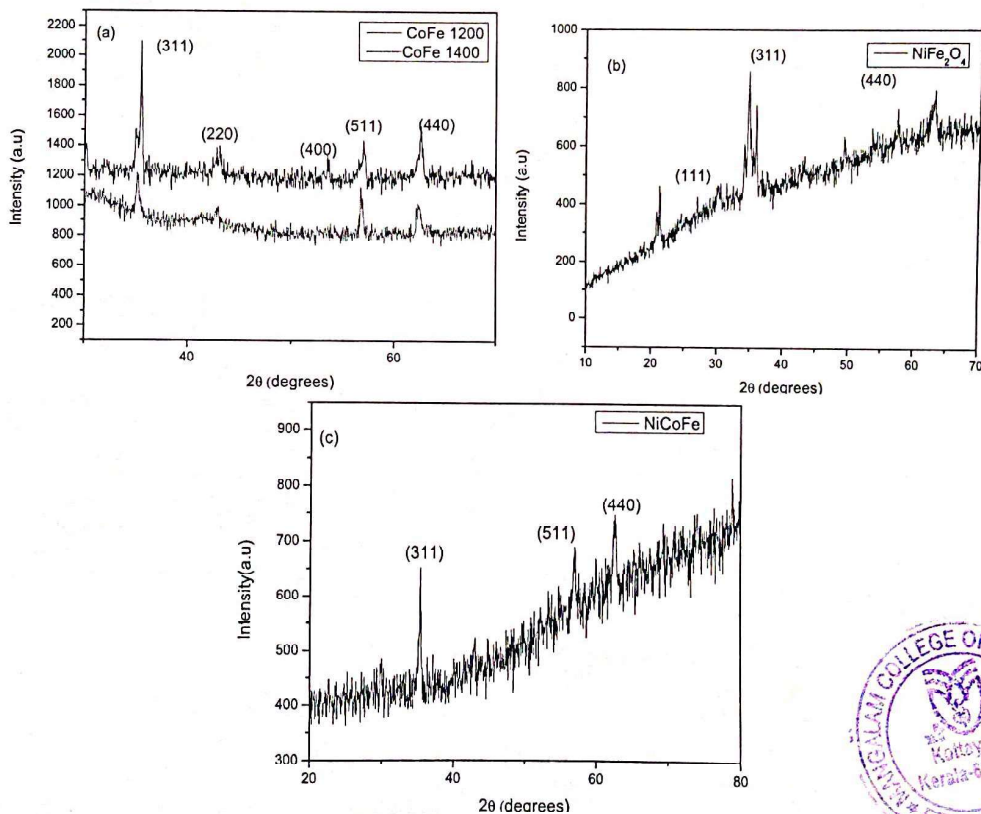
For the synthesis of NiFe<sub>2</sub>O<sub>4</sub>/graphene, 26 mg of graphene got dissolved into 70 ml of ethanol with sonication for 1 h. Then 291 mM of Ni(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O and 808 mM of Fe(NO<sub>3</sub>)<sub>3</sub>·9H<sub>2</sub>O were added into the graphene solution with stirring for 30 min at room temperature. The pH was maintained at 10.0 with 6 M NaOH solution. This was kept in an autoclave for 20 h @ 180 °C. Finally, the precipitate was washed and dried (see Fig. 1).

### 2.4. Characterization

#### 2.4.1. SEM/EDAX

The morphology of the Graphene and ferrite powder was studied by scanning electron microscope (SEM) (model JSM 840A, JEOL) showed in Fig. 1. The X-ray diffractometer with CuKα radiation (λ is the wavelength of the X-ray radiation = 1.5406 Å) source, the X-ray diffraction pattern of the sample is recorded with a step scan mode (0.058/s) and the intensity data is collected over the range of 20–90. From the XRD plots (Fig. 2) the interplanar spacings of NiCoFe<sub>2</sub>O<sub>4</sub>, CoFe<sub>2</sub>O<sub>4</sub> nanocrystals obtained similar values of 0.239 nm, corresponding to the (311) crystal planes of NiCoFe<sub>2</sub>O<sub>4</sub> [16] while that of NiFe<sub>2</sub>O<sub>4</sub>, Ni<sub>0.25</sub>Zn<sub>0.75</sub>Fe<sub>2</sub>O<sub>4</sub> got 0.256 nm, corresponding to the (311) crystal planes. The intense peak at 35° with d spacing



Fig. 1. SEM of Graphene and NiCoFe<sub>2</sub>O<sub>4</sub> with graphene.Fig. 2. XRD plot of (a) CoFe<sub>2</sub>O<sub>4</sub>, (b) NiFe<sub>2</sub>O<sub>4</sub> sintered at 1200, (c) NiCoFe<sub>2</sub>O<sub>4</sub> sintered at 1200.

of 0.25 nm corresponds to the (311) plane of NiFe<sub>2</sub>O<sub>4</sub> nanoparticles [17,18].

The average particle size also was determined from the full width at half maximum (FWHM) of the XRD patterns, using the well-known Scherer formula:

$$D = 0.9 \lambda / (\beta \cos \theta),$$

where D is the crystallite size (nm),  $\beta$  is the full width of the diffraction line at half of the maximum intensity measured in radians,  $\lambda$  is the X-ray wavelength of Cu K $\alpha$  = 0.154 nm, and  $\theta$  is the Bragg angle. The particle sizes estimated using the Scherer formula were found to increase with the calcination temperature, CoFe<sub>2</sub>O<sub>4</sub> it is from about 44 nm at 1200 °C to about 77 nm at 1400 °C (Table 1), a sim-

ilar increase with the calcination temperature, from about 10 nm at 673 K to about 41 nm at 923 K was reported earlier by Naseri et al. [19]. With the increase in temperature CoFe<sub>2</sub>O<sub>4</sub> particles got enlarged, CoFe<sub>2</sub>O<sub>4</sub> nanoparticles consisting of a core with the usual spin arrangement and a boundary surface layer with disordered atomic moments [20]. The existence of a spinglass shell in ferrite through broken exchange bonds at its surface and variations in the coordination of surface cations [21]. But for smaller particle size lowered the surface contribution that decreased the Ms. Similarly, the average particle size for NiCoFe<sub>2</sub>O<sub>4</sub> is 17 nm, NiFe<sub>2</sub>O<sub>4</sub> it is 12 nm. Ramadevi, et al. received an average particle size for cobalt ferrite and nickel doped cobalt ferrite samples of 20 and 27 nm [22]. From Table 2 the radius of the impurity ion Ni<sup>2+</sup> ion (0.72 Å) was





**Table 2**  
Average particle size (nm) of nanoparticles determined from XRD.

Nanoparticles	Calcination temperature (°C)	Average particle size XRD (nm)	Ms (emu/g)
CoFe <sub>2</sub> O <sub>4</sub>	1200	44	62.2
CoFe <sub>2</sub> O <sub>4</sub>	1400	77	63.3
NiCoFe <sub>2</sub> O <sub>4</sub>	1200	17	50.5
NiFe <sub>2</sub> O <sub>4</sub>	1200	12	30.7

smaller than the host ion Co<sup>2+</sup> ion (0.74 Å), that led to a decrease in bond length thereby an increase in force constant on both sites.

#### 2.4.2. Magnetic hysteresis measurements

The magnetic field in the range -10 to +10 kOe was produced by a transformer with 1200 primary turns inducing a voltage in the secondary turn generates magnetic flux. Thus, a closed ferromagnetic circuit is formed. The output range is from 0.00001 to 10,000 e.m.u at room temperature. The primary circuit current and an induced secondary voltage are sent by a USB data logger to the computer. The sample was loaded onto a pan which is rotated at 360° w.r.t magnetic field. The output from the testing set up named PAR 155 is fed to X - Y(t) recorder.

### 3. Results and discussions

#### 3.1. Magnetic property analysis of cobalt ferrite, nickel cobalt ferrite and nickel zinc ferrite

M-H magnetic hysteresis loops of CoFe<sub>2</sub>O<sub>3</sub>, and Ni<sub>0.25</sub>Zn<sub>0.75</sub>Fe<sub>2</sub>O<sub>4</sub> sintered at different temperatures are plotted in Figs. 3 and 4. Hysteresis loops of the nickel ferrite and nickel-cobalt with graphene samples analyzed are represented in Fig. 5. We can observe different behaviour for the samples with graphene addition for NiCo5wt.-graphene and 10 wt graphene after moderate temperature sintering but NiFe-graphene obtain very similar loops for the unsintered samples.

From Fig. 5 magnetic hysteresis curve of NiCoFe<sub>2</sub>O<sub>4</sub> with 5 wt% graphenes obtaining the Ms value 40.8 emu/g and with 10 wt% graphenes obtaining the Ms value 43.8 emu/g. The addition of graphene to Nickel Cobalt Ferrite improved the saturation magnetization from 40.8 to 43.8 emu/g with an increase in graphene content from 5 to 10 wt%. Hence an increase in magnetization of 6.8 % was obtained with the influence of graphene alone.

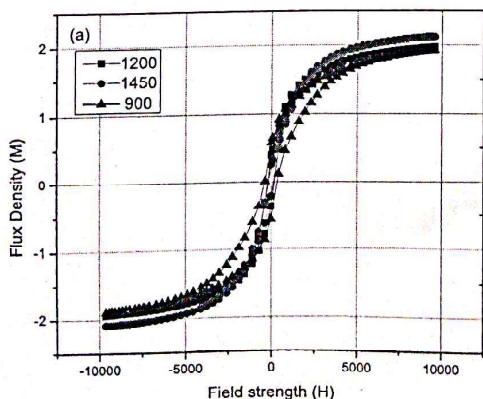


Fig. 3. CoFe<sub>2</sub>O<sub>3</sub> (900 °C sintering) = 53.74 emu/g CoFe<sub>2</sub>O<sub>3</sub> (1200 °C sintering) = 62.2 emu/g CoFe<sub>2</sub>O<sub>3</sub> (1400 °C sintering) = 63.36 emu/g

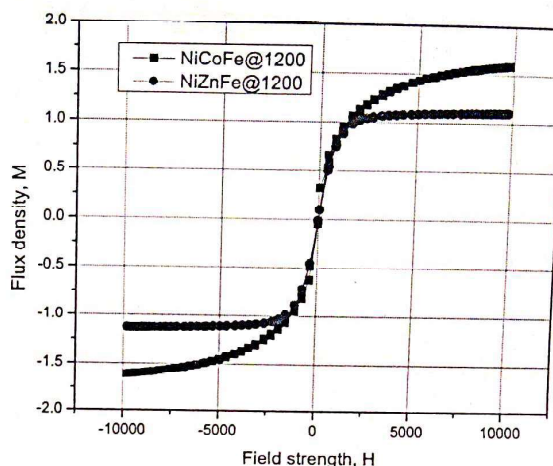
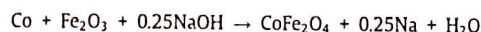


Fig. 4. Ni<sub>0.25</sub>Zn<sub>0.75</sub>Fe<sub>2</sub>O<sub>4</sub> sintered @ 1200 Ms = 31.48 emu/g and NiCoFe<sub>2</sub>O<sub>3</sub> sintered @ 1200 Ms = 50.57 emu/g.

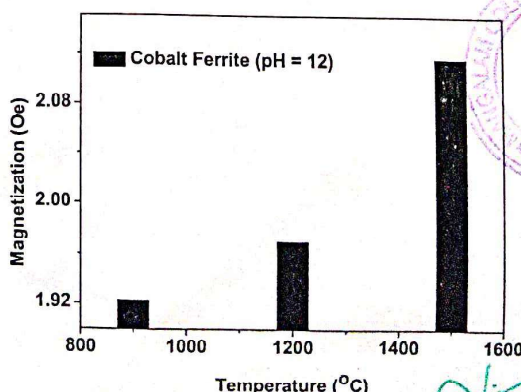
While Nickel Ferrite with 20 wt% graphene without sintering gaining the Ms value 30.79 emu/g.

From Fig. 5(a) the NiCoFe<sub>2</sub>O<sub>4</sub> for 5 wt% and 10 wt% graphene samples shown different hysteresis loops, with non-attainment of saturation, that proves an onset of superparamagnetic behavior [23]. Based on the typical shape of MH curve which is same as that mentioned by Suneetha et al [34].

For the CoFe<sub>2</sub>O<sub>4</sub> (Fig. 3(a)) the area under the curve is higher at lower sintering temperature than at higher sintering temperature that is associated with greater magnetic losses. The reaction for the formation of Cobalt ferrite is as given below:



Ceylan et al. [24] reported with NiFe<sub>2</sub>O<sub>4</sub> gained a saturation magnetization, with the Ms value 52.9 emu/g, where an improvement in hysteresis was through alignment of atomic spins by exchange interactions along with rotational barriers due to magnetocrystalline, magnetoelastic, and shape anisotropy that constrained the particles in different metastable orientations. Here NiFe<sub>2</sub>O<sub>4</sub> gained 30.7 emu/g with the smallest average particle size 12 nm. Dey et al. [25] synthesized nanosized Ni<sub>0.5</sub>Zn<sub>0.5</sub>Fe<sub>2</sub>O<sub>4</sub> by the





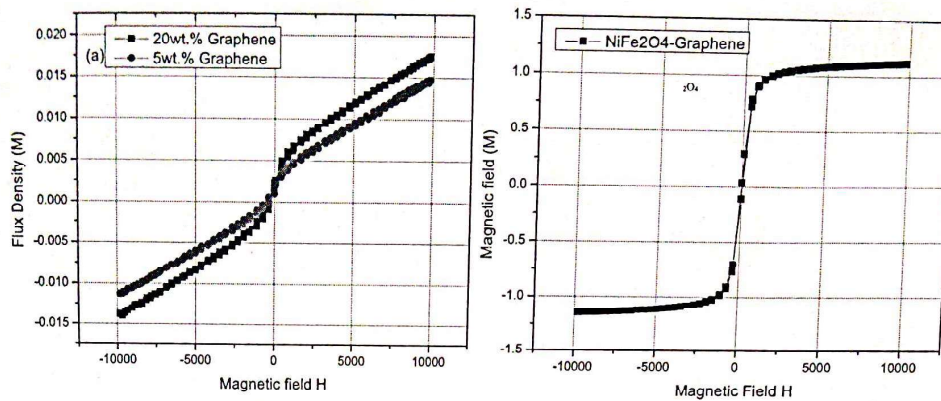


Fig. 5. Magnetic hysteresis curve (a) NiCo<sub>2</sub>O<sub>4</sub>-5 wt and NiCo<sub>2</sub>O<sub>4</sub>-10 wt graphene (b) NiFe<sub>2</sub>O<sub>4</sub> -20 wt-graphene without sintering.

high energy ball milling method with a specific saturation magnetization 30.7 emu/g at 27 °C while with Ni<sub>0.25</sub>Zn<sub>0.75</sub>Fe<sub>2</sub>O<sub>4</sub> got Ms value 31.4 emu/g with the average particle size of 19 nm. Nickel-substituted cobalt ferrites are highly resistive and magnetostrictive while cobalt ferrite is a well-known hard magnetic material with moderate magnetization. Here a higher Ms for CoFe<sub>2</sub>O<sub>4</sub> is attributed to the increase in the average particle size towards the single domain size. While nickel ferrite is a typical soft magnetic material [26] and a decrease in the grain size led to a decrease in the saturation magnetization. The interaction of nickel with graphene disturbs the hybridization between d electrons of Nickel and pi orbital of graphene. Thereby, a small magnetic behaviour exhibited by the graphene. Also, graphene is nonmagnetic in nature as the electrons in the outer rings are perfectly paired but when got twisted or stacked graphene generates some magnetism. Hence an ultimate increase in the magnetic property with the increase in graphene ferrite composite.

3.2. TGA DTG of NiCoO<sub>4</sub>-5 wt-graphene, NiCo<sub>2</sub>O<sub>4</sub>-10 wt-graphene, NiFe<sub>2</sub>O<sub>4</sub>-graphene

Table 3 lists weight loss at various temperature ranges. Fig. 6 gives the TGA-DTG curves (from ambient temperature to 800 °C). The endothermic peak at around 100 °C accompanied by a higher weight loss (about 7 % for NiCo<sub>2</sub>O<sub>4</sub>-graphene and 3 % for NiFe<sub>2</sub>O<sub>4</sub>-graphene) can be attributed to the dehydration of absorbed moisture content of the sample. The endothermic peak shifted 255 °C from 148 °C for an increase in graphene weight from 5 to 10 wt% for NiCo<sub>2</sub>O<sub>4</sub> and NiFe<sub>2</sub>O<sub>4</sub> 20 wt-graphene its 163.39 °C here the heat absorption is maximum with higher graphene content. In the temperature range 100–600 °C, 29 % and 19 % mass loss in NiCo<sub>2</sub>O<sub>4</sub> 5 wt-graphene and NiCo<sub>2</sub>O<sub>4</sub> 10 wt-graphene respectively. But for NiFe<sub>2</sub>O<sub>4</sub> 20wt-graphene with a single-stage decomposition obtained 8 % mass loss. For the temperature range 600–800 °C mass loss of 8 %, 7 %, and 3.9 % respectively for NiCo<sub>2</sub>O<sub>4</sub> 5 wt-

Table 3  
Weight loss at various temperature range.

Samples	0–100 °C	100–600 °C	600–800 °C	Residue
NiCo <sub>2</sub> O <sub>4</sub> + 5wt.Graphene	6.125 % (0.1134 mg)	29.724 % (0.5502 mg)	8.764 % (0.1622 mg)	55.27 % (1.073 mg)
NiCo <sub>2</sub> O <sub>4</sub> + 10wt.Graphene	7.288 % (0.1566 mg)	19.541 % (0.4199 mg)	7.872 % (0.1692 mg)	65.26 % (1.402 mg)
NiFe <sub>2</sub> O <sub>4</sub> + 20wtGraphene	3.295 % (0.07693 mg)	8.004 % (0.1869 mg)	3.994 % (0.09325 mg)	84.71 % (1.978 mg)

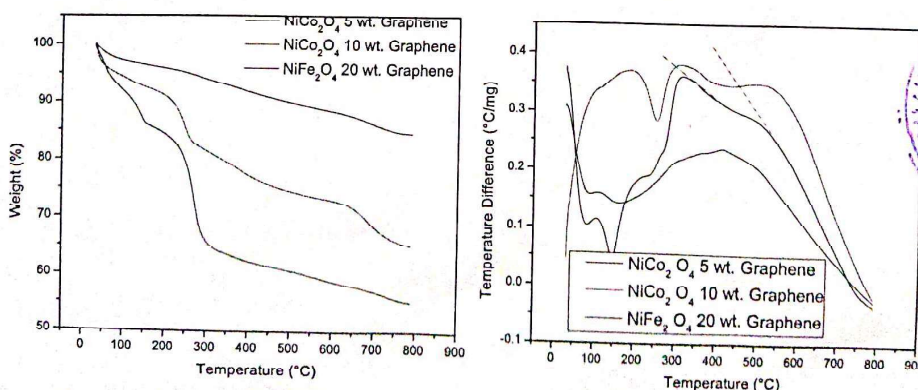


Fig. 6. (a) TGA curve of NiCo<sub>2</sub>O<sub>4</sub>-5 wt-graphene, NiCo<sub>2</sub>O<sub>4</sub>-10 wt-graphene, NiFe<sub>2</sub>O<sub>4</sub>-20 wt-graphene and (b)DSC of NiCo<sub>2</sub>O<sub>4</sub>-5 wt-graphene, NiCo<sub>2</sub>O<sub>4</sub>-10 wt-graphene.



graphene, NiCo<sub>2</sub>O<sub>4</sub> 10 wt-graphene, and NiFe<sub>2</sub>O<sub>4</sub> 20 wt-graphene. For NiCo<sub>2</sub>O<sub>4</sub> 10 wt-graphene an exothermic peak around 600 °C, with a small weight loss was observed. Thermal stability enhanced upon the increase in graphene concentration for NiCo<sub>2</sub>O<sub>4</sub> 10 wt-graphene. The residue left for NiFe<sub>2</sub>O<sub>4</sub> 20wt-graphene gained by 22.9 % for a higher graphene loading.

From Fig. 6(b) two endothermic phase is visible around 350–500 °C and 500–800 °C represented in DTG curve. This could be ascribed to the growth of ferrite crystallites. The slope of lead lines in Fig. 6(b) of phase 1 is evidently sligher than that of phase 2, which indicates the faster growth of ferrite crystallites in phase 2. Thus, for higher crystallite size thermal stability got enhanced [25].

#### 4. Conclusion

Different ferrites such as CoFe<sub>2</sub>O<sub>4</sub>, NiFe<sub>2</sub>O<sub>4</sub>, NiCoFe<sub>2</sub>O<sub>4</sub> were prepared by a co-precipitation method followed by sintering at 900 °C, 1200 °C, 1450 °C respectively. The investigation ends by understanding the strengthening by chemical polarization through internal chemical bonds attained through sintering. With the increase of sintering temperatures, the saturation magnetization increases due to the weakening of spin canting. The magnetic losses of the composites are due to natural resonance and the eddy currents. From the TGA-DTG curve, the endothermic peak shifted to 255 °C from 148 °C for an increase in graphene weight from 5 to 10 wt% for NiCo<sub>2</sub>O<sub>4</sub> and NiFe<sub>2</sub>O<sub>4</sub> 20 wt-graphene its 163.39 °C here the heat absorption is maximum with higher for 10 wt graphene content. Within the temperature range of 100–600 °C, 29 % and 19 % mass loss for NiCo<sub>2</sub>O<sub>4</sub> 5wt-graphene and NiCo<sub>2</sub>O<sub>4</sub> 10wt-graphene respectively and for NiFe<sub>2</sub>O<sub>4</sub> 20 wt-graphene with a single-stage decomposition obtained 8 % mass loss. Thus, the thermal stability enhancement achieved with graphene addition with reduced mass loss and higher heat of absorption. Hence, the addition of graphene to ferrite leads to the development of lightweight magnetic composites retaining magnetic properties and enhancing the thermal stabilities.

#### CRedit authorship contribution statement

**Manuel George:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing- original draft, Writing- review & editing. **K. Pratheesh:** Resources, Software, Supervision, Validation, Visualization. **Akash Mohanty:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration. **Nakul Suresh:** Investigation. **Tijo Varghese:** Investigation. **Richard Sunny:** Investigation. **S. Narayanan:** Investigation.

#### Data availability

Data will be made available on request.

#### Declaration of Competing Interest

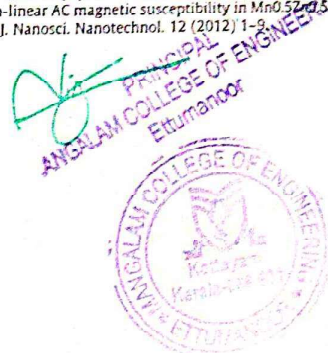
The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: MANUEL GEORGE reports a relationship with Mangalam College of Engineering that includes: employment.

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## Mechanical properties studies on rubber composites reinforced with Acacia Caesia fibre

Navaneeth Santhosh<sup>a</sup>, Sudhimon Selvam<sup>a</sup>, Rahul Reghu<sup>a</sup>, Jishnu Sundaran<sup>a</sup>, Benphil C. Mathew<sup>a</sup>, Sivasubramanian Palanisamy<sup>b</sup>

<sup>a</sup> Dept of Mechanical Engineering, Mangalam of Engineering, Ettumanoor, India

<sup>b</sup> Dept of Mechanical Engineering, Dilkip Research Institute of Engineering and Management Studies, Neral, Maharashtra, India

Dr. K. PRATHEESH  
Head of Department  
Department of Mechanical Engineering

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### ABSTRACT

Acacia Caesias are inexpensive, have superior mechanical properties, high strength, are less abrasive, and are environmentally benign and biodegradable. The main objective of the present work is to study the mechanical properties of Acacia Caesia reinforced natural rubber composites at different weight fractions of Acacia Caesia under treated and non-treated conditions. At first, the fibre is treated with NaOH, and then a composite is manufactured for both untreated and treated fiber. After the synthesis of a Acacia Caesia reinforced natural rubber composite, the effects of surface treatment on its mechanical properties are studied. Natural reinforced natural rubber composites were manufactured according to ASTM standards using a compression moulding technique. The developed composites were then tested for their mechanical properties, tensile, tear, hardness, and properties. The standard test method used is ASTM D624 for tensile properties.

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### 1. Introduction

Modern polymer chemistry and technology are focused on preparing nanocomposites and bio-based composites. In the case of polymer-based composites, nanotechnology provides solutions to several problems, and the advanced nanomaterials thus obtained have specific properties suitable for demanding applications. A composite material can be defined as a macroscopic combination of two or more distinct materials. Acacia caesia reinforced biodegradable composites are the best alternative to conventional materials. Acacia Caesias are cheaper in cost, environmentally friendly, and biodegradable. The matrix materials are the majority part of the composite, which binds the fibres to each other in the composite to increase the adhesion between the matrix and fiber. The reinforcing materials are mainly fibre materials, and they are used to increase the strength and stiffness of the matrix [11]. Natural rubber is a naturally occurring elastomeric polymer of isoprene (cis-1, 4-polyisoprene). The reinforcing efficiency of acacia caesia depends upon the nature of cellulose and its crystallinity [2]. Components which are present in Acacia Caesias are cellulose ( $\alpha$ -cellulose) hemicelluloses, lignin, pectin, and waxes. The moderate mechanical properties of Acacia Caesias prevent them from

being used in high performance applications where carbon fibre reinforced composites would be utilized, but for many reasons they can compete with glass fiber. The low specific weight, which results in a higher specific strength and stiffness than those of glass, is a benefit. The use of renewable Acacia Caesias contributes to sustainable development. The developed composites were then tested for their mechanical properties: tensile, tear, density, abrasion, hardness, compression, and cure properties. The properties of a composite are dependent on the properties of the constituent materials and their distribution and interaction [12]. At present, composite materials play a key role in the aerospace industry, the automobile industry, and in other engineering applications as they exhibit outstanding strength to weight and modulus to weight ratios. Tables 1 and 2

NR is a naturally occurring elastomeric polymer of isoprene (2-methyl-1, 3-butadiene). It can be extracted from the latex of only one kind of tree, the Hevea Brasiliensis. Cellulose is a natural polymer consisting of Danhydroglucose (C6H11O5) repeating units joined by  $\beta$ -1, 4-glycosidic linkage at the C1 and C4 positions. Hemicellulose is different from cellulose. It comprises a group of polysachrides compiled from a combination of five and six carbon ring sugars. Lignin is a complex hydrocarbon polymer with both



**Table 1**  
Details of samples.

Ingredients	G (gm)	1 (gm)	2 (gm)	3 (gm)	4 (gm)	5 (gm)	6 (gm)	7 (gm)	8 (gm)	9 (gm)
Natural Rubber	100	100	100	100	100	100	100	100	100	100
ZnO	5	5	5	5	5	5	5	5	5	5
Stearic Acid	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
TDQ	1	1	1	1	1	1	1	1	1	1
CBS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sulphur	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

**Table 2**  
Contents of the composites.

Samples	Natural Rubber (gm)	Acacia caesia	
		Length (mm)	Weight (gm)
G	100	-	-
1	100	5	10
2	100	5	20
3	100	5	30
4	100	10	10
5	100	10	20
6	100	10	30
7	100	15	10
8	100	15	20
9	100	15	30

aliphatic and aromatic constituents, and it is totally insoluble in most of the solvents and can't be broken down into monomeric units. Lignin is considered to be a thermoplastic polymer having a glass transition temperature of around 900 °C and a melting temperature of around 1700 °C. It is totally amorphous and hydrophobic in nature. It is not hydrolyzed by acids, but soluble in hot alkali, readily oxidised and easily condensable with phenol [3]. Chemically, NR is *cis*-1, 4-polyisoprene. It is a linear, long-chain polymer with repeating isoprenic units (C<sub>5</sub>H<sub>8</sub>). It has a density of 0.93 KG/m<sup>3</sup> at 20 °C. Natural *trans*-1, 4-polyisoprene is a crystalline thermoplastic polymer. Here we used Ribbed Smoked Sheet Grade 4 (RSS4).

The main component of acacia caesia is cellulose. They are basically lignocellulosic with helical wound cellulose microfibrils in an amorphous matrix of lignin and hemicellulose. These fibres consist of several fibrils running along the fibre length. In addition to cellulose, a lesser quantity of hemicelluloses and lignin will be present in the fibers. Lignin is the cementing material for the cellulose fibril, and it gives strength to the fibers. The fibre properties are dependent on its chemical composition and internal fibre structure, which vary along the different sections of the same plant and also between different plants [15].

The proportions used for our experimental work are based on an analysis of a literature review of recent journals related to rubber composites obtained from natural and artificial fibres. From the data obtained, we can see that many mechanical properties and chemical structures were changed, thereby increasing their physical properties [14]. We can produce products with low investment at a low cost. More importantly, the most significant advantage of acacia caesia as a substitute for traditional materials is that it is completely biodegradable, making it extremely environmentally friendly [13]. Furthermore, the raw fibre material is abundant in nature. It's one main drawback is that it can't be used in high-strength applications for some particular Acacia Caesias. Natural rubber composites with acacia caesia (acacia caesia) reinforcing are used in a wide range of engineering and consumer products. Wear resistant and anti-vibration pads, floor mats, door panels, load-bearing bushes, and other items can be made from this material, which has improved tensile and tear strengths. These materials are used in the manufacture of toys, as well as in the

automotive and aerospace industries. Plywood can be replaced with some fiber-reinforced composites [4].

## 2. Literature review

Nowadays, we need more good materials to replace older materials for many uses, so we need to find some new materials like composites. Composites have many more good characteristics than normal materials have. We can see that natural rubber reinforced with banana fibre possesses high strength and is comparable with other such materials. And sisal fibre reinforced rubber also possesses good properties. [5].

It was to obtain the natural rubber composites filled with short jute fibres and investigate the influence of the applied fibrous filler amount on the tensile properties, tear strength, behaviour under cyclic compression, hardness, rebound resilience, abrasion resistance, density, and swelling parameters (by the equilibrium swelling method) of composites. Moreover, morphological analysis (by the SEM method) and dynamic mechanical analysis (by the DMA method) were performed. On the basis of FTIR and TGA results, the chemical composition of applied short jute fibres was estimated. The use of natural rubber as a matrix and short jute fibres as a filler permits the production of environmentally friendly materials because both components are derived from natural and renewable resources [1].

A series of short-isora fiber-reinforced natural rubber composites were prepared by the incorporation of fibres of different lengths (6, 10, and 14 mm) at 15 phr loading and at different concentrations (10, 20, 30, and 40 phr) with a 10 mm fibre length. Short-fiber-reinforced rubber composites are a rapidly growing class of materials because of their improved physical and mechanical properties, easy processability, and economic advantages. Mixes were also prepared with 10 mm long fibres treated with a 5 % NaOH solution [3].

The sisal and oil palm fibres were incorporated into a natural rubber matrix, and the influence of fibre ratio on the cure and tensile properties of hybrid fiber-reinforced natural rubber composites was analysed. Tensile strength and modulus were found to decrease with the loading of oil palm fiber. Longitudinally oriented composites showed better mechanical properties than transversely oriented composites. Maximum torque values were found to increase with oil palm fibre content. A positive hybrid effect was observed for the tensile properties [6].

A bio-based nano-sized material, cellulose nanocrystals (CNC), extracted from southern pine pulp, was employed as a reinforcing agent in a natural rubber (NR) matrix was studied. The NR/CNC nanocomposites were prepared by a solution mixing and casting method [2].

Characterize mechanical properties such as tensile strength, tear strength, and hardness for both longitudinal (00) and transverse fibre orientations (900) of a hybrid composite with unidirectional, continuous, and 40 % v/v hybrid of banana fibre and sisal fibres (1: 1) natural rubber latex. Banana and sisal fibres are made up of thick-walled cell tissue and bonded by natural gums. Banana fibre is similar to natural bamboo fibre, but its fineness and spin



ability are better than bamboo and ramie fibres. It is mainly composed of cellulose, hemicelluloses, and lignin. Both banana and sisal fibres are good alternatives to synthetic fibers. The fibres are also eco-friendly, chemical-free, non-toxic and odour-free. The elastomer material developed from rubber latex and hybrid (B/S) fibres as reinforcement exhibited improved mechanical properties like tensile strength, tear strength, and hardness. The longitudinal (00) loaded hybrid (B/S) fiber-latex specimen gave an increase in tensile strength over pure rubber latex and an increase of 282.7 % in tear strength over pure latex for 40 % v/v fibre loading. The hardness of the developed materials improved as well compared to pure latex [5].

Jute fibre of different lengths is selected and it is mixed with natural rubber. The fibres are uniformly cut into sets of lengths of 5 mm, 10 mm, and 15 mm, each weighing 20 g for each 100 g of natural rubber. The fibre was mixed with rubber in a laboratory by two roll mixing mills with a size of 150 × 300 mm as per ASTM at a friction ratio of 1:1.25. The mill opening was set at 0.2 mm. The nip gap, mill roll speed ratio, and number of passes were kept the same in all mixes. The test specimens for determining the physical properties were prepared in standard moulds by compression moulding on an electrically heated hydraulic press at 150 °C. Mechanical properties such as ultimate tensile strength, tear strength, swelling and hardness characteristics of the composites are tested. The incorporation of fibre into the rubber matrix increases the hardness of the composites, which is related to strength and toughness. The close packing of fibres in the compound increases the density while decreasing the resilience. The properties are improved by the incorporation of jute fibre. This demonstrates that an effective treatment and high-precision manufacturing can significantly improve mechanical properties. The properties vary with a change in their length. The best result for curing time and tensile strength is obtained for a 5 mm mix at 13.93 MPa. The best results for tear tests and swelling tests are obtained for 10 mm mixes. The maximum tear strength is 33.56 N/mm. Maximum hardness is 56 Shore A, which is given by a 15 mm mix [7].

Elastomeric composite using only naturally occurring materials. Two additional samples were made with the addition of 10 % w/w activated coconut shell powder to evaluate the effect of filler powder in the composites. A total of six samples were made and are being evaluated for their mechanical properties like tensile strength and tear strength. The results show that an increase of 73 % tensile strength was obtained for alkalinized sisal fibre composite with respect to natural rubber. Tear strength showed an exceptional increase of up to 246 % for alkalinized sisal fiber. Hardness values increased to 200–228 % for the composites. The best abrasion resistance is shown by alkalinized impregnated fiber. Compressive strength is the maximum for raw fibre and coconut shell powder filled rubber composites [8].

### 3. Experimental setup

In this experiment, we used a universal testing machine to find out tensile strength and tear strength. A hardness testing instrument is also used for finding the hardness value. The test is done as per ASTM standards.

#### 3.1. Objectives of the research work

The major objectives of the work are to analyse the cure time and mechanical properties and to compare the properties of composite samples at different lengths and weight fractions with those of normal rubber.

### 3.2. Experimental procedures

#### 3.2.1. Composite preparation

The composites were prepared by the embodiment of acacia caesia of different lengths and different loadings for fibres into the NR matrix along with suitable chemical composition. Mixes were made according to ASTM specifications in a laboratory (150 × 300 mm) two-roll mixing mill with a friction ratio of 1:1.25. The mill's opening was set at 0.2 mm. The fibre was introduced at the end of the mixing process, with special attention paid to maintaining the compound flow direction so that the majority of fibres followed it. At 150 °C, the samples were vulcanised [9].

#### 3.2.2. Cure characterisation

After the mixing of materials, the vulcanised material matrix at 150C will undergo finding cure time. "Cure time" refers to the amount of time it takes for an elastomer to cure entirely. The bond will fail if an elastomer is not given enough time to cure. Cure refers to the variation in cure characteristics of composites with different fibre lengths and loadings. In general, for all of the mixes, the torque initially decreased, then increased, and finally levelled off. The levelling off was an indication of the completion of curing. The introduction of fibres into the mix generally increases the torque values. This increase was due to the presence of long natural fibers, which imparted more restriction to deformation [9].

#### 3.2.3. Specimen preparation

Compression Moulding and Injection Moulding are the two most common methods for moulding rubber matrix. Compression moulding is the most popular option among these options, according to studies [9].

**3.2.3.1. Compression moulding.** The compression moulding machine used is indexpell. The rubber fibre matrix is preheated and inserted into a heated mould cavity in this process of moulding. The top force, or plug member, is used to close the mould, and pressure is applied to drive the material into contact with all mould areas. The specimen is then cured under heat and pressure. Vulcanisation is another name for this process. Compression moulded specimens come in a variety of shapes, each with their own set of mechanical properties [9].

#### 3.2.4. Tests for mechanical properties

**3.2.4.1. Tensile test.** The test is conducted on the UTM machine Instron 5965 by holding the specimen at 90° perpendicular and applying force in the opposite direction, the material elongates and breaks at the maximum ultimate breaking point, which is determined in accordance with ASTM D412 Fig. 1.



Fig. 1. Specimen for tensile test.



3.2.4.2. *Tear test.* On the same universal testing machine, which is Instron 5965, the tear strength, a measure of a material's resistance to tear force, is determined in accordance with ASTM D624. A test specimen with a 90-degree angle on one side and with tab ends is used to determine the tear strength of Acacia Caesia fibre reinforced natural rubber composites Fig. 2.

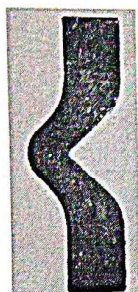


Fig. 2. Specimen for tear test.

3.2.4.3. *Hardness test.* Hardness measurement of a substance implies the resistance of a material to undergoing plastic deformation. The shore A durometer is commonly used to evaluate the hardness of elastomers such as natural rubber. A durometer with a reading of up to 90 units on the shore. The shore A durometer is simply placed above the specimen and applies 2 lb of force for 4 s, and three trials are taken into account and are determined in accordance with ASTM 2240 Fig. 3.

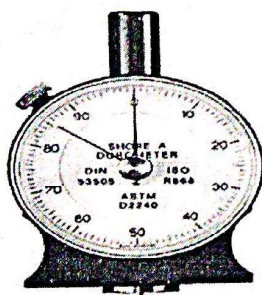


Fig. 3. Shore A durometer.

### 3.3. Materials and preparation

#### 3.3.1. Specimen and sample formation

The basic constituents of this work are natural rubber as the base material and acacia caesia (*Acacia Caesia*) as reinforcement material. For composite preparation, natural rubber having a weight of 100gm and acacia caesia (*acacia caesia*) having lengths of 5 mm, 10 mm, 15 mm and weights of 15gm, 30gm, and 60gm were selected. Using two roll mills, compounding of natural rubber only and natural rubber + acacia caesia takes place, and chemicals are added in between the processes. Using a cure time testing machine, the cure characteristics of the composite are determined. After this process, the composite has to be gone for the compression moulding at 1500C to form the fabricated structure [10].

### 4. Results & discussion

The compression moulding technique necessitates cure time in order to manufacture composite materials. At a temperature of 150 to 160 °C, the mould is created by compression for the curing time. The presence of fibres in compounds has an advantageous quality for the composite by forming a matrix with cross links. The reinforcement of acacia caesia (*Acacia Caesia*) to natural rubber has high reinforcing efficiency, which influences the vulcanisation process and the formation of cross links in the matrix.

#### 4.1. Tensile strength

From Table 3, the highest tensile strength was sample-3. This happened because there were fibres that held together the natural rubber matrix so that the composite became stronger and increased the bonding between acacia caesia and natural rubber. The test results show a decrease in tensile strength from sample 7 to sample 9. Tensile strength tends to decrease due to the excessive content of the natural fiber. The sample becomes harder when adding more fibres to the natural rubber.

#### 4.2. Tear strength

From Table 3, the highest tear strength was for sample -8. Here, when the fibre content is increased, the tear strength also seems to increase. But all the samples with fibre loading show better tear strength than the acacia caesia alone.

#### 4.3. Hardness

From Table 3, sample-5 has a high hardness value. And sample-9, with high fibre loading, has the least value. From the above charts, samples having less fibre content show better properties

Table 3  
Test results of different samples.

Samples	Cure Time (seconds)	Tear Strength (KN/m)	Tensile strength (Young's Modulus)	Hardness (Shore A)
Sample G	300	0.42	328.06	21
Sample 1	300	2.28	110.54	27
Sample 2	300	4.56	455.27	38
Sample 3	284	9.1	1333.72	24
Sample 4	300	3.23	228	32
Sample 5	283	5.83	277	48
Sample 6	753	13.01	38.97	28
Sample 7	323	9.78	235.21	34
Sample 8	440	15.19	150	32
Sample 9	783	10.79	153	14



than natural rubber. Samples 2, 3, and 5 have better results in all three mechanical properties (Hardness, Tear strength, and Tensile strength), so samples 2, 3, and 5 can be chosen among all these for our purpose.

The results don't suggest that a particular sample is good in all categories, but they show tremendous variation in its properties apart from natural rubber alone. Depending on the criteria of operation and usage, samples can be considered and focused on further development.

### 5. Conclusions

This work shows the successful fabrication of Acacia Caesia reinforced natural rubber composites. Acacia Caesia reinforced composite has a decreasing tensile strength in fibre loading. With the Acacia Caesia fibre reinforced natural rubber composite, we got an increasing value of tear strength with the increase in fibre loading. It indicates that the adhesion between Acacia Caesia fibres and natural rubber is more effective. Material made from Acacia Caesia fibre is more advantageous and has mechanical properties comparable to other composite materials. In addition, the hardness value increased. There is a huge possibility of combining Acacia Caesia and rubber to form a composite, which would be extremely beneficial to the rubber industry because it would be a bio composite that is more environmentally friendly and biodegradable.

### Data availability


Data will be made available on request.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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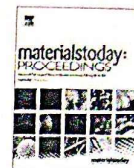






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## Micro thermal behavior of Ti- Mg composite processed through friction stir processing

S. Selvakumar<sup>a</sup>, S. Aneesh<sup>b</sup>, J. Rabi<sup>c</sup>, N. Mohammed Raffiq<sup>d,\*</sup>, K. Ganesh Babu<sup>e</sup>

<sup>a</sup>Department of Aeronautical Engineering, Nehru Institute of Engineering and Technology, Tamilnadu, India

<sup>b</sup>Department of Aeronautical Engineering, Nehru Institute of Technology, Tamilnadu, India

<sup>c</sup>Department of Mechanical Engineering, Managalam College of Engineering, Kerala, India

<sup>d</sup>Department of Food Technology, Nehru Institute of Technology, Tamilnadu, India

<sup>e</sup>Department of Mechanical Engineering, Chendhuran College of Engineering and Technology, Tamilnadu, India

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### ABSTRACT

Friction Stir Processing (FSP) has expanded its regime due to its promising potential to develop surface based composites with enhanced properties. The current study involves addition of 4 % magnesium in titanium to form a metal matrix composite through friction stir processing to evaluate thermal and microstructure characteristics of the resulting composite material. The main aim of the study is to understand the effect of adding small amount of magnesium over the thermal conductivity of the prepared composite. The Ti-Mg composite has been prepared through FSP and subjected for heating from temperature ranging from 130 °C – 530 °C. The composite material obtained through FSP is found to possess better thermal conductivity with an improvement ranging from 7.35 % – 8.86 % than the base material. SEM analysis carried out ensures the presence of magnesium particle dispersed in titanium base metal. Regression equation developed for the percentage increase in thermal conductivity have resulted with low error percentage ranging between –2.4 % to 8.44 %. The study carried out ensures the potential of FSP in developing titanium based composites with improved thermal conductivity through addition of magnesium at a small volume fraction of 4 %. The future study concentrates on increasing the reinforcement content and varying the FSP input parameters for evaluating mechanical, thermal and corrosive properties of the composite developed.

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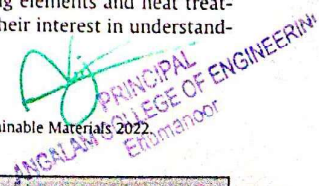
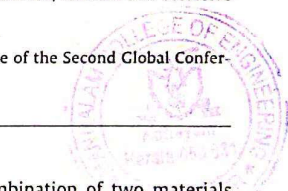
### 1. Introduction

Composite materials are essential in the aviation industry because they give structural strength similar to metallic alloys while being lower in weight. As a result, an aircraft's fuel efficiency and performance improve. Because of their excellent physical qualities and remarkable strength and stiffness-to-density ratios, composite materials are particularly appealing to aviation and aerospace applications. A composite material is made up of relatively strong, stiff fibers that are encased in a tough resin matrix. Composite materials have played a big part in weight reduction, thus they are utilized in everything from gliders and hot air balloon gondolas to fighter planes, space shuttles, and passenger jets. Com-

posites have been produced as a combination of two materials with varying properties where one material serves as a matrix and other one as reinforcement. The matrix material can be metals, ceramics, polymers which can be reinforced with synthetic and natural reinforcements. Aluminum, Titanium and Magnesium are found to have wide adoption as matrix materials in diverse industrial applications due to their excellent compatibility with reinforcing materials. Titanium is a strong, lightweight metal with a wide range of applications. Because of these properties, titanium is a popular choice in the aircraft sector. Aerospace applications necessitate parts that are both light and robust by their very nature. Numerous research activities have conducted around the globe for altering the properties of pure titanium to make them more suitable candidate in aerospace applications by different means such as adding reinforcements, alloying elements and heat treatment. Many researchers have shown their interest in understand-

\* Corresponding author.

E-mail address: [drmfnoor@gmail.com](mailto:drmfnoor@gmail.com) (N. Mohammed Raffiq).





ing the properties of developed composites through experimental and numerical simulations. Different methods have been followed by authors for development of surface composites such as Friction stir welding (FSW), Friction stir processing (FSP) etc. FSP made samples are generally cooled in still air for grain refinement after processing and the recent trend in FSP includes additional cooling methods incorporated in the system for attaining improved properties of the final sample. Jinwen et.al [1] studied the mechanical properties and microstructure of pure titanium alloy with (TiHf) Si<sub>3</sub> reinforcements and the authors have reported about the improvement in tensile strength obtained through the homogeneous distribution of reinforcement particles. Leucht and Dudek [2] investigated the properties of titanium alloys reinforced with Si-C fibres processed through fibre coating and hot isostatic processing. The amount of oxygen incorporated influences the strength and matrix ductility of the composites developed. Muhammad et.al [3] added graphene nanoplatelets (GNP) with magnesium titanium alloys for the improvement of ductility and strength. The authors have reported that the combination of Ti and GNP serve as an effective reinforcing filler against deformation. Tjong and Yiu [4] reported about the different forms of reinforcements such as particulate and whisker for titanium matrix composites to enhance the structural characteristics. Syeda et.al [5] developed aluminium titanium alloys with SiC reinforcement particles through powder metallurgy processing method and tested hardness of the resulting composite in varying proportions of different elements. The SiC reinforced samples have shown a considerable improvement in hardness and micro structural studies validate the dispersion of reinforcements in proper manner. The authors have recommended the alloys developed are light in weight and suitable for aerospace applications. Achihei Dragoş [6] processed titanium alloys for aerospace applications through thermal route. The experimental studies carried out by the authors include quenching, tempering of alloys and measurement of microhardness, elongation variation, expansion/contraction, linear expansion coefficient, transformation points, density modification. The authors have performed microstructure studies using electron microscopy at different magnitudes such as 1000x, 1500x to understand the presence of biphasic structure ( $\alpha + \beta$ ) typical for TiAl6V4 alloy. Ratna sunil et.al [7] have developed magnesium based metal matrix composites through FSP process by adding Al<sub>2</sub>O<sub>3</sub> powder targeting bone implant applications. The authors have used different pin profiles at varying speed to form the composites and the resulted composites have been subjected to SEM analysis to understand the micro structural properties of the developed composite. Ke Qiao et.al [8] prepared Magnesium zirconium oxide nanocomposites through FSP process and compared the developed composite with non reinforced magnesium plates. The prepared samples were tested for hardness, tensile strength and corrosion properties. The authors have reported that magnesium plates with reinforcement are found to have superior properties than its counterpart under different aspects. Issac and his co-authors [9] reported about developed AZ31 magnesium matrix composites with titanium particulate reinforcement through FSP. The authors have studied the effect of FSP process parameters over mechanical properties of final samples. Gangil et.al [10] fabricated magnesium nitinol particulate composites through FSP and studied the effect of tool profile and reported that the incorporation of particulates have improved the hardness values.

The literature survey carried out about the past research happened in titanium, magnesium based composites and alloys ensure the potential of FSP method in developing surface composites with acceptable properties. Based upon the survey, Friction stir processing (FSP) has been identified as the technique to develop Ti-Mg composites in the current study. In the present work, titanium has been taken as base material and Mg as the reinforcement at

small amount (4%). The developed composite is heated at different temperatures to understand the changes in thermal conductivity of the prepared sample. The future scope of the current work will be evaluating mechanical properties of the developed Ti-Mg composite such as hardness, tensile strength and validating the same with numerical simulations. In addition to that FSP process parameters may be optimized through experimental design and multi criteria decision making.

## 2. Materials and methods

The present study involves studying the micro thermal behavior of Titanium magnesium composite developed through friction stir processing technique. Titanium is being considered as base metal and magnesium is added with 4 % volume fraction. Titanium is a chemical element with symbol Ti found as an oxide in nature and can be reduced to lustrous transition metal with silver color. The density of titanium is low and possesses high strength, resistance to corrosion. Titanium has been used in the aircraft industry for many years. Pure titanium and titanium alloys, such as Ti-6Al-4V, are mostly employed for airframe and engine parts in the commercial world. Because of the low fuel consumption of aircraft, titanium demand is likely to grow. Table 1 shows the physical and mechanical properties of pure titanium base metal.

Magnesium (Mg) is a chemical element with the atomic number 12 and the symbol Mg. It's a gleaming grey solid with many of the same physical and chemical properties as the other alkaline earth metals. Magnesium is utilized in products like vehicle seats, luggage, laptops, cameras, and power tools that benefit from being lightweight. It's also used to eliminate sulphur from molten iron and steel. Magnesium is utilized in flares, fireworks, and sparklers because it ignites easily in air and burns brightly. Magnesium alloys and composites reinforced with different reinforcing elements pose exceptional set of mechanical properties made them as suitable candidate for aerospace applications. Table 2 shows the physical and mechanical properties of pure magnesium.

The inclusion of magnesium in titanium base metal is achieved through friction stir processing method and final surface composite produced consists 4 % volume fraction magnesium. Titanium was chosen because it has the same strength as aluminium but is

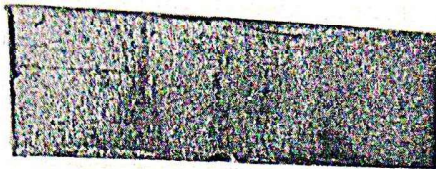
**Table 1**  
Properties of Pure Titanium Base Metal.

S.No	Property /Characteristic	S.I Unit	Value
1	Density	g/cm <sup>3</sup>	4.506
2	Tensile strength	MPa	220
3	Modulus of elasticity	GPa	116
4	Shear modulus	GPa	43
5	Brinell Hardness	BHN	70
6	Elongation at break	%	54
7	Poisson Ratio	-	0.34
8	Thermal Conductivity	W/mk	17

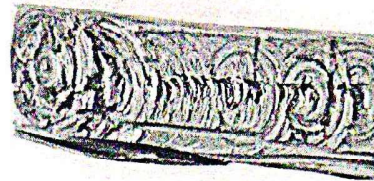
**Table 2**  
Properties of Pure Magnesium.

S.No	Property /Characteristic	S.I Unit	Value
1	Density	g/cm <sup>3</sup>	1.80
2	Tensile strength	MPa	225-240
3	Modulus of elasticity	GPa	45
4	Shear modulus	GPa	16
5	Brinell Hardness	BHN	80
6	Elongation at break	%	8-12
7	Poisson Ratio	-	0.28
8	Thermal Conductivity	W/mk	156





(a) Titanium Base Metal



(b) FSPed Ti-Mg Composite

Fig. 1. (a), (b) Titanium Base metal and FSPed Ti-Mg Sample.

lighter and can endure higher temperatures. Magnesium was chosen because of its ductility, malleability, and hardness. For fabricating the samples for property evaluation, Titanium was taken in the form of rectangle bar with dimensions  $80 \times 10 \times 10$  mm and magnesium in powdered form. The selected materials were subjected to friction stir processing in a vertical machining centre. A groove of 1.5 mm depth is created at the centre of the base metal and powdered magnesium is filled in the groove through FSP process. Friction Stir Processing uses Tungsten Carbide as a tool. It is rotated against the groove region at a speed of 1200 rpm. Fig. 1 (a) and (b) shows the titanium base metal and Ti-Mg composite obtained through FSP. Fig. 2 shows schematic representation of FSP.

### 3. Experimental work

The prepared Ti-Mg composite sample and pure titanium base metal has been subjected for evaluation of thermal conductivity at different temperature values ranging from  $130^\circ\text{C} - 530^\circ\text{C}$ . For the purpose of thermal conductivity measurement of both the samples immersion water rod, infrared thermometer gun has been used. Both FSPed and Non FSPed samples are placed in the immersion water rod for heating at the tip for 1 min. The temperature at the tip of the sample and opposite end is measured using infrared thermometer gun. The same procedure is repeated for different temperature values to calculate the value of thermal conductivity using fouriers law. Thermal conductivity values of both the samples were recorded and tabulated for further analysis. Fig. 3 shows the thermal conductivity test of FSPed sample using immersion water rod and infrared thermometer.

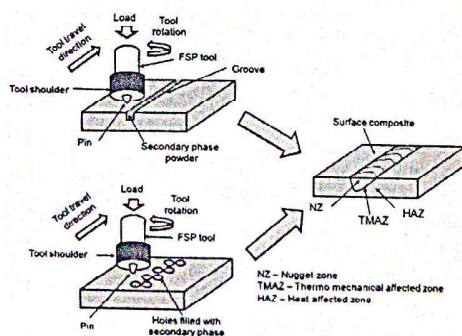


Fig. 2. Schematic representation of FSP (Ratna Sunil et.al).

### 4. Microstructure analysis

Microstructural examination can range from simple parameter determination, such as grain size or coating thickness, to more complex analysis. Knowing the combination range of chosen materials is required for composite material microstructure characterization. It will aid in the determination of grain size, porosity, bonding evaluation, surface coating, failure mechanisms, and crack formation. The present study involves analyzing both the base sample and FSPed composite sample for understanding the internal microstructure formed after undergoing FSP process and sample heating. The samples have been observed in two different magnifications such as 100x and 500x to understand the dispersion of magnesium in titanium. The etching of both samples is carried out using Keller's agent. Fig. 4 shows the optical microscope for micro structural analysis at ambient temperature.

The images obtained through optical microscope of pure base metal reveals the microstructure in  $\alpha$  form at temperatures adopted for testing. From both the magnification values followed the microstructure conforms the purity of base metal without any added elements or reinforcements. Fig. 5 shows the SEM image of base titanium metal without presence of any additional reinforcements.

Fig. 6 (a) and (b) obtained through the image analysis of FSPed sample confirms the presence of magnesium dispersed in titanium base metal. At higher magnifications such as 500x the presence of added magnesium can be well witnessed in titanium base metal.

### 5. Results and discussion

The thermal conductivity of both samples after heating them at different temperatures are tabulated and observed for the changes incurred with the addition of magnesium with pure metal. Thermal conductivity values of pure base metal starts decreasing at very low percentage from the initial temperature  $130^\circ\text{C} - 412^\circ\text{C}$ . At temperature  $450^\circ\text{C}$  the value of thermal conductivity starts increasing by 3% and shows a steady increasing progress. Table 3 shows the experimental values of thermal conductivity of pure and FSPed titanium samples for comparison.

Thermal conductivity values of FSPed Ti-Mg starts decreasing at very low percentage from the initial temperature  $130^\circ\text{C} - 350^\circ\text{C}$ . At temperature  $374^\circ\text{C}$  the value of thermal conductivity starts increasing by 3.38% and shows a decreasing curve till  $450^\circ\text{C}$ . Finally when the temperature reaches  $530^\circ\text{C}$  thermal conductivity again increases by 0.74%. Fig. 7 shows the plot of temperature vs thermal conductivity of both the samples heated.

The values of thermal conductivity obtained for both the samples have been compared and it is observed that the FSPed Ti-Mg sample is found to have higher thermal conductivity than the base



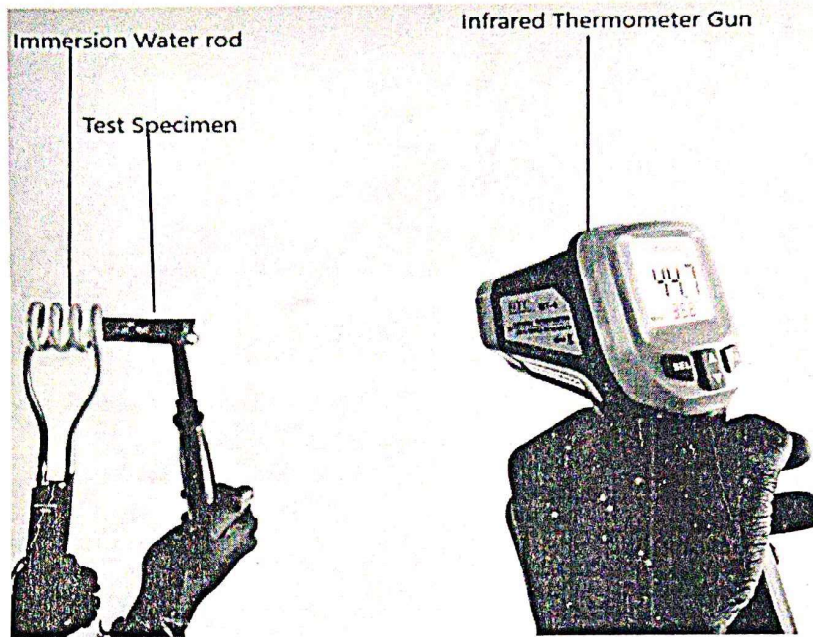


Fig. 3. Thermal Conductivity Test.



Fig. 4. Optical Microscope for Image Analysis.

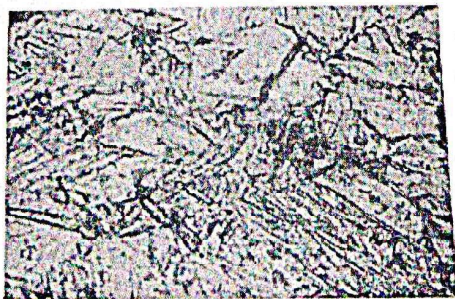
metal. The increase in thermal conductivity ranges between 7.35 % and 8.86 %. Percentage increase in thermal conductivity follows both increasing and decreasing fashion with increase in temperature.

The percentage increase in thermal conductivity is further analyzed through regression to understand the relationship exists with temperature. The regression equation developed has been used for predicting the value of increase in thermal conductivity. The predicted values are compared with the experimental values resulted to understand the error percentage. Table 4 shows the error percentage resulted from regression equation.

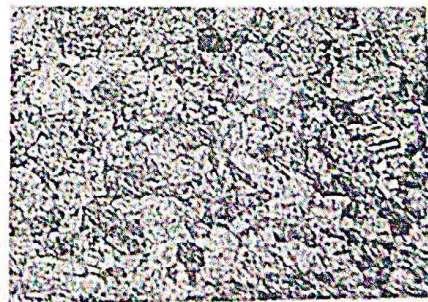
Equation (1) shows the regression Equation for Increase in Thermal Conductivity of Ti-Mg Composite in comparison to Ti metal with increase in temperature.

$$\text{Percentage of Increase in Temperature} = 7.6185 + 0.0015 * \text{Temperature} \quad (1)$$

The error percentage between the predicted value and experimental value ranges between -2.40 % to 8.44 % for the percentage increase in thermal conductivity of Ti-Mg composite with increase in temperature while comparing with pure titanium base metal.



(a) Sample 1 : Titanium without FSP (100x)

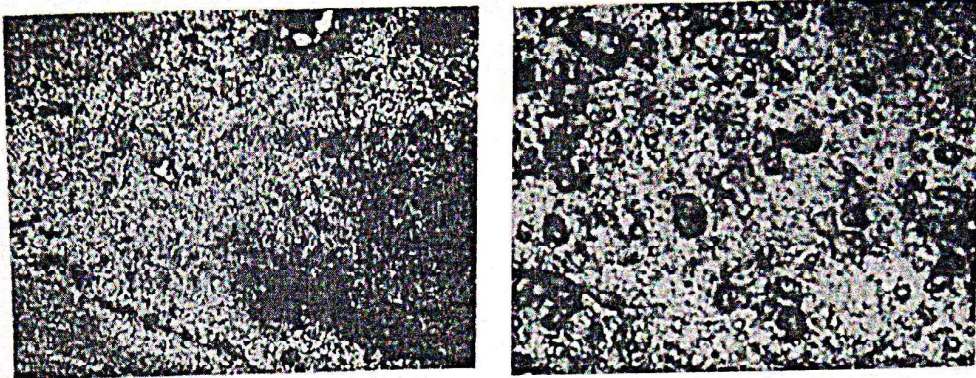


(b) Sample 1 : Titanium without FSP (500x)

Fig. 5. (a), (b) Images of Base Titanium Metal at different Magnifications.







(a) Sample 1: Titanium with FSP (100x)

(b) Sample: Titanium with FSP (500x)

Fig. 6. (a), (b) Images of FSPed Ti-Mg Composite at different Magnifications.

**Table 3**  
Experimental Values of Thermal Conductivity of Pure and FSPed Titanium Samples.

S.No	Temperature (°C)	Thermal Conductivity (W/m.k) (Without FSP)	Thermal Conductivity (W/m.k) (With FSP)	Increase in %
1	130	20.40	21.90	7.35
2	210	19.98	21.53	7.75
3	280	19.63	21.22	8.09
4	303	19.52	21.12	8.10
5	327	19.40	21.02	8.86
6	350	19.28	20.09	8.40
7	374	19.16	20.77	8.40
8	412	18.97	20.57	8.43
9	450	19.54	20.11	7.98
10	530	19.70	20.26	7.91

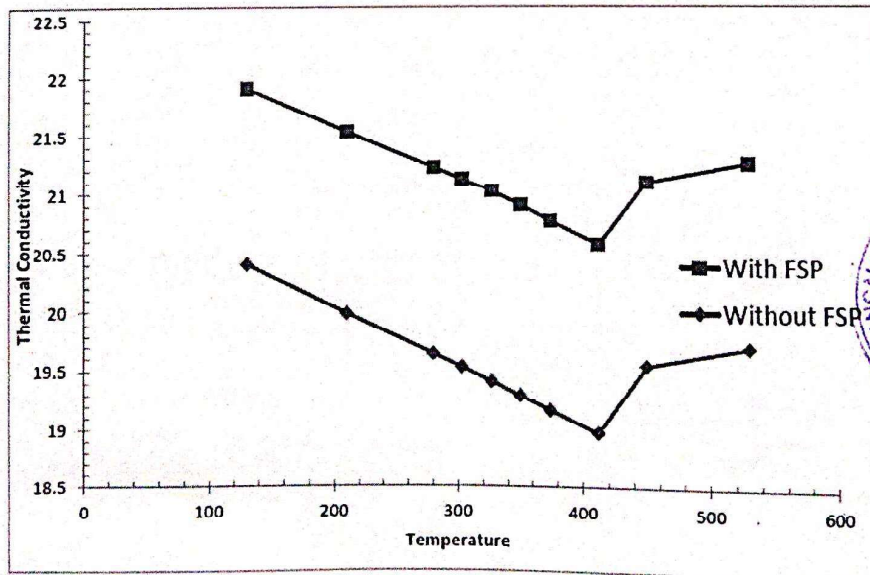


Fig. 7. Plot of Temperature vs Thermal Conductivity of Pure and FSPed Titanium Samples.



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**Table 4**  
Error Percentage Calculation.

S.No	Temperature (°C)	Percentage Increase in Thermal Conductivity - Experimental Value	Percentage Increase in Thermal Conductivity - Predicted Value	Error %
1	130	7.35	7.81	-6.32
2	210	7.75	7.94	-2.40
3	280	8.09	8.04	0.60
4	303	8.10	8.08	0.29
5	327	8.86	8.11	8.44
6	350	8.40	8.15	3.01
7	374	8.40	8.18	2.58
8	412	8.43	8.24	2.24
9	450	7.98	8.30	-3.99
10	530	7.91	8.42	-6.44

## 6. Conclusion

The addition of magnesium with titanium at a volume fraction of 4 % is carried out to evaluate the changes in thermal conductivity of the resulting composite material in comparison to the pure titanium base metal. The following points are drawn as conclusion from the work done.

1. Thermal conductivity of the Ti-Mg composite goes on decreasing fashion with respect to changes in temperature from 130 °C – 350 °C. Starting from 350 °C thermal conductivity follows both decreasing and increasing fashion alternatively.
2. With respect to increase in temperature both Ti and Ti-Mg composite adopts an increase in thermal conductivity until certain temperature level and falls down. After getting decreased again the value of thermal conductivity goes on increasing.
3. Thermal conductivity of pure titanium is found to be higher at low temperature such as 130 °C and a highest decrease of 7 % is observed at 412 °C with respect to lowest temperature adopted in the experiments.
4. Thermal conductivity of Ti-Mg composite is found to be higher at low temperature such as 130 °C and a highest decrease of 8.26 % is observed at 350 °C with respect to lowest temperature adopted in the experiments.
5. In comparison, Ti-Mg composite is found to possess higher thermal conductivity than parent metal titanium with an increase ranging between 7.35 % – 8.86 % with a temperature difference of 400 °C from the range adopted.
6. Error percentage obtained from predicted values ranges between -2.4 % to 8.44 % which is in acceptable range.
7. The volume fraction of magnesium may be varied to higher levels and addition of other reinforcement elements may provide a better insight about the changes in diverse properties of titanium base metal.
8. Additional evaluation of mechanical properties in comparison to thermal property may throw light over the suitability of developed composite for critical aerospace applications and carrying out finite element simulations will be the future scope of study.

## CRedit authorship contribution statement

**S. Selvakumar:** Writing – original draft. **S. Aneesh:** Writing – review & editing. **J. Rabi:** Supervision. **N. Mohammed Raffiq:** Con-

ceptualization, Methodology, Writing – original draft. **K. Ganesh Babu:** Supervision.

## Data availability

Data will be made available on request.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

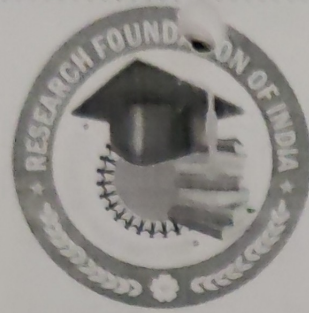
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# CYBERSECURITY & CONSUMER AWARENESS IN DIGITAL MARKETING

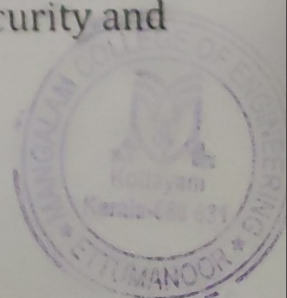
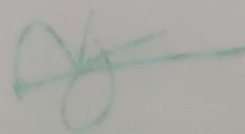
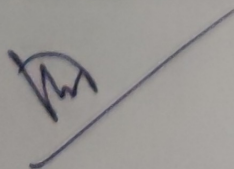
**Dr. Prima Anne George**

Associate Professor, Mangalam College of Engineering

## 1 INTRODUCTION

The digitalised world, has opened its avenues to encompass different spheres of life. The business arena has been made more competitive, where employees have become more productive, customer experience have widened, new technologies have been implemented in all functional areas and thereby every nook and corner in business has undergone change. Following suit this phenomenon has paved way to tremendous transformation in marketing too. A marketer could digitally cater to all those needs, wants or desires of a customer, or even more which he had once provided in the traditional method of marketing. Phases and stages of customer experience funnel has been delivered digitally. Marketing is now believing in inbound processes and customer engagement in a digitally designed space. Digital customers can be social media users, web customers, mobile customers, blockchain customers, e mail customers and so on. The improvement and advances in the technology has directed marketers to explore the opportunities in social media (Ellison, Lampe & Steinfield, 2010; Kaplan & Haenlein, 2010; Obar & Wildman, 2015).

In the digital era, customer data and details which are of immediate use or those which have future implications has given strategic advantage for the organisation. Customer confidence has become an integral part for sharing of information from their side. The data extended to the organisation by a consumer is rested upon the trust the consumer has towards the organisation. He presumes the information is under control and is secure. This evokes the concept of cybersecurity and its importance as far as a customer is concerned.





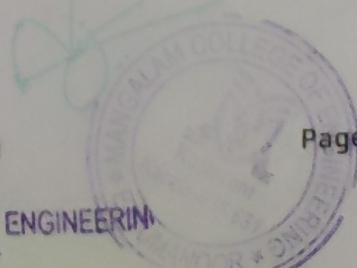
## 2 CYBER SECURITY

Cybersecurity denotes the security or the protection given to the user and his/her assets from the probable threats that arise out of the cyberspace (Von Solms & Van Niekerk, 2013). Cybersecurity is the security or the safety given to the user and the systems involved in the cyberworld from situations that are against the law or illegal (Craig, Diakun-Thibault, Purse, 2014).

For ensuring one's security in the cyber world, companies mostly follow broad level accountability and integrated approach which includes both the internal aspects and external ones. Security breaches are largely found to be caused by human errors whether that is an employee or a customer. Companies usually ensure security through all the possible ways where a breach is possible. That may be by way of contracts with companies whom they enter into online businesses, exceptional monitoring, for example a temporary number valid for a predetermined shopping period or for a particular amount to ensure security in the particular transaction and so on. Public key encryption, intrusion detection routines, virus scanners, audit trails, back up of data (Chaffey & Smith, 2017) are all practised for data security. It is not only right technologies that is needed to fight against cyberattack instead an organisation wide strategy has to be made covering all the possible outlets of a breach. Companies should be able to communicate the benefits and the probable risk associated with sharing the information. The customer needs to be educated as to how to avoid the occurrence of a breach and what are the precautions, he/she has to take for the same.

## 3 CYBER SECURITY AND CONSUMER

Data sharing by a customer ensures him comfort and hassle-free transaction of products and services and the process become simple and easy. But once a cyber security breach happens, the blame will always be on the company even if the fault happened from the customer's end. The customer will probably not even understand his role in the breach. The customer should be aware of the personal information that is being used





by the company either directly given by the customer or indirectly known from their digital presence. In that manner, information can be;

- a) Voluntarily disclosed like name, age, gender, email address etc.
- b) Unknowingly disclosed like location, browsing history etc.
- c) Predicted information made using profiles, information voluntarily disclosed and unknowingly disclosed. Customers value predicted data the most and voluntarily given data the least (Morey, Forbath & Schoop, 2015).

Fiserv's cybersecurity awareness study on American consumers in 2019 showed that 1% knows little to nothing about cybersecurity, 11% was somewhat aware of the cybercrime but does not take any action to protect oneself, 44% were aware about the threat of cybercrime but thinks of protecting himself when convenient time arises, 38% knew the dangers but does not have the information as to how to protect from the threats and 6% only have taken necessary steps to stay educated and ensure protection in cyberworld. The study had shown that 46% was somewhat informed, 18% very well informed, 16% not very informed, 11% extremely well-informed, and 9% not at all informed about the cybersecurity.

The consumer always prefers to have a smooth and sudden response from digital interaction in less time, and password attempts before resetting the login details are found to be on an average of more than three (IBM Consumer Survey: Security side effects of the Pandemic, 2021).

The personal cybersecurity and data privacy habits when studied showed that an average of 15 new online accounts were created for each respondent and 44% do not plan to delete or deactivate the new accounts even when covid conditions does not exist. A similar percentage of 44 used the potentially insecure apps or websites they adopted during pandemic even after it. 82% has opined that they use the same credentials for multiple online accounts. 34% wrote the login credentials on paper and they were unaware of the risk and never heard of password management app.



Another survey was conducted on cybersecurity by ISACA, an international professional association which focuses on IT governance. The study was titled, 'State of Cybersecurity 2022- Global Update on Workforce Efforts, Resources and Cyberoperations', carried out on consumers of US, UK and India with regard to their perspective regarding cybersecurity. It was seen that one among three consumers or their family members had the experience of security breach with their personal information. On the occurrence of such a breach, one among three customers showed hesitation in engaging with such organisations that have shown irresponsibility with their Personal Identifiable Information. The lost trust has restrained the customers from having further engagements with the company. The study has shown that customers are very much concerned about the protection of their information being shared to any organisation.

The control and prevention of cybercrime associated with public can be effectively executed by providing awareness of the cybersecurity and the risks associated with security breach (Grabosky, 2016).

Cyberattacks make the customer feel insecure and create a feeling of helplessness in their inability to protect their data. The study has shown that three among five Indians, feel an incapacity that there is nothing they can do in securing their data in the cyberspace. They realise it to be a risky affair and at any time could happen to them. The digital world has opened another world of shopping experience and digital engagement. The customer is aware that his valid information is no longer kept safe with him, on the other hand it's a part of the cyberworld. He/she understands there is risk associated with the data in the hands of organisations that are incapable of ensuring security for the data provided. So, with the increased concern about the matter, most customers are now preferring to be associated only with businesses those are transparent in data collection and follow strict security policies. This cybersecurity awareness is thus creating a culture of cybersecurity in the digital era.



#### **4 COMMON SECURITY MISNOMERS FACED BY CONSUMERS**

##### **a) IoT**

Personal devices now call for providing personal information, and technology enables us to operate those devices by connecting and operating with other devices. These devices are susceptible to data theft, phishing, spoofing etc. The security threats related to password can be prevented by unique ID and a strong password. As with combating any other breaches, all the necessary steps have to be taken to protect from such threats.

##### **b) Bluetooth**

Bluetooth enabled devices as one's earphones, cars and watches has opened the doors of risk in data breach through ample means. Bluetooth even though a weak shortrange signal, can be used for cyberattack using specialised radio systems that can send and receive Bluetooth signals from a longer distance.

##### **c) Wi-Fi**

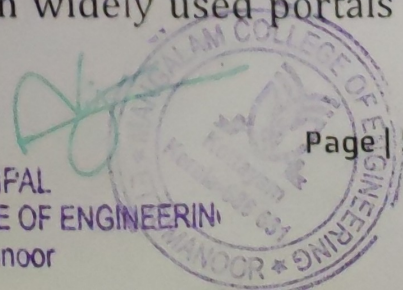
Wi-Fi has revolutionised the digital world completely. One can access and log on to the network ranging from home or from anywhere of one's preference, from different locations with different passwords provided to you. Those networks if not protected with Wi-Fi Protected Access (WPA), will possibly broadcast the information to any other person within the reach of broadband.

#### **5 CYBERSECURITY THREATS AND PRECAUTIONS TO BE TAKEN IN VARIOUS**

##### **Digital Marketing Platforms**

##### **a) Email Marketing**

Email marketing is the most promising way for engagement marketing and significantly brings revenue for the firm. It is found that 94% of the security breach in digital world is through email. The common notion among the customers is that when it comes to security of accounts, it is bank accounts, online payment apps or certain widely used portals that





has to be essentially considered as risky. Though they are sensitive in nature, major danger does not lie in those accounts but rather in the email address and password that is not secured rightly. Customers have to be aware of proper password hygiene and in case the primary email is compromised change the password of all accounts connected to the email has to be changed.

### **b) Social Media Marketing**

The purpose of social networking sites is to enable communication and to connect people and establishments. It has brought about tremendous change in the way people connect with each other. This has also brought with it the concern with regard to the privacy and security of the user. Various platforms are available for the communication, so with the hackers to hack.

In face book friend request is sent to a person directly or by befriending the target users' friend which encourages for the acceptance of the same seeing the number of connected friends. LinkedIn business accounts and users accounts becomes so vulnerable in the cyberspace, as these networks are loaded with information of those associated with a particular organisation be it an employee or an associate. They are easy target for phishing attack when email details are hacked, an opening for collecting the designation and contact of the employees, customer data and so on.

Security breach occur in social media through lack of strong passwords, downloads that are unauthorised, careless sharing of information in the social media. Resetting of password is allowed with the help of security question and the answer for such questions can be easily accessed from other social media sites of the target user. An attacker can easily gather information of a target and threat can be in the form of brand impersonation, which can deceive users in sharing information or to enter into financial dealings. If the social media is under the control of unauthorised persons or hijacked by the hacker, he can spread spams and messages detrimental to the organisation's reputation.



Steps has to be strategically devised by the company to check the social media accounts vigilantly with the help of social media monitor tools. Have first validation script to counter check whether the information provided by the customer match with one another like phone number, pin code etc. Customer and leading IP address has to be tracked for authenticity.

### c) Content marketing

Content marketing attract audiences by providing valuable information to the customers. Content Marketing System (CMS) is provided by various software like WordPress. The hackers could easily understand the functions of such system and breach the security. A strong password and avoidance of using the CMS in public network sites can avoid such ill effects to some extent.

### d) E-commerce

The risk of security challenges in e commerce can limit the conversion rate and prevent customer engagement as they perceive the risk of financial frauds. The security process should be clear to the customers and there by the company could gain the trust of the customers. Two factor authentication and secure payment methods has to be extended to the customers and customer data and details should not be disclosed unnecessarily.

## 6 FORMS OF CYBERATTACKS IN DIGITAL MARKETING

"Cyberattack is any unauthorised cyber act aimed at violating the security policy of a cyber asset and causing damage, disruption or disruption of the services or access to the information", (Li & Liu,2021).

The major types of cyberattacks can be

- a) **Spoofing:** The email is sent from fake id that resembles the company id, to lure the recipients to respond to the mail which will turn beneficial to the hacker.
- b) **Phishing:** The hacker disguise himself/herself as a customer or client of the company, by hacking the customers login details. Such a



situation provides a favourable ground for malpractices. Hackers devise marketing schemes and pretend those as from the company. These scams affect the digital reputation of the company. Another threat is that hacker sends fake replies for the company's marketing emails pretending as customers.

- c) **Malware:** It indicates type of software that is predominantly malicious in nature which can be a program or file that is made for the purpose of creating intentional damage to a computer, network or server. Malware can take different forms like virus, worm, Trojan horse, spyware, rootkit etc.
- d) **Social Engineering:** While considering cyber security, social engineering refers to the hacker attack wherein attacker exploit human vulnerabilities like influence, persuasion, deception, manipulation and inducing which will result in the breach of security objectives like confidentiality, integrity, availability, controllability and auditability of cyberspace elements such as infrastructure, data, resource, user and operation (Wang, Zhu, Liu & Sun, 2021). Phishing, Pretexting, Baiting, quid pro quo, tailgating and CEO fraud are the various types of social engineering practices.
- e) **Fake accounts:** Bogus accounts are created using bots for the purpose of committing crime in the cyberspace. This can be for spreading fake news, influencing product reviews or spreading a malware. Various fake profiles can be compromised profiles, cloned profiles, and online bots such as spam-bots, social-bots and influential bots (Wani, Jabin Yazdani, Ahmad 2018).

## 7 CUSTOMER EDUCATION ABOUT CYBER SECURITY

The concept of cyber security is not rested solely in the hands of the business organisation, as practices of the customer also pave for security breach. The compromises from the side of the customer while accessing one's email, bank account, payments made through digital mode etc. can contribute to cyber security breach. Cyber security is the duty of the organisation in which customer plays a crucial role. Mostly organisations are proactive in taking their cybersecurity decision within the

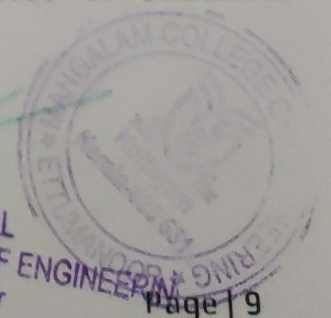


organisations but neglect the aspect of educating the customer for the same. For an attacker the easy target is people whether internal or external to the organisation. Educate the customer regarding the breach is the need of the day which the companies neglect to do systematically while extra caution is normally taken about the internal factors to prevent security breach. Such awareness can be regarding two factor authentication in email exchanges, creating a strong password, usage of password management software etc. This can be done by posting the matters of cybersecurity in the social media platforms. During the time of account opening or during signing up, suggestions for properly securing the cyberspace can be given.

## 8 CONCLUSION

Marketing practices has been revolutionised with the advent of digital technologies. This has opened wide prospects for the business in reaching out to their customers. Digital interaction in the form of share, comments, likes, responses, views, clicks etc has been characterised as customer engagement. Such digital campaigns and digital engagement set the path for customer and customer retention in an effective way. Gaining of customer trust is pivotal in this regard and it has to be maintained throughout. The major risk involved in the same is the breach in cybersecurity and thereafter the customer's personal data is misused. Both firm's value and customer trust is negatively affected, when a security breach is reported (Choong, Hutton, Richardson, & Rinaldo, 2016; Martin, Borah, & Palmatier, 2017). A firm's success in the digital era necessarily depends on identifying its distinctive competencies (Day, 2011) and marketing capabilities (Teece, 2007; Srinivasan & Hanssens, 2009). In the case of breach of cybersecurity, the organisation will lose its customers which is usually not accounted and this causes potential loss for the organisation (Gordon & Smith, 2007). This indicates the role of customer and the importance of customer awareness in the issues regarding cyber security.

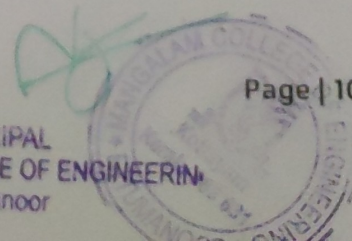
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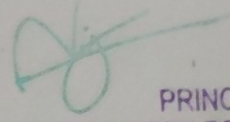
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