

**AN EXPERIMENTAL ANALYSIS OF PARTIAL  
REPLACEMENT OF COARSE AGGREGATE WITH WASTE  
RUBBER TYRES WITH DIFFERENT TYPES OF CONCRETE**

*A Major (Stage II) project report submitted in partial fulfillment of the requirements  
for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

*in*

**CIVIL ENGINEERING**

*by*

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**CERTIFICATE**

This is certify to that the Major (Stage II) project report entitled **AN EXPERIMENTAL ANALYSIS OF PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH WASTE RUBBER TYRES WITH DIFFERENT TYPES OF CONCRETE** submitted by the following students in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Civil Engineering, and is a bonafide record of the work performed by

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## ABSTRACT

At present, global waste tire generation considerably exceeds consumption. Moreover, waste rubber tires (WRTs) are a cause of concern, as huge volumes are being discarded and buried, thus causing serious environmental pollution. Rubberized waste concrete (RWC) is a type of environmentally friendly construction material. The main challenge encountered when manufacturing rubberized concrete is the low adhesive properties between the cement paste and rubber particles. This paper demonstrates the effects, through experiments, of using waste tire rubber instead of recycled coarse aggregate (RCA) on two types of cement, i.e., sulphate resistant cement (SRC) and ordinary Portland cement (OPC), where SRC is a specially blended cement designed to improve concrete performance and workability in the most aggressive environments. All tested samples contained 10% silica fume (SF) and 0.2% fly ash (FA), and the substitution of recycled aggregate content with waste rubber tire (WRT) at different percentages of 100%, 75%, and 50% was evaluated. The research investigated the synergistic effect on the workability and mechanical properties of various cement types with different amounts of rubber aggregate. It was found that the sulphate-resistant (SRC) type can increase the compressive strength than OPC with a percentage of 25% with the same content of WRT at concrete mix. Moreover, ductility and cracking behaviour are improved, and it appears that it is also possible to make lightweight rubber aggregate concrete with this type of mixture. Using this type of cement, it is possible to restore satisfactory ductility to the waste tires, thus facilitating a reduction in the formation of potential plastic cracks. Moreover, the indicative compressive strength development for SRC with recycled rubber in concrete positively contributes to a reduction in formed cracks. However, SEM microstructural analyses suggest a higher proportion of C-S-H intermixed with sulphate reaction phases of SRC rubberized mortar than those of OPC; thus, given that crystal growth results in a decreased percentage of air voids rather than decreased internal cracking, it is clearly shown that the average crack width increases in OPC mortar compared with SRC. Finally, t-testing was used as an inferential statistical tool to determine whether there is a sizeable distinction between the properties of the two categories of materials, OPC and SRC, by comparing the mean and standard deviation of the values for compressive and tensile strength.

**Keywords:** waste rubber tires; recycled aggregate; cement mortar; silica fume; ductility; cracking; performance.

## CHAPTER -5

### CONCLUSION

- ❖ The workability of concrete get increases with the increase in percentage of shredded rubber is added. This is due to the lack of water absorption by the shredded rubber.
- ❖ The modulus of elasticity of concrete also decreases with the increase in percentage of shredded rubber. 5% replacement of waste shredded rubber proves exceptional well in compression.
- ❖ Flexural strength when compare to the conventional concrete specimens all the tests is done by M30 grade of concrete.
- ❖ By the replacement fine aggregate by shredded rubber we can safeguard the environment by burning tires. This type of concrete is used for partition wall, compound wall, industrial flooring and in place where more wear and tear resistance requires.
- ❖ Recycled rubber positively contributed to the reduction in cracks in the resulting concrete.
- ❖ As a recommendation for future work, study should be undertaken of the ductility index evaluation method and the derivation of the energy area ratio, to ensure that ductility evaluation results are based on the brittleness index values of rubberized concrete.
- ❖ Rubber waste can be used with non-structural concrete such as lightweight concrete or fill concrete.
- ❖ As the rubber is mixed in appropriate proportions, the workability of concrete is increased.
- ❖ Rubber is used to absorb the vibrations developed from the railway tracks.
- ❖ Use of rubber in concrete makes eco-friendly to the environment. Also reduces the pollution caused due to burning of tyres.
- ❖ This study investigated the effects of cement types used within a rubberized concrete mixture on the resulting properties. The most important aspects that were affected are workability, compressive strength, split tensile, ductility, and failure behavior. The waste tires rubber aggregate was mixed with either SRC or OPC. All mixtures contained 10% SF and 0.2% fly ash, and the percentage of WRT content was varied between 0%, 50%, 75%, and 100% Overall, the results indicate the following:
  - The workability was higher for fresh rubberized mixtures of SRC than those of OPC. Increasing the amount of WRT as a replacement for RCA caused a decrease in the density by approx. 50.5% for OPC and 40% for SRC, although the highest increase in porosity was observed, of approx. 56%, for both types of cement.
  - The reductions in WRT as a percentage of RCA led to decreases in water absorption

(WAR) and void ratios for both OPC and SRC; in contrast, water absorption and air voids were higher in OPC than in SRC, by 30% and 13%, respectively.

- WRT rubber reduced the compressive and tensile strength by 35% and 60%, respectively, for both SRC and OPC, and the reduction in the amount of WRT used to replace RCA concrete also led to increased compressive and tensile strength. Therefore, the decreasing percentage depends on the amount of recycled rubber in the concrete mixture.
- Recycled rubber positively contributed to the reduction in cracks in the resulting concrete.
- Replacement WRT in concrete 50% from weight of coarse aggregate had the effect of increasing the ductility and subsequently reducing brittleness as a factor of SEM images showed the presence of pores/voids around the rubber and the polymer composite, whereas uniform dispersion of silica fume particles was observed in the polymer matrix.
- As a recommendation for future work, study should be undertaken of the ductility index evaluation method and the derivation of the energy area ratio, to ensure that ductility evaluation results are based on the brittleness index values of rubberized concrete.
- ❖ The optimum moisture content will be varies about 1% to 2% due to addition of shredded rubber content.
- ❖ The liquid limit and plastic limit are reported as 53.8% and 26.5% respectively.
- ❖ The maximum dry density and optimum moisture content are 17.29kN/m<sup>3</sup> and 18%.
- ❖ According to soil classification IS: 1498-1970, the soil is comes under CH (clay of high plasticity) as the liquid limit is more than 50%.
- ❖ The unconfined compressive strength and California bearing ratio increases with the increase in cement content at an optimum fiber content of 5%.
- ❖ The unconfined compressive strength has increased from 15kN/m<sup>2</sup> to 76kN/m<sup>2</sup> for 2% cement and 249kN/m<sup>2</sup> for 4% cement for black cotton soil.
- ❖ Deep foundations and raft foundations for structures on soil with low bearing capacity can be replaced by shallow foundation with soil stabilized by shredded rubber waste.
- ❖ California bearing ratio has increased from 1.24% to 4.55% for 2% cement and 13.10% for 4% cement for black cotton soil for unsoaked condition.
- ❖ California bearing ratio has increased from 1.24% to 2.99% for 2% cement and 11.05% for 4% cement for black cotton soil for soaked condition.
- ❖ Increases in CBR value significantly reduce the total thickness of the pavement and hence the total cost involved in the project.

- ♦ Shredded rubber fiber can be considered as a good reinforcement material.
- ♦ Upon 4% cement modification, the soil could become non-plastic and showed maximum strength as that of 5% addition of tyre chips could improve the shear strength parameters significantly. The above concluded parameters are reported according to limited tests carried in laboratory and are tested only with the addition of 5%, 10%, 15% of rubber shreds which are having dimensions of 10 to 20mm length and 2 to 3mm thickness.

  
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# **DESIGN OF PERVIOUS CONCRETE**

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
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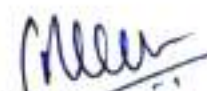
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## ABSTRACT

Pervious concrete is a special type of concrete, which consists of cement, coarse aggregate, water and if required, admixtures and other cementitious materials. As there are no fine aggregates used in the concrete matrix, the void content is more which allows the water to flow through its body. So the pervious concrete is also called as permeable concrete and porous concrete.

There is lot of research work is going in the field of pervious concrete. The compressive strength of pervious concrete is less when compared to the conventional concrete due to porosity and voids. Hence, the usage of pervious concrete is limited even though it has lot of advantages. If the compressive strength and flexural strength of pervious concrete is increased, then it can be used for more number of applications. For now, the usage of pervious concrete is mostly limited to light traffic roads only. If the properties are improved, then it can also be used for medium and heavy traffic rigid pavements also. Along with that, the pervious concrete eliminates surface runoff of storm water, facilitates the ground water recharge and makes the effective usage of available land.

The main aim of our project is to improve characteristics of pervious concrete. But it can be noted that with increase in strength, the permeability of pervious concrete will be reduced. Hence, the improvement of strength should not affect the permeability property because it is the property which serves its purpose.

## CHAPTER-5

### CONCLUSION AND SCOPE FOR FUTURE WORK

#### 5.1 CONCLUSION:

- The size of coarse aggregates, water to cement ratio and aggregate to cement ratio plays a crucial role in strength of pervious concrete.
- The void ratio and unit weight are two important parameters of pervious concrete in the context of mix design.
- The compressive strength and coefficient of permeability of pervious concrete are inversely proportional to each other up to addition of 8% of fines.
- Among the two methods of increasing compressive strength of pervious concrete, the addition of fines has gave more value when compared to replacement of cementitious materials.
- The addition of fines and replacement of cementitious materials will reduce the permeability capacity of pervious concrete.
- The compressive strength of pervious concrete is increased by 15.25% when 5% fine aggregates were added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 18.13% when 6% fine aggregates were added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 21.57% when 7% fine aggregates were added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 25.93% when 8% fine aggregates were added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 23.96% when 9% fine aggregates were added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 20.52% when 10% fine aggregates were added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 7.17% when 10% fly ash was replaced in the place of cement.
- The compressive strength of pervious concrete is increased by 14.05% when 10% rice husk ash was replaced in the place of cement.



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# DESIGN AND ESTIMATION OF RURAL ROAD CONSTRUCTION

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
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## BACHELOR OF TECHNOLOGY

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## ABSTRACT

Transportation plays a major role in the development of the human civilization. For instance, one could easily observe the strong correlation between the evolution of human settlement and the proximity of transport facilities also, there is a strong correlation between the quality of transport facilities and standard of living, because of which society place a great expectation from transportation facilities. A road is a route or way between two places that has been paved or otherwise improved to allow travel by foot, bicycle, or motor cycle. The extension of rural road network is of vital importance for bringing the social amenities, education, and transportation of agricultural products from tribal villages to market yards and distribution centers.

India is the second largest road network in the world with the total length of around (4,320,000) km. India road network consists of 1000 km expressways, (79,243) km National Highways, (1, 31,899) km State highways and other district and rural roads. The total road length in the state of **TELANGANA** is about (26935) km with various types of roads such as NH(2690 km), SH(3152), Major District(12079 km) and Other District(9014)km. The project main aim is to design and estimation of 3km road way to provide transportation facilities from **GUNDLAPALLI TO JANGAPALLI** of **GANNERUVARAM** mandal. Single lane pavement to double lane pavement (3m wide with 1.5m shoulder on either side of road) is recommended from **KARIMNAGAR** district in **TELANGANA** and it also covers a small village which located in between two points.

  
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## CHAPTER-10

### CONCLUSION

Construction of flexible pavement for GUNDLAPALLI to JANGAPALLI of GANNERVARAM road is followed the specified design data. CBR value for soil sub grade used for the road construction is under allowable limit i.e., 2.33%. Tests required for the materials used in the construction are tested in treatment plan and adequate results have been obtained. Traffic survey for GUNDLAPALLI roads is made through manual counting and allotted a design period of 10 years for the pavement.

According to the design of the pavement, the each layer has following thickness:

- Granular sub base GSB = 440mm
- Granular base GB = 225mm
- Binding course BM = 50BM
- Wearing course WC = 20 PC

The total estimate for 2 lane roadway as per IRC recommendations and MoRT&H specifications is Rs 104587158.

  
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A  
MAJOR PROJECT (STAGE-II) REPORT  
ON  
**MODIFICATION OF BITUMEN BY USING PLASTIC  
WASTE**

A major project (Stage-II) report submitted in partial fulfillment of the requirements  
for the award of the degree of

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This is certify to that the major project (Stage-II) report entitled "**MODIFICATION OF BITUMEN BY USING PLASTIC WASTE**" submitted by the following students in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in "**Civil Engineering**", and is a bonafide record of the work performed by

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## ABSTRACT

Bituminous is a composite material mostly used in construction projects like road surfacing, airports, parking's lots etc. It consists of asphalt or bitumen (used as binders) and minerals together and laid down in compacted.

Now a day's the steady increment in high traffic intensity in terms of commercial vehicles and the significant variation in daily and seasonal temperature put as in a demanding situation to think of some alternative for the improvements of the pavements characteristics and quality by supplying some necessary modifications which shall satisfy both the strength as well as economic aspects. So, we can see, where ever a road is under reconstruction the previous structure of the road (bitumen) is wasted in many circumstances. Therefore, we are going to use that bitumen for checking whether it can be reused or not.

  
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## CHAPTER-6

### CONCLUSION

1. The increase in percentage of polymer decreased the penetration value. This shows that the addition of polymer increases the hardness of the bitumen.
2. The penetration values of the blends are decreasing depending upon the percentage of polymers and the type of polymer added.
3. The ductility decreased by the addition of plastic waste to bitumen. The decrease in the ductility value may be due to interlocking of polymer molecules with bitumen.
4. Flash and fire point increased with the increase in the percentage of polymer. The polymer bitumen blend road surfaces are less affected by fire hazards.
5. This shows that the blend has better resistance towards water. This may be due to better binding property of the polymer bitumen blend.
6. The softening point increased by the addition of plastic waste to the bitumen. Higher the percentage of plastic waste added, higher is the softening point.
7. The influence over the softening point may be due to the chemical nature of polymers added.
8. The increase in the softening point shows that there will be less bleeding during summer. Bleeding accounts, on one side, increased friction for the moving vehicles and on the other side, if it rains the bleedings accounts for the slippery condition. Both these adverse conditions are much reduced by polymer-bitumen blend.

  
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# **SUSTAINABLE ENERGY GENERATION BY BIOFUEL CELL FROM SEPTIC TANK**

*A major project report submitted in partial fulfilment of the requirements*

*For the award of the degree of the*

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This is to certify that the major project entitled **"Sustainable Energy Generation By Biofuel Cell From Septic Tank"**, submitted by the following students in partial fulfilment of the requirements for the award of the Degree of Bachelor of technology in civil engineering, and is bonafide record of the work performed by

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## ABSTRACT

Non convention energy generation is one of the important social needs. Our country investing huge money on that for solar energy and wind energy. Lot of research is in progress to utilize waste material. The sewage from the residential building generates methane gas by microorganism in the sludge. So far the septic tanks are constructed in the residential building for collection and draining of effluent from the residence. The effluent collection at the septic tank is containing organic matter those are consumed by micro-organism and are generating hydrogen ion and other gases in an anaerobic and aerobic condition.

It is proposed to utilize a septic tank into a power generation unit by incorporating stack of biofuel cell driven by micro-organism. The biofuel cell is designed by the concept of  $H^+$  ions in the anaerobic condition reacting with oxygen in aerobic condition to form water through proton exchange membrane. This process drives electron from anode to cathode is tapped. The generated power is regulated and the constant power supply is obtained which is useful for residential purpose. A prototype cell was fabricated and tested by polarization. It is found that the voltage gain is 0.59 V. The power generation Design an electrolyte for anaerobic and aerobic condition.

**Key Words:** Sustainable energy, Biofuel cell, Polarization, electrodes and voltage stabilizer.

## CHAPTER 8

### CONCLUSION

The application of microbial fuel cell for electricity generation using septic waste water provides an answer for power generation.

This technology can be used for wastewater treatment systems in homes and its biodegradation efficiency can be calculated by measuring the COD and by this method we can generate electricity by using waste water

MFCs are a promising new technology for generation of electrical energy. This technology involves using microorganisms to convert readily available substrates into electricity through biological processes contained within the MFC reactor. The power density produced judge performance, which is the most important aspect of the technology.

Overcoming high resistance in MFCs remains a major challenge. The development of less expensive materials for enhancing MFC technology to produce highly sustainable efficient electrical energy is another challenge. In the current state, MFCs can be used to power low power electrical appliances especially in rural areas.

  
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# **CASE STUDY ON TRAFFIC VOLUME, SIGNALS AND ROAD SAFETY**

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**VAAGESWARI COLLEGE OF ENGINEERING**



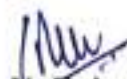
**CERTIFICATE**

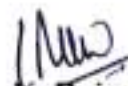
This is certify to that the major project entitled **CASE STUDY ON TRAFFIC VOLUME, SIGNALS AND ROAD SAFETY** submitted by the following students in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in civil engineering , and is a bonafied record of the work performed by

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The work embodied in this major project has not been submitted to any other institution for the award of any degree.

  
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**EXTERNAL EXAMINER**

## ABSTRACT

Each year, more than 1.2 million people die across the globe due to road crashes. India ranks high when it comes to number of accidents on the road. Road safety is one of the most serious public health issues in our country. It has an impact on everyone, whether one drives a vehicle, walks or rides a cycle. Road safety refers to the measures which must be adopted by everyone while using roads. These safety methods are meant for reducing the risk of accidents and injuries or casualties on the road. These rules must be followed by all users of roads including pedestrians, cyclists, motorists, and bus and truck drivers. Safety methods also relate to the construction, layout of roads as well as traffic regulation systems. However, mortality rates have come down significantly due to improvements in automobile technology. Nevertheless, there are many potential hazards on the road that can cause injuries or even death. Furthermore, ignoring road signs which provide important information such as crossroads or intersection can also be the leading cause in vehicular accidents. In conclusion, all these dangerous situations can be easily avoided if road rules are strictly followed and vehicles are wellmaintained. For sustainability, road safety interventions need to be guided and governed by policy in the implementation and development. In this project, we are planning to analyse the road safety from alugunur to nustulapur via Hyderabad – mancherla highway which is of 11 km.

**KEY WORDS:** Road safety development and management, road design, traffic engineering, speed, accident data, evaluation, traffic signals, traffic rules.

## CHAPTER 7

### SUMMARY & CONCLUSION

Traffic signal is an aid to control traffic at intersections where other control measures fail. The signals operate by providing right of way to a certain set of movements in a cyclic order. Depending on the requirements they can be either fixed or vehicle actuated and two or multivalued. The design procedure discussed in this chapter include interval design, determination of cycle time, and computation of saturation flow making use of HCM guidelines.

This report attempts to contribute to the body of knowledge on road safety. It is hoped that it will inspire and facilitate increased cooperation, innovation and commitment to preventing road traffic crashes around the world. While there are many interventions that can save lives and limbs, political will and commitment are essential and without them little can be achieved. The time to act is now. Road users everywhere deserve better and safer road travel.

  
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# **EXPERIMENTAL STUDIES ON PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH IN CONCRETE ELEMENTS**

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
for the award of the degree of*

## **BACHELOR OF TECHNOLOGY**

*in*

### **CIVIL ENGINEERING**

*by*

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*Under the Guidance of*  
**Mr. E.RAKESH REDDY**  
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**Ramakrishna colony, Karimnagar-505527**

**2022**

  
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Department of Civil Engineering  
**VAAGESWARI COLLEGE OF ENGINEERING**




**CERTIFICATE**


This is certify to that the major project (Stage-II) report entitled **EXPERIMENTAL STUDIES ON PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH IN CONCRETE ELEMENTS** submitted by the following students in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Civil engineering, and is a bonafide record of the work performed by

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## ABSTRACT

In today's world, the main emphasis is on green and sustainable development. Presently a large amount of fly ash is generated in thermal power plants as waste material with an improper impact on the environment and humans. Fly ash a waste generated by thermal power plants is such a big environmental concern. The experimental studies on mortar containing fly ash as a partial replacement of cement at different proportions were carried out to quantify its utilization. The use of fly ash in concrete formulations as a supplementary cementitious material was tested as an alternative to traditional concrete. Good fly ash will be an indispensable mineral admixture for high-performance concrete. The use of the right quality of fly ash, results in a reduction of water demand for the desired slump, although, its use in concrete significantly improves the long-term strength and durability and reduces the heat of hydration.

In this project, experimental investigations were carried on fly ash and have been physically characterized. The cement has been partially replaced by fly ash accordingly in the range of 0 % ( without fly ash) 10% , 20% & 30% by weight of cement for M20 Mix and M30 Mix. These tests were carried out to evaluate the mechanical properties for the results for compressive strength for 7 days, 14 days, and 28 days.

**Keywords:** fly ash, cement, M20 grade concrete, M30 grade concrete, compressive strength.

  
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## CHAPTER 10

### CONCLUSION

From the experimental work carried out for the M20 and M30 grades of concrete by partial replacement of cement with 10%, 20% and 30% of fly ash, the following conclusion was drawn.

- Slump loss of concrete increases with an increase in the water cement ratio of concrete.
- The ultimate compressive strength of concrete decreases with an increase in the water cement ratio of concrete.
- Slump loss of concrete goes on the increase with the increase in the quantity of fly ash.
- The use of fly ash in concrete can save coal & the thermal industry disposal costs and produce greener concrete for construction.
- The cost analysis indicates that per cent cement reduction decreases the cost of concrete but at the same time strength also decreases.
- The 10% and 20% replacement of cement with fly ash ultimate compressive strength of concrete decreases.
- For M20 grade concrete the compressive strength of concrete increased as increasing curing period up to 20% replacement of cement with fly ash beyond 20% the compressive strength decreased as curing period increased.
- For M30 grade concrete up to 10% of replacement of cement with fly ash the compressive strength increased beyond 10% the compressive strength decreased as curing period increased.

The study concludes that fly ash can be an innovative supplementary cementitious construction material but judicious decisions are to be taken by engineers.

  
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**AN EXPERIMENTAL STUDY ON PERFORMANCE OF CRUMB  
RUBBER MODIFIED BITUMEN WITH VARYING PACKING  
CHARACTERSTICS**

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

*in*

**CIVIL ENGINEERING**

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**2021-2022**

**Department of Civil Engineering**  
**VAAGESWARI COLLEGE OF ENGINEERING**



**CERTIFICATE**

This is certify to that the major project (Stage-II) report entitled "**AN EXPERIMENTAL STUDY ON PERFORMANCE OF CRUMB RUBBER MODIFIED BITUMEN WITH VARYING PACKING CHARACTERSTICS**" submitted by the following students in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Civil engineering, and is a bonafide record of the work performed by

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## ABSTRACT

India is a rapid urbanizing country. Due to overall development new roads are being constructed for ever increasing population. Density of vehicular traffic increases day by day. The wear and tear of tires from these vehicles is undoubted. So a large number of scrap tires are being generated. A large number of waste and worn out tires are 15-20% each year. These tires are discarded indiscriminately or stockpiled. The used tires cause a great threat to human health and environment, the waste tire rubber has become a problem of disposal. Driving comfort and low maintenance. The rheology of CRMB depends on internal factors such as crumb rubber quantity, type, particle size. The present study aims in investigating effect of crumb rubber on bitumen as a modifier in various proportions. Common laboratory test will be performed on the modified bitumen in various proportion of Bitumen and thus analyzed. Marshall method is adopted for mix design. Finally a comparative study is made among the plain Bitumen and modified Bitumen by varying the proportions of crumb rubber.

The pavement surface in rural area should be strong enough to withstand the heavy loads applied on it. The rough surfaced wheel like bullock carts are travelled on the surface therefore the pavement should be strong enough to avoid the cracks so we have to improve the property of the bitumen to increase the strength of the pavement. The durability of the road surfaces depends largely on the type and quality of bitumen used. Rubber modified bitumen uses stress absorbing membrane that reduce the reflective cracking because of its elastic properties. With fewer cracks there are fewer repairs, so crumb rubber assisting in reducing maintenance cost. Thus the pavement construction with rubber bitumen has long lifespan.

  
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## CHAPTER 10

### CONCLUSION

The use of crumb rubber as a modifier in bitumen can improve the properties of bitumen. Crumb-rubber gives the Marshall stability values of bitumen by using 6%,8%,10%,12% crumb rubber with bitumen mix which is better than the Marshall stability value of conventional bitumen mix.

The OBC conventional got at 5.5% of bitumen with stability of 17.77KN, that to adding various % of crumb rubber they are 6,8,10,12,then we got OBC with crumb rubber at 10% with stability of 38.27KN. It is observed that air voids decrease, which is necessary for better strength and service life of the pavement. At last we concluded that modification of binder with crumb rubber increases stability. This will contribute success in improving serviceability in terms of permanent deformation.



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# **A STUDY ON STABILIZATION OF BLOCK COTTON SOIL BY USING FLY ASH**

*A Major project report submitted in partial fulfilment of the requirements  
for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

*in*

**CIVIL ENGINEERING**

*by*

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**June-2021**

Department of Civil Engineering

**VAAGESWARI COLLEGE OF ENGINEERING**



**CERTIFICATE**

This is certify to that the major project report entitled “**A STUDY ON STABILIZATION OF BLOCK COTTON BY USING FLYASH**”, submitted by the following students in partial fulfilment of the requirements for the award of the Degree of Bachelor of Technology in Civil Engineering , and is a bonafied record of the work performed by

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Vaageswari College of Engineering  
SAMPURNA

## ABSTRACT

The soil at a given site is not always ideal. They may lack strength and compress too much under load. In such situations rather it would be better for an engineer in charge to relocate the facility or alter the soil structure, stabilize the soil. Now with the scarcity of good building sites, the engineer has to contend with the available site & improve the soil properties and build. This stabilization can be defined as a method to improve the engineering properties of soil. A well-stabilized soil will have higher shearing strength, lower compressibility and lower permeability and a better freeze and thaw resistance. These are the fundamental requirements for a safe and economical design of foundations, highway, pavements and airport runways.

Soil is a complex material. Recycled and waste materials like fly ash, bagasse ash, rice husk ash can be used to soil stabilization to improve physical and chemical properties of soil. In addition to those properties which can be improved by soil stabilization are shear strength of soil, UCS and bearing capacity etc. The objective of this study is to check the amount of fly ash at which a sample of soil and fly ash gives optimum values of UCS and after that is added in different proportions in the sample of soil and optimum quantity of fly ash to achieve the optimum value of CBR.

## CHAPTER -7

### CONCLUSION

Based on the present tests, the following conclusions can be drawn:

1. Specific gravity increases with increase in amount of fly ash.
2. Liquid limit increases with increase in amount of fly ash.
3. Plastic limit increases with increase in amount of fly ash.
4. It increases the shear strength.
5. It increases soil bearing capacity of foundation.
6. By adding additives it improves soil strength.
7. The inclusion of different percentage of fly ash in natural soil generally resulted in some increasing in unconfined compressive stress.
8. Fly ash has good potential for use in the geotechnical application. When used in structural fills or embankments, fly ash offers several advantages over natural soils or rock.
9. The relatively low unit weight of fly ash makes it well suited for placement over soft or low bearing strength.

  
Principal  
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# **STABILIZATION OF BLACK COTTON SOIL USING FLYASH**

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
for the award of the degree of*

## **BACHELOR OF TECHNOLOGY**

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This is certify to that the major project (Stage-II) report entitled  
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## CHAPTER-8

### CONCLUSION

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9. The relatively low unit weight of fly ash makes it well suited for placement over soft or low bearing strength.

  
Principal  
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# **“WASTE WATER TREATMENT BY ELECTROCOAGULATION”**

*A major project report submitted in the partial fulfillment of requirements  
for the award of the degree of*

## **BACHELOR OF TECHNOLOGY in CIVIL ENGINEERING**

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<b>B. SHIREESHA</b>	<b>17S41A0111</b>
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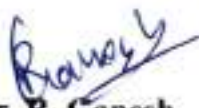


**CERTIFICATE**

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## ABSTRACT

Coagulation and flocculation are traditional methods for the treatment of polluted water. Electrocoagulation presents a robust novel and innovative alternative in which a sacrificial metal anode doses water electrochemically. This has the major advantage of providing active cations required for coagulation, without increasing the salinity of the water.

Electrocoagulation is a complex process with a multitude of mechanisms operating synergistically to remove pollutants from the water. A wide variety of opinions exist in the literature for key mechanisms and reactor configurations. A lack of a systematic approach has resulted in a myriad of designs for electrocoagulation reactors without due consideration of the complexity of the system. A systematic, holistic approach is required to understand electrocoagulation and its controlling parameters. This will enable a priori prediction of the treatment of various pollutant types.



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## CHAPTER 11

### CONCLUSIONS

The technology has been applied at BMP over a period of 2 years. A range of different processing options and variables were thoroughly investigated and ultimately excellent results achieved.

The undertaken research and experiments proved that electrocoagulation is a revolutionary technology, significantly underused in wastewater treatment.

The removal rates, particularly for difficult to treat contamination such as soluble phosphorus are much superior to the results achieved using the traditional wastewater treatment methods.

**The following conclusions were reached:**

- Electrocoagulation can be successfully used for the treatment of wastewater generated in the low temperature rendering facility (stick water).
- The most suitable and economically practical for the EC treatment is a combination of stick water and the kill floor effluent (blood water), in the 50:50 ratio.
- Free fat must be removed from the sheep processing kill floor wastewater before mixed with stick water.
- Typical removal rates are as follows:

Phosphorus	70 – 90 %
Oil & Grease	90 – 95 %
TKN	50 – 65 %
TSS	90 – 95 %
COD	80 – 90 %
- The sludge produced during the process can be returned to the by products plant and utilised while mixed with the rest of the product.

  
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**A TOPIC ON “SMART OFFSHORE STRUCTURE FOR  
RELIABILITY PREDICTION PROCESS”**

*A major project report submitted in partial fulfillment of the requirements  
for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

*in*

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*by*

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MOHAMMED ABDUL KAREEM	(17S41A0151)
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## ABSTRACT

A review of the developments within the field of structural reliability theory shows that some gaps still exist in the reliability prediction process and hence there is an urgent desire for improvements such that the estimated structural reliability will be capable of expressing a physical property of the given structure. The current reliability prediction process involves the continuous estimation and use of reliability index as a way of estimating the safety of any given structure. The reliability index  $\beta$  depends on the Probability Density Function (PDF) distribution for the wave force and the corresponding PDF of resistance from respective structural members of the given structure. The PDF for the applied wave force will depend on the PDF of water depth, wave angular velocity and wave direction hence the reliability index as currently practiced is a statistical way of managing uncertainties based on a general probabilistic model.

This research on Smart Offshore Structure for Reliability Prediction has proposed the design of a measurement based reliability prediction process as a way of closing the gap on structural reliability prediction process. Structural deflection and damping are some of the measurable properties of an offshore structure and this study aims at suggesting the use of these measurable properties for improvements in structural reliability prediction process. A design case study has shown that a typical offshore structure can deflect to a range of only a few fractions of a millimetre. This implies that if we have a way of monitoring this level of deflection, we could use the results from such measurement for the detection of a structural member failure. This advocated concept is based on the hypothesis that if the original dynamic characteristics of a structure is known, that measurement based modified dynamic properties can be used to determine the onset of failure or failure propagation of the given structure.

This technology could reveal the location and magnitude of internal cracks or corrosion effects on any given structure which currently is outside the current probability based approach. A simple economic analysis shows that the recommended process shows a positive net present value and that some \$74mln is the Value of Information for any life extension technology that could reveal the possibility of extending the life of a given 10,000bopd production platform from 2025 to 2028.

**Keywords :** Reliability, HUMS, Business controls, Risk, uncertainty, Offshore Structures, structural reliability, technology analogue, Smart process, real time data acquisition, dynamic reservoir simulation updating.

  
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## CHAPTER – 5

### RESEARCH CONCLUSION

The goal of forecasting is not to predict the future but to tell you what you what you need to know to take action in the present [39]. Similarly the objective of reliability engineering in offshore structures should be to find what we need to know in other to predict the current safety performance of any given structure. The desire for a proactive safety culture in offshore structural engineering could not have come at a better time than now due to increased demand for energy as a catalyst for development on one hand and the general global economic stagnation that calls for cost cutting measures on the other hand. Other drivers for this improved HSE performance include projected increase in the number of new offshore structures in support of oil and gas exploration and renewable energy extraction.

Notwithstanding every effort aimed at guaranteeing energy supply and security, it is projected that fossil fuels will continue to supply the main share of the world's energy supply in the foreseeable future. Offshore structures are very vital in chasing the limited patches of offshore petroleum and natural gas around the world as well as offshore renewable energy. The increasing demand for renewable energy is driven by climate change, soaring global electricity demand and the scarcity of fossil fuels among other things. The wind power and solar energy are the most competitive of the renewable energy sources and are helping countries lacking natural resources gain greater independence from fossil fuels and secure their own climate friendly energy supply. It is projected that renewable energy will account for 17% of world energy demand in 2030. In 2012 four hundred and seventeen (417) offshore structures were constructed for wind turbine. Similar numbers of structures were constructed for hydrocarbon exploration and production and it is expected that this growth in the overall number of construction projects will continue. Unlike the maintenance inspection of offshore structures which involve diving for shallow water inspection, inspection of offshore wind turbine towers are cost prohibitive. The additional cost and safety issues for erecting the required scaffold is much more than that required for diving in offshore structures hence the application of the recommendations of this research can also be applicable in monitoring of the reliability of offshore wind turbine structures.

# **A TOPIC ON “A STUDY ON EFFECTS OF ADMIXTURE ON HIGH STRENGTH CONCRETE”**

*A major project report submitted in partial fulfillment of the requirements*

*for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

*in*

**CIVIL ENGINEERING**

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## ABSTRACT

In this study super plasticizer admixtures were used for the concrete to study the effects on the properties of fresh and hardened concrete and to achieve the requirements of high strength concrete in low water cement ratio. Superplasticizer which is also known as high range water reducers are chemical admixtures used where well-dispersed particle suspension is required. These polymers are used as dispersants to avoid particle segregation, and to improve the flow characteristics of concrete. Flocculation of cement particles occur in a concrete mix without superplasticizer which reduces the workability of concrete, however for the same water-cement ratio there is a uniform distribution of cement particles for a concrete mix with superplasticizer. This paper is a study of the effect of two different types of superplasticizer namely: conplast 430, Sulphonated Naphthalene Formaldehyde (SNF), on the workability and mechanical properties of concrete mixtures.

  
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## CHAPTER-6

### CONCLUSION:-

- The compressive strength of M45 concrete, OPC cement with SP430 has gradually increase with the age of curing.
- the slump value of M45 concrete , opc cement with SNF has more slump value compared to cement with SP430.thus, there is a decrease in the compressive strength of the concrete with SNF.
- It is observed that the compressive strength of OPC cement with 0.5% of SP430 is greater than of OPC cement is 12% - 20%
- It is also observed that the compressive strength of OPC cement with 1% of SP430 is greater than of OPC cement is 20% - 30%
- It is further observed that there is gradual increase in the compressive strength of OPC cement with 1% of SP430 when compared with OPC & OPC cement with 5% of SP430
- Then further comparison of SP430 ( 1% & 0.5% dosage) and SNF( 1% & 0.5% dosage).
- It clearly shown in graph that the compressive strength SP430 increases when compared with SNF.
- And when compared to SNF there is decreases in slump value of SP430.
- By comparing the costs of both superplasticizer they are economy.
- The cost of SNF is about Rs60 per litre. The cost comes upto be Rs5216 for mixing one meter cube of concrete using SNF.
- The cost of SP430 is about Rs32 per litre. The cost comes upto be Rs3495 for mixing one meter cube of concrete using SP430.
- Hence, SP430 is a better superplasticizer tha SNF, by considering characteristic behavior of fresh and hardened concrete and economy point of view.
- And hence desire production of M60 concrete is achived by adding 1% of SP430 admixture to M45 concrete.

# STABILIZATION OF BLACK COTTON SOIL USING LIME

*A major project report (stage-II) submitted in partial fulfillment of the  
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## ABSTRACT

The design foundation on black cotton soil (expansive soil) has always been a difficult task for the engineers as the structure resting on black cotton soil cracks without any warning. Black cotton soil is found in M.P., Karnataka, Maharashtra and Andhra Pradesh in our country. Soil proportion changes depending upon their constituents, i.e. water content, density, bulk density, angle of friction, shear strength etc. The properties of black cotton soil can be modified by stabilizing the soil can be modified by stabilizing the soil with the use of additives or by mechanical means. In this project an attempt has been made to stabilize the soil using lime. Experimental work has been carried out with 4 % and 6 % of lime content. The experimental work is based on different percentages of lime content in soil on tests for soil Liquid limit, Plastic limit, O.M.C., M.D.D, Bulk density and Dry density, C.B.R, test, Grain size analysis and Swelling pressure. The aim is to improve the engineering properties of the black cotton soil such that the structure built on this soil can be efficiently withstanding applied loads. It was found that the engineering properties of black cotton soil substantially improved by addition of lime.

  
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## CONCLUSION

In this project work, it has been found that the properties of black cotton soil get effectively modified by varying proportions of lime. In this experimental program stabilization of soil has been carried out by mixing lime in varying percentages (4% and 6%). The following conclusions are drawn from this experimental study:-

1. It has been found that an addition of 4% lime decreases the liquid limit by 12.1 %, while 6% addition of lime shows a decrease of only 17.7%.
2. M.D.D. is found to decrease by 3.16% and 5.06% at 4% and 6% lime content respectively.
3. It was found that O.M.C. does not change with a decrease of 14.3% in O.M.C. was observed at 6% lime content.

  
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# INVESTIGATION OF PROPERTIES OF GEOPOLYMER CONCRETE BY USING QUARRY DUST

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## ABSTRACT

The major problem in the world is facing today is the environmental pollution. In the construction industry mainly the production of Portland cement will cause the emission of pollutants results in environmental pollution. We can reduce the pollution effect on environment, by increasing the usage of industrial by-products in our construction industry. Geopolymer concrete is such a one and in the present study, to produce the geo-polymer concrete the Portland cement is fully replaced with fly ash and the fine aggregate is replaced with quarry dust and alkaline liquids are used for the binding of materials.

The alkaline liquids used in this study for the polymerization are the solutions of Sodium hydroxide (NaOH) and sodium silicate ( $\text{Na}_2\text{SiO}_3$ ). Different molarities of sodium hydroxide solution i.e. 8M, 10M and 12M are taken to prepare different mixes. And the compressive strength is calculated for each of the mix. The cube specimens are taken of size 150mm x 150mm x 150mm. The Geopolymer concrete specimens are tested for their compressive strength at the age of 7days, mixes of varying sodium hydroxide molarities i.e. 8M, 10M and 12M are prepared and they are cured by direct sun-light and strengths are calculated for 7 days, 14 days and 28 days.

The result shows that the strength of Geopolymer concrete is increasing with the increase of the molarity of sodium hydroxide.



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## CHAPTER 6

### CONCLUSIONS

Based on the experimental work reported in this study, the following conclusions are drawn.

- Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of fly ash & quarry dust based geo-polymer concrete.
- Longer curing time, in the range of 4 to 96 hours (4 days), produces higher compressive strength of fly ash & quarry dust based geo-polymer concrete. However, the increase in strength beyond 24 hours is not significant.
- The fresh flyash-based geo-polymer concrete is easily handled up to 120 minutes without any sign of setting and without any degradation in the compressive strength.
- The mix GP3 gives higher compressive strength, as it has high molarity of NaOH
- we Observe that the compressive strength is increased with the increase in the molarity of the sodium hydroxide.
- After three days of curing the increase the compressive strength is not sufficient. The geo-polymer concrete shall be effectively used for the beam column junction of the reinforced concrete structure
- Geo-polymer concrete shall also be used in the Infrastructure works.
- In addition to that fly ash shall be effectively used and hence no landfills are required to dump the fly ash

  
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# **A CASE STUDY ON USAGE OF PLASTIC WASTE IN PAVER BLOCKS**

A Major project report submitted in the partial fulfilment of the requirements  
for the award the degree of

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**In**

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## ABSTRACT

The aim of this project is to replace cement with plastic waste in paver block and to reduce the cost of paver block when compared to that of convention concrete paver blocks. At present nearly 56 lakhs tones of plastic waste is produced in India per year. The degradation rate of plastic waste is also a very slow process. Hence the project is helpful in reducing plastic waste in a useful way .In this project we have used plastic waste in a useful way.

In this project we have used plastic waste in different proportions with quarry dust, coarse aggregate and ceramic waste. The paver blocks were prepared and tested and the results were discussed. This waste product is used as replacement of coarse aggregate. The purpose of mixing fly ash and stone dust is to decrease the density of blocks. The main aim is to use the plastic in construction fields.

**Key words:** Compressive strength, Concrete, Plastic waste, Paver block, Workability.

  
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## CHAPTER-6

### CONCLUSION

The tiles were prepared by replacing cement and aggregate. In the manufacturing of tiles we used sand and plastic. In addition to this we also prepared moulds by using fly ash and stone dust to the sand and plastic. The mix proportion for mould taken is 1:4 where 1 kg of plastic and 4 kg of sand, and then mix proportion of plastic, sand and fly ash i.e. 1:1.5:3. We also made tiles by adding small stone chips in small quantity for better friction purpose. The tiles which were made by using plastic and fly ash had not shown good compressive strength. The tiles which was made by using plastic and sand has the good compression strength, good friction and also there is less water absorption as compared with the normal tiles. The preferable results are obtained for moulds made by using plastic and sand with a mix proportion of 1:4. The tile made by using plastic and sand shows good compression strength results i.e.  $8.7 \text{ N/mm}^2$ , Whereas tile made by plastic sand and stone dust in proportion of 1:1:2 is  $7.99 \text{ N/mm}^2$ . As per above results compression strength of tile prepared by using plastic and sand got more preferable value than normal tile. In addition to compression strength test we conducted water absorption test, acid resistance test, hardness test, fire resistance test. After conducting all the above test we got more preferable values than normal tile.

- By the above result analysis we can say that plastic sand tiles are good for parking tiles.
- It will give a good aesthetic view than compared to normal tile.
- Even if failure occurs in the tile by heating we can remold the tile and we can reuse.
- It may cause some amount of pollution to the environment by releasing harmful gases during melting of plastic; by taking proper measures we can control the pollution.

  
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# COMPARATIVE STUDY ON FIBER REINFORCED CONCRETE AND CONVENTIONAL CONCRETE

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## ABSTRACT

Fiber Reinforced Concrete (FRC) is a composite material consisting of fibrous material which increases its structural integrity. Fibers are an ideal ingredient for improving the performance and durability of concrete and mortar. They increase energy absorption and fire resistance. Whilst reducing shrinkage crack, fracture formation and crack widths.

When water freezes, it expands. Since there is water in moist concrete, it's susceptible to freezing, which creates pressure in the concrete's pores. If this pressure exceeds to concrete's tensile strength, it can rupture. When concrete is exposed to multiple freeze-thaw cycles, cracking, scaling and crumbling can occur. Adding fibers to the concrete will improve its freeze-thaw resistance and help keep the concrete strong and attractive for extended periods of time.

During the curing process, concrete experiences shrinkage as the water evaporates. This process can cause cracks or other imperfections in the concrete. Fibers can help to improve a concrete's resistance to shrinkage, which will in turn reduce its cracking.

In applications where the look and feel of the concrete is important, micro-synthetic or stealth fibers can create a clean, nearly invisible finish. If your concrete will be used in a driveway, patio, or walkway, this sleek look will catch the eye of neighbors and guests.

**Keywords:** Fiber Reinforced concrete, Fire resistance, Shrinkage crack, Improve Freeze – Thaw resistance, Reduce Effects of Shrinkage, Look.

  
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## CHAPTER-7

### CONCLUSIONS

- OPFRC exhibited increase in 28 day compressive and flexural strength by about 21 percent and 6.4 percent, respectively, as compared to control mix. It also exhibited a significant reduction in drying shrinkage. The drying shrinkage of control concrete was 0.06 percent while that of the FRC was 0.03 percent.
- The 28 days compressive strength of concrete cubes reinforced with steel fibers at optimum dosage is found to be  $54.44 \text{ N/mm}^2$ . As Compared to the conventional concrete compressive strength increases by 28.82%.
- The 28 days Split tensile strength of Cylindrical specimens reinforced with steel fibers at optimum dosage is found to be  $5.66 \text{ N/mm}^2$ . As compared to the conventional concrete split tensile strength increases by 23.50%.
- The 28 days of Flexural strength of beams reinforced with steel fibers at optimum dosage is found to be  $6.22 \text{ N/mm}^2$  respectively. As compared to the conventional concrete flexural strength increases by 34.05%.
- The water absorption value of steel fiber reinforced concrete is found to be 0.47%. As compared to the conventional concrete water absorption capacity is reduced by 53%.
- The water absorption value of polypropylene fiber reinforced concrete is found to be 0.37%. As compared to the conventional concrete water absorption capacity is reduced by 65.74%.
- The sorptivity value of steel fiber reinforced concrete is found to be  $0.081 \text{ mm/min}^{0.5}$ . As compared to the conventional concrete sorptivity capacity is reduced by 50.00%.
- The sorptivity value of Polypropylene fiber reinforced concrete is found to be  $0.041 \text{ mm/min}^{0.5}$ . As compared to the conventional concrete sorptivity capacity is reduced by 74.69%.

  
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- PFRC can be used advantageously over normal concrete pavement. Polymeric fibers such as polyester or polypropylene are being used due to their cost effective as well as corrosion resistance. PFRC requires specific design considerations and construction procedures to obtain optimum performance. The higher initial cost by 15-20% is counterbalanced by the reduction in maintenance and rehabilitation operations, making
- PFRC cheaper than flexible pavement by 30-35%. In a fast developing and vast country like India, road networks ensure mobility of resources, communication and in turn contribute to growth and development.
- Resistance to change though however small disturbs our society hence we are always reluctant to accept even the best. It's high time that we overcome the resistance and reach for the peaks. PFRC opens a new hope to developing and globalizing the quality and reshaping the face of the "True Indian Roads".
- Mechanical properties of the conventional concrete can be improved by the addition of steel fibers and polypropylene fibers.
- It can be concluded that the durability properties of conventional concrete can be improved by the addition of steel fibers and polypropylene fibers.
- The optimum dosage of crimped steel fibers is found to be 1.5% and that of polypropylene fibers is 0.3%.
- Concrete reinforced with crimped steel fibers shows better results as compared to the polypropylene fibers.

  
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# **SOIL STABILISATION USING GEOSYNTHETICS**

A major project report submitted in partial fulfillment of the requirements for the award  
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This is certify to that the major project report entitled **SOIL STABILISATION USING GEOSYNTHETICS**, submitted by the following students in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Civil Engineering, and is a bonafide record of the work performed by

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## ABSTRACT

Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing with additives. The different types of method used for soil stabilization are: Soil stabilization with cement, Soil stabilization with lime, Soil stabilization using bitumen, Chemical stabilization and a new emerging technology of stabilization by Geo textiles and Geo synthetic fibers.

In this study, we are making use of bamboo fibers as geo synthetic material for stabilization of soil. With the introduction of bamboo fibers to the soil the CBR values will improve and thickness of pavement layer also gets reduced. It also reduces the intensity of stress on subgrade. Bamboo fibers is such a geosynthetic material which is easily available, ecofriendly and also cost effective. With the application of soil stabilization method in construction the overall cost gets reduced when compared to the ordinary method of construction.

The different tests were conducted in order to determine the different characteristics and properties of the black cotton soil and obtained with following results. The liquid limit of the soil with addition of bamboo fibers was found to be decreasing when compared to liquid limit of soil

alone. The plastic limit of the soil decreased with the addition of fibers. The shrinkage limit of the soil was increased with increase in fibres.

The MDD of the soil with addition of bamboo fibers by weight of soil is found to be increasing up to 0.75% after that it decreases and the corresponding OMC is decreased with addition of fibers. The shear strength of soil decreased substantially with addition of fibers. The CBR value of the soil increased substantially.

From the limited laboratory study conducted we concluded that the 0.75% of bamboo fiber can substantially improve the properties of Black cotton soil. And thus 0.75% of bamboo fiber is the optimum fiber content for black cotton soil.

**Keywords:** Geosynthetics, Bamboo fibre, Soil stabilization, Geo textiles, Black cotton soil.

  
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## CHAPTER 6

### CONCLUSIONS

On the basis of present experimental study, the following conclusions are drawn

1. According to the Highway Research Board classification, the black cotton soil sample has been categorized as A-7-6 (4.549)
2. There is substantial increase in MDD with increase in addition of fibers upto 0.75% by weight beyond which it decreased.
3. There is substantial decrease in OMC with increase in addition of fibers.
4. In unconfined compression test it was observed that the shear strength of the soil has increased with the increase in percentage of bamboo fibers, when compared to that of shear strength of soil tested without fiber.
5. The shear strength of the soil is maximum when 1% (by weight of soil) of bamboo fibers is added to it. Hence in order to obtain higher shear resistance 1% of fibers (by weight of soil) can be considered as the optimum fiber content.
6. The California bearing ratio (CBR) of the soil alone is obtained as 1.82% and it increased to 5.41% after stabilizing it with optimum percentage of bamboo fibers.
7. The percentage increase in CBR value after stabilizing it with optimum percentage of fibers is 197.25%.
8. In the case of sedu soil there is substantial increase in MDD with increase in addition of fibers.
9. In unconfined compression test it was observed that the shear strength of the soil has decreased with the increase in percentage of bamboo fibers, when compared to that of shear strength of soil tested without fiber.
10. The California bearing ratio (CBR) of the soil alone is obtained as 4.28% and there substantial increase in CBR value with addition of fibres.

# **A CASE STUDY ON HIGH STRENGTH CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH GGB**

*A major project report submitted in partial fulfillment of the requirements  
for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

*In*

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## ABSTRACT

Concrete is mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure. viz, buildings industrial structures, bridges and highways etc., leading to utilization of large quantity of concrete. As cost of concrete is attributed to the cost of its ingredients which is expensive, this led to usage of economically alternative materials in its production. High Performance Concrete (HPC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituents and normal mixing. This leading to usage of economically alternative materials in its production. This requirement is drawn the Attenuated Slag (GGBS) at a different proportion. GGBS is by-product of steel manufacturing industry and it is a fine powder of iron slag. The present paper focuses on investigating characteristics of M50 concrete with partial replacement of cement with Ground Granulated Blast Furnace Slag (GGBS). Compressive strength of M50 grade of concrete with 0.35 water to cement ratio was investigated; in which, to determine compressive strength with partial replacement of cement with GGBS. In our experimental investigations, it is observed that, the compressive strength of concrete has been increased by 3%. The concrete mix of M50 prepared was tested at 7, 14 & 28 days. GGBS being a by-product serves as an eco-friendly material. The use of GGBS overcome pollution problem in the environment and it helps in the durability of concrete.

**Keywords:** Granulated Blast Furnace Slag, economically alternative materials, Compressive strength, concrete mix.



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## CHAPTER-4

### CONCLUSION

- The partial replacement of OPC with GGBS improves the workability, as it has been observed that the slump value increases with the increase of replacement of cement with GGBS.
- The use of GGBS in concrete resulted in an increase in setting time, as the initial rate of reaction of slag is slower than that of cement.
- The delay in setting time is closely linked to the GGBS replacement level, as higher amount of slag increases the setting time.
- Shear type of failure was observed in slump as the GGBS content was increased.
- The replacement of OPC by GGBS up to 40 % shows the increase of 2~3% in compressive strength of 28 days curing; however beyond 40% replacement by GGBS the reduction in strength is substantial.
- The use of GGBS as partial replacement of cement helps to reduce the Energy consumption in the manufacturing of cement.
- The replacement of cement by GGBS helps to reduce the cement content of concrete, thereby reducing the cost of construction because the price of GGBFS is about 25 - 50% less than that of OPC.
- Reuse of the slag helps to protect the environment from pollution and friendly disposal of the waste slag from steel industries.
- All kinds of pozzolanic materials are efficient in reducing the permeability of concrete far below the control one.
- Workability of concrete increases with the increase in GGBFS replacement level.
- As the GGBS content increases, the water/binder ratio also decreases for the same workability and thus, the GGBS has positive effects on the workability.

  
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# **A STUDY ON STRENGTH OF EXTERNAL AND INTERNAL SELF CURING CONCRETE**

A Major project report submitted in partial fulfilment of the requirements

for the award of degree of

**BACHELOR OF TECHNOLOGY**

IN

**CIVIL ENGINEERING**

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## ABSTRACT

Curing plays a major role in the construction of a building. And the major disadvantage of curing is the excess wastage of water in the form of runoff. In places where water is hard to find, places like Rajasthan, the process of curing becomes hard and costly also. To avoid the cons caused due to general curing, this experiment is conducted. The development of self-curing materials is now being considered for real engineering applications. In the past decade, there has been a huge interest in materials that can self-cure, and provide strength equal to that of general curing. Self curing chemicals can be made from a variety of polymers and chemicals. In this experiment, a few types of chemicals are considered and are tested on cubes and cylinders to test its compressive strength and split tension for 3 days, 7 days and 28 days. M35 mix was considered as reference. The various conclusions obtained were presented.

Concrete is most widely used construction material due to its good compressive strength and durability. Concrete can be cured by water curing and by self-curing agent. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Self curing concrete is the one which can cure itself by retaining its moisture content. In the present study, the effect of admixture (PEG 400) on compressive strength, split tensile strength, flexural strength and durability test by varying the percentage of Polyethylene Glycol (PEG) by weight of cement from 0% to 2% were studied for M20 and M30 mixes. Super plasticizers are water reducers which are capable of reducing water content by about 30 percent. It was also found that 1% of PEG 400 by weight of cement was optimum for M20, while 0.5 % was optimum for M30 grade concretes for achieving maximum strength without compromising workability.

**Key words:** Self curing, Polyethylene Glycol, Super plasticizers, compressive strength, split tensile strength, flexural strength.

## CHAPTER-12

### CONCLUSION

Experimental work has been conducted on different self curing chemicals and the results were presented and discussed. The following conclusions can be derived from the above results: From the experiment conducted, it has been observed that the values of cubes and cylinders, after 28 days, from general curing, give high results. The values of all the other cubes and cylinders, from the various chemicals used, gave weak results except for the chemical, Polyethylene Glycol 200 used at 1%. The use of 1% of Polyethylene Glycol 200; gives approximately close values to that of general curing. The compressive strength of cubes, for 28 days, of the use of 1% of PEG is equal to the values obtained from general curing. The splitting tension of PEG used at 1% is observed to be more than that of general curing for 28 days.

The strength of self-curing concrete the optimum dosage of PEG400 for maximum strengths (compressive, tensile and flexural strength) was found to be 1% for M20 and 0.5% for M30 grades of concrete. The strength and durability properties of internally cured concrete with PEG prove to be best among the alternatives percentage and prove to be the best when compared to external curing. Strength of self curing concrete is on par with conventional concrete.

While considering the internal curing with that of external curing, the cost of internal curing proves to be cheaper when compared with that of external curing. Performance of the self-curing agent will be affected by the mix proportions mainly the cement content and the w/c ratio.

  
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# **EXPERIMENTAL STUDY ON CELLULAR LIGHTWEIGHT CONCRETE**

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
for the award of the degree of*

## **BACHELOR OF TECHNOLOGY**

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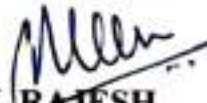
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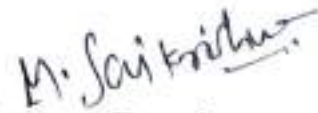
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## ABSTRACT

Cellular Lightweight Concrete is a versatile material which is made up of cement, fly ash and synthetic or protein based foam. Basically it is a new material which is currently using in India for walling purpose. Cellular lightweight concrete gives better sound insulation, thermal insulation, durable, lightweight, uniform size & shape, reduce permeability. It is non-load bearing structural element which has lower strength than conventional concrete. Cellular concrete is popular because of its light weight which reduces self-weight of structure. In this paper light weight cellular concrete blocks are casted with 65% of Fly ash and 35% of cement with foam content 1.5% of total weight and to increase its strength sand and quarry dust is added in its composition which replace fly ash upto 30% at an interval of 10%. to check properties of these cellular lightweight concrete (CLC) blocks test like compressive strength, density and water absorption is done in the laboratory

  
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## CHAPTER 6

### CONCLUSION

Present study contains a study of properties of Cellular lightweight concrete and also the utilization of quarry dust in the proportion of Cellular light weight concrete. Conclusions is drawn from the present study is given below:

1. Dry density of the CLWC is increased when quarry dust is partially replaced by fly ash content in it. It is also concluded that increasing content of quarry dust in the composition, increases the density of CLWC, replacement of fly ash quarry dust upto 30% possess increment of 3.70% in dry density.
2. Water absorption of CLWC is decreased when quarry dust is partially replaced by fly ash content in it, when increasing content of quarry dust in the composition, decreases the water absorption of CLWC, replacement of fly ash by quarry dust upto 30% possess decrement of 30.04% in water absorption.
3. Compressive Strength of the CLWC is increased when quarry dust is partially replaced by fly ash content in it. It is also observed that increasing content of quarry dust in the composition, increases the compressive strength of CLWC, replacement of fly ash by quarry dust upto 30% possess increment of 33.33% in compressive strength.
4. Study shows that increase in the density of CLWC decreases the water absorption and increases the compressive strength and when water absorption is increased of CLWC compressive strength and dry density is decreased.

  
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# **DESIGN & ESTIMATION OF A RESIDENTIAL BUILDING**

A major project report submitted in the partial fulfillment of the  
requirements for the award of the degree of

**BACHELOR OF TECHNOLOGY**

in

**CIVIL ENGINEERING**

by

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## **ABSTRACT**

Food, clothing and shelter are the primary requirements of a human being. Shelter is one of the most important and basic need for survival. Due to huge population growth, people have shifted from rural to urban areas and are building large-scale houses in small areas. Hence proper planning and purposeful design of a building is very important.

Planning (all the drafting and detailing) is done by using Auto CAD. Design of RCC structural components (slab, beam, column, staircase etc.) is done by "Limit State Method" using IS 456:2000 code. Design of building steel is done as per IS 800:2007. Different loads acting on the member are considered according to IS 875:1987. Estimation is done by using rates from Schedule of Rates (2020-21).

In this project, design and estimation of a residential building is discussed.

  
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## **CHAPTER 11**

### **CONCLUSION**

This project includes all the various activities like orientation, planning according to the rules and regulations of NBC code, considering vastu principles for happy living and drawings of plan, elevation and sectional views. And also arrangement of different building components and furniture as per the requirements is important in planning. Design of each and every component should be accurate and should not have failure in any case. So, it is essential to design each component carefully because one is dependent on the other.

  
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# **UTILIZATION OF WASTE PLASTIC FOR MANUFACTURING OF BRICKS**

A major project (Stage-II) report submitted in partial fulfillment of the  
requirements for the award of the degree of

**BACHELOR OF TECHNOLOGY**

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BRICKS” submitted by the following students in partial fulfillment of the  
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## ABSTRACT

Plastics are key resources in circular economy and recycling after the end of useful life with economic value creation and minimal damage to environment is the key to their sustainable management. Studies in a large stream of researches have explored impregnating waste plastics in concrete and reported encouraging results with multiple benefits. The present study makes a critical review of some of these findings and gleans some common useful trends in the properties reported in these studies. The study also presents results of experimental work on bricks made of non-recyclable waste thermoplastic granules constituting 0 to 20% by weight, 4kg of fly ash, cement and sand making up the remainder. The bricks were cured under water for 28 days and baked at temperature ranging from 90oC to 110oC for 2 hours. The key characteristics of these bricks are found to be lightweight, porous, of low thermal conductivity, and of appreciable mechanical strengths.

Though such bricks hold promise, no similar study appears to have been reported so far. Unlike other processes of making porous bricks, which usually involve incineration to burn combustible materials in order to form pores with implication of high carbon emission, the proposed process is non-destructive in that the bricks are merely baked at low temperature, sufficient to melt the waste plastic that gets diffused within the body of the bricks. The compressive strengths after addition of waste plastic is same as normal brick strength. And also reduce the water absorption capacity of brick is reduced compare with nominal brick. Efflorescence values were low than the normal brick. The bricks are likely to add energy efficiency in buildings and help create economic value to manufacturers, thereby, encouraging the ecosystem of plastic waste management involving all actors in the value chain. A mathematical model is developed to predict compressive strength of bricks at varying plastic contents. The study introduces a new strand of research on sustainable thermoplastic waste management.

  
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## CHAPTER-7

### CONCLUSIONS

- Waste plastic, which is available everywhere, may be put to an effective use in brick.
- Plastic bricks can help reduce the environmental pollution, thereby making the environment clean and healthy.
- Plastic sand bricks reduce the usage of clay in making of bricks.
- Plastic sand bricks give an alternative option of bricks to the customers on affordable rates.
- Water absorption of plastic sand brick is zero percent.
- Compressive strength of plastic sand brick is 5.6N/mm<sup>2</sup> at the compressive load of 96KN.
- We conclude that the plastic sand bricks are useful for the construction industry when we compare with Fly Ash bricks and 3rd class clay bricks.

  
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# **EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT WITH WASTE GLASS POWDER**

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
for the award of the degree of*

## **BACHELOR OF TECHNOLOGY**

*in*

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**2022**

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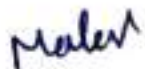



**CERTIFICATE**

This is certify to that the major project (Stage-II) report entitled **"EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT WITH WASTE GLASS POWDER"** submitted by the following students in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Civil engineering, and is a bonafide record of the work performed by

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## ABSTRACT

Increase in the demand of conventional construction materials and the need for providing a Sustainable growth in the construction field has prompted the designers and the use of industrial waste products are very constructive. Million tons of waste glass is being generated annually all over the world. Once the glass becomes a waste it is disposed as landfills, which is unsustainable as this does not decompose in the environment. Glass is principally composed of silica.

Use of milled (ground) waste glass in concrete as partial replacement of cement could be an important step toward development of sustainable (environmentally friendly, energy-efficient and economical) infrastructure systems. In this experimental investigation is taken to study the properties of concrete made with Waste glass powder. The replacement is done partially in the proportion of 0%, 10%, 15%, 20% and 25% with waste glass powder in concrete for M30 grade of concrete. The effect on workability of concrete made with waste glass powder were investigated for the 0%, 10%, 15%, 20% and 25% waste glass powder replacement, the hardened properties such as compressive strength observed. The compressive strength at 7, 14 and 28 days were tested. A 20% replacement of cement with waste glass was found convincing considering cost and the environment. keywords: waste glass powder, compressive strength, workability.



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## CHAPTER 9

### CONCLUSION

From the experimental work carried out for M30 grade of concrete by partial replacement of cement with 0%,10%,15%,20% and 25% of waste glass powder.

- Utilizing waste glass powder it is conceivable to diminish the utilization of concrete and the related vitality interest effect on air contamination and CO<sub>2</sub> emission. The slump of concrete appears to increment in waste glass powder in the concrete mix. Up to 20% waste glass powder the strength was considerable.
- All the destination of this experimental study are accomplished, concrete utilizing with waste glass powder has a high workability. The outcome accomplished from the slump test clarifies that by utilizing waste glass powder will expand the workability of concrete.
- Therefore, considering the strength criteria of concrete, the replacement of cement by waste glass powder is feasible upto 20%.
- Very finely ground waste glass powder have shown sufficient pozzolanic properties to serve as partial cement replacement. Thus reducing the use of cement and the associated energy demand and impact on air pollution and CO<sub>2</sub> emission
- Usage of waste glass powder in concrete will reduce the disposal problem of waste glass and proves to be environmental friendly construction material

  
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# ANALYSIS AND DESIGN OF AN IRRIGATION SYSTEMS

*A major project submitted in partial fulfillment of the requirements*

*for the award of the degree of*

## BACHELOR OF TECHNOLOGY

*in*

### CIVIL ENGINEERING

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DEPARTMENT OF CIVIL ENGINEERING  
**V A A G E S W A R I C O L L E G E O F E N G I N E E R I N G**



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## ABSTRACT

The artificial application is used to assist the growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. In the modern challenge of improving the growth of plants and reducing costs justifies that the development of an irrigation system that will minimize the waste of water and reduce workers and monitor overhead is crucial. Land and water are the basic needs for agriculture and economic development of the country. According to International Water Management Institute (IWMI), one-third of the world's population will face absolute water scarcity by the year 2025. Agriculture which consumes more than 80% of the country's exploitable water resources. The overall development of the agriculture sector and the intended growth rate in GDP is largely dependent on the judicious use of the available water resources. Hence, this Scheme on Micro Irrigation (MI), which aims at increasing the area under efficient methods of irrigation

Sprinkler irrigation requires an understanding of soil-water-plant relationships and that irrigation timing and amount depends on soil water holding capacity, weather, and crop growth progress. Adequate system design, installation, proper operation and maintenance are important for realizing the benefits of sprinkler irrigation over the system lifetime. Furrow irrigation is also suited to the growing of tree crops. In the early stages of tree planting, one furrow alongside the tree row may be sufficient but as the trees develop then two or more furrows can be constructed to provide sufficient water. Sometimes a special zig-zag system is used to improve the spread of water. Drip irrigation is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation.

This project helps to analyze the usage of water, type of soil, type of crop, area of land, source of water, pressure energy of different types of irrigations on land selected, and to supply the water by designing and installing the drip irrigation system and furrow irrigation system in the selected land.

### KEYWORDS:

Sprinkler irrigation, Drip irrigation, Furrow irrigation, Analysis and Design system, International water management institute (IWMI), Micro irrigation (MI), Soil-water-plant relationship

## CHAPTER-9

### CONCLUSION:

Traditional agriculture is an extractable process where all resources - human, water, and land are taken and applied to immediate use. Modern agriculture uses planned technology and emphasizes management practices of conservation and renewability of resources. Modernization forces the growth of an infrastructure concomitant with rural development, urbanization, and industry. Overall economic development depends on the effective use of population and conservation of water and land as vital resources of the environment. The concepts of probability, water balance, and rainfall-runoff techniques integrated with socio-economic research methodologies can be used to evaluate the potential for the integration of these techniques into the modernization process. The steppe and pasture region with its traditional farming system of rainfed barley-livestock suffers from continuous barley cropping and overgrazing of natural pastures which causes water loss and soil degradation to progress at an alarming rate. New strategies for managing existing water and land resources, in harmony with traditional practices, can be formulated to intensify the effectiveness of human resources using capital investment in equipment to implement varying scales of irrigation systems and water harvesting farming.

Based on the following different types of analysis and design process of irrigations the selected land is suitable for drip irrigation because of the crops which are planted in that field. Also According to the seasonal variations and the other needs, the drip irrigation is installed in the field. The sprinkler and furrow irrigations are also useful for the selected land but as the land is of clay soils water must be applied slowly to avoid surface water ponding and runoff. So, drip irrigation is selected on the land.

  
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# **A CASE STUDY ON SEISMIC RETROFFITING OF REINFORCED CONCRETE BUILDINGS**

*A major project submitted in partial fulfillment of the requirements  
for the award of the degree of*

## **BACHELOR OF TECHNOLOGY in CIVIL ENGINEERING by**

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## ABSTRACT

Recent earthquakes, starting with the 1971 San Fernando Earthquake in California, left major destructions damaged the infrastructure, and raised questions about the vulnerability and design practice of structures, especially concrete structures. Design codes have being updated to include seismic previsions but structures build before 1971 have to be retrofitted. The focus of this paper is concrete structures. Surveys done after earthquakes have shown that the major problem with concrete structures is columns. Other critical structural elements include, but are not limited to, gravity design frames, footings, shear walls, connections, and beams. There are two major categories of retrofit options for concrete structure; local and global methods. Local methods focus at the element level on a particular member that is deficient and in improving it to perform better Those methods include adding concrete, steel, or composite to the outside of the member. All three methods are effective but each present some disadvantages: concrete is labor intensive, steel requires heavy construction equipment's, and composites have high initial cost. Global methods concentrate at the structure level and retrofit to obtain a better overall behavior of the entire structure. The different global techniques are addition of shear walls or steel bracings, and base isolation. All three methods are effective. Shear walls are usually an expensive solution but they are flexible in their distribution allowing them to be hidden in the architecture. Steel bracings allow for openings but their connections to the existing structure can be problematic. Finally, base isolation is an option that is becoming increasingly popular and that provides good behavior in earthquake for low to mid high structures.

**KEYWORDS:** Retrofitting, Local method, Global method, Jacketing, seismic vulnerability, Seismic retrofitting, Base isolation

  
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## CHAPTER-9

### CONCLUSION

#### 9.1. GENERAL CONCLUSIONS

A general overview of the results showed that a better structural seismic performance of the model after the seismic retrofitting was accomplished, and prove that the chosen structural methodology of this modification is a sufficient optimized design for this existing building.

More detailed, applying steel bracings and prefabricated concrete walls (shear walls) improved the structure's characteristics such as stiffness, strength and ductility. The stiffness was mainly enhanced by the added steel bracings in the longitudinal direction, which increased the frequency remarkably. Moreover, the structure became more ductile primarily because of the steel bracings applied; hence, an improved of the capability to undergo plastic deformation before fracture is achieved. After performing the seismic retrofitting, the strength of the structure was developed by both applied retrofitting techniques; however the shear walls had the largest contribution for the stabilization of the accomplished structural performance. Another aspect that lead to these achieved improvements is the choice of material and section properties for seismic retrofitting.

Since our research is regarding an existing structure, all the existing conditions and properties must be maintained as much as possible the same, such as support types, connections between the structural elements, sizes of each structural element, soil type and so forth. The reason is to adjust to the current situation and achieve more realistic results. In conclusion, we maintained as much as possible all the properties and conditions of the structure; therefore, the obtained results are reasonable and realistic. However, another conclusion is that we should not have enormous expectations on the level of strengthening improvements of the structure against seismic hazards since, the present conditions limit the analysis.

This research study provides gaining more knowledge concerning the strengthening of existing structures under seismic vibrations. Moreover, understanding more the concept of

seismic retrofitting methods and how they can be properly applied in practice in order to obtain an appropriate retrofitting with sufficient results that fulfil the requirements of the building regulations and standards

## 9.2. FUTURE RESEARCH

This research study is giving rise for future investigations and improvements in seismic retrofitting techniques and seismic damage control; which are of high importance since, they have an extensive contribution to the present state of development.

Moreover, it constitutes a reasonable base for further investigation of local analysis of the structure. Since, we were studying the global behavior of the structure the main purpose was to improve the strengthening of the structure by examining the frequencies and displacements of the structure and not going into detail such as studying the sections and reinforcement of the structural elements, and forces at each connection of the building. These can be investigated thoroughly in future researches. Furthermore, by performing a global analysis it is a reasonable start and an effective procedure for evaluating the most critical features of the structures which provides a great aid for further local seismic analysis.

New innovative methods can be used in the future, by using a combination of seismic retrofitting techniques to optimize the functionality of the structure under seismic hazards. This is an advantageous way of combining different retrofitting strategies, where they strengthen and improve the structures characteristics, by taking benefit of their merits and demerits.

  
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# **SELF HEALING BACTERIAL CONCRETE**

*A major project (Stage-II) report submitted in partial fulfillment of the requirements  
for the award of the degree of*

## **BACHELOR OF TECHNOLOGY**

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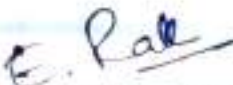


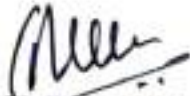
**CERTIFICATE**

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## ABSTRACT

Cracks in concrete are inevitable and are one of the inherent weaknesses of concrete. Water and other salts seep through these cracks, corrosion initiates, and thus reduces the life of concrete. So, there was a need to develop an inherent biomaterial, a self-repairing material which can remediate the cracks and fissures in concrete. Bacterial concrete is a material, which can successfully remediate cracks in concrete. This technique is highly desirable because the mineral precipitation induced as a result of microbial activities is pollution free and natural. As the cell wall of bacteria is anionic, metal accumulation (calcite) on the surface of the wall is substantial, thus the entire cell becomes crystalline and they eventually plug the pores and cracks in concrete. This paper discusses the plugging of artificially cracked cement mortar using *Bacillus Pasteurii* and *Sporosarcina* bacteria combined with sand as a filling material in artificially made cuts in cement mortar which was cured in urea and  $\text{CaCl}_2$  medium. The effect on the compressive strength and stiffness of the cement mortar cubes due to the mixing of bacteria is also discussed in this paper.

It was found that use of bacteria improves the stiffness and compressive strength of concrete. Scanning electron microscope (SEM) is used to document the role of bacteria in microbiologically induced mineral precipitation. Rod like impressions were found on the face of calcite crystals indicating the presence of bacteria in those places. Energy-dispersive X-ray (EDX) spectra of the microbial precipitation on the surface of the crack indicated the abundance of calcium and the precipitation was inferred to be calcite ( $\text{CaCO}_3$ ).

**Keywords:** *Bacillus pasteurii*, compressive strength, Bio Concrete, healing, water absorption.

## CHAPTER-11

### CONCLUSION

The bacteria which are known to be alkali-resistant, i.e., they grow in natural environments characterized by a relatively high pH (10-11). In addition, these strain can produce spores which are resting cells with sturdy cell walls that protect against extreme environmental mechanical- and chemical stresses. Therefore, these specific bacteria may have the potential to resist the high internal concrete pH values (12-13 for Portland cement-based concrete), and remain viable for a long time as well, as spore viability for up to 200 years is documented. We hypothesized that concrete-immobilized spores of such bacteria may be able to seal cracks by bio mineral formation after being revived by water and growth nutrients entering freshly formed cracks. Although the exact nature of the produced minerals still needs to be clarified, they appear morphologically related to calcite precipitates.

The mechanism of bacterially-mediated calcite production likely proceeds via organic carbon respiration with oxygen what results in carbonate ion production under alkaline conditions. The produced carbonate ions which can locally reach high concentrations at bacterially active 'hot spots' precipitate with excess calcium ions leaking out of the concrete matrix. This microbial calcium carbonate precipitation mechanism is well studied and occurs worldwide in natural systems such as oceans, bio films, microbial mats and stromatolites. For an autonomous self-healing mechanism all needed reaction components, or self-healing agents, must be present in the material matrix to ensure minimal externally needed triggers. To conclude we can state that the application of bacteria as a self-healing agent in concrete appears promising.