WWW.IJRPR.COM

**International Journal of Research Publication and Reviews**

Journal homepage: www.ijrpr.com ISSN 2582-7421

# Performance of Concrete by Using Hypo Sludge and Steel Fibre as Partial Replacement of Cement and Sand by Adding Superplasticizer

***Denendra Meena*** [a], ***Dr. Rajeev Singh Parihar*** [b]

[a] M. Tech. Scholar, Department of Civil Engineering
[b] Professor, Department of Civil Engineering

**A B S T R A C T :**

The two main building materials utilised in reinforced concrete constructions worldwide are concrete and steel. Apart from this, concrete is the material that is used most commonly. The processes used to make these materials produce emissions of greenhouse gases (GHG). By reducing the environmental impact and enhancing the sustainability of cement replacement while retaining the mechanical and physical properties of concrete, GHG emissions can be reduced. The ecology is severely polluted by the disposal of these materials. Hypo Sludge (HS), a waste material from the paper industry, is dumped as slurry in large amounts. Therefore, substituting HS for some of the cement used to make concrete can help to lessen the issue of environmental pollution. The current study, which is based on prior research, uses HS as a partial replacement of cement varying up to 40% for concrete manufacturing in combination with the addition of Steel Fibre (SF) up to 4% with superplasticizer with the goal of determining an acceptable optimum replacement of HS without noticeably reducing physical and mechanical properties compared to regular concrete of the same grade. Conclusions were made based on laboratory tests to determine mechanical properties including compressive strength, split tensile strength, and flexural strength performed after 7 days and 28 days of curing. Experiments and concrete mix design were performed using relevant Indian Standards. According to the results, adding both HS and SF up to a particular degree increases the compressive, tensile, and flexural strength of concrete at all curing ages. To offer concrete maximum strength and workability as well as an initial and final setting, the best ratio is 20% HS, 2% steel fibre, and 800 cc of superplasticizer. Compressive strength has measured at 7 and 28 days and has 25 N/mm2 and 44 N/mm2, respectively. The split tensile strength is 8 N/mm2 and 6 N/mm2, respectively, after seven and twenty-eight days, whereas the flexural strength is 3N/mm2 and 4 N/mm2. Regular concrete costs 7 percent more than HS and SF mixed concrete.

**Keywords:** HS, SF, workability, compressive strength, split tensile strength, flexural strength.

## 1. Introduction

Through the integration of industrial waste into concrete, the environment and energy can be saved. The use of these by-products offers environmental advantages like diversion of the material from the waste bodies, reduction of the energy used in processing virgin materials, usage of virgin materials and a decrease in pollution. For the production of ordinary Portland Cement (OPC), used earth resources like limestone. During the manufacturing of one tonne of OPC, an equal amount of carbon dioxide is released into the atmosphere, which is harmful to the environment. Hypo sludge helps to keep the economy going while adding beneficial qualities to the concrete. In order to achieve sustainable development, several recent research projects have concentrated on the use of hypo sludge in the production of cement and concrete. The use of waste from the paper industry in the making of concrete has been looked into by numerous researchers. Disposal cost of paper industries can be reduced by using hypo sludge in concrete and produced the green concrete for construction. High temperature strength, high wear resistance, and good toughness properties are necessary for today's applications in steel grades and high strength grade concrete. For production blinding, fine powdered material is used for different purposes and work. For different work, these fine particles are converted into particular shapes and sizes. For that, there are four main steps: powder manufacture, powder blending, compacting, and manufacture sintering. The compaction process is generally projected at a normal temperature. Steel Fiber is very small and the hard alloy carbides greatly increase the wear resistance.

### *1.1 OBJECTIVES OF THE PRESENT INVESTIGATION*

The main objective set for this present investigation is to study the improvement of the strength of conventional concrete using hypo-sludge and steel fiber. The objective of the research is to find out the effect of the use of hypo sludge and steel fibre as a partial replacement of cement and sand.

The main objectives in the present investigation are as following: -

- A comparative study of conventional concrete and concrete prepared with various percentages of hypo sludge and steel fibre in the mix.
- Investigate the potential of hypo sludge and steel fiber, which can be partially mixed into the concrete.

- Investigate the various properties of the new concrete mix like workability, compressive strength, split tensile strength and flexural strength.

## 1.2 Literature survey

Jithendra and Elavenil (2019) Increased superplasticizer dosage can have a considerable impact on the workability and strength characteristics of ambient-cured Geopolymer concrete. This study assesses the effects of various superplasticizer dosages on the workability and strength characteristics of geopolymer concrete based on GGBS. This study used 100% GGBS, a sodium silicate to sodium hydroxide ratio of 2.5, an alkaline to binder ratio of 0.5, a superplasticizer (2% to 6%), and a sodium hydroxide concentration of 12M to make geopolymer concrete. With an increase in superplasticizer under ambient curing, a sizable increase in workability and a minor loss in strength were noted. For precast construction with ambient curing, 6% superplasticizer and 12M NaOH concentration of GGBS-based Geopolymer concrete were recommended.

Reddy and Sharada (2020) It is suggested to use paper waste as hypo sludge in concrete mix that has cementitious qualities like silica and magnesium in order to reduce paper waste and environmental damage. Cement is the primary component of concrete. Cement production releases a significant amount of carbon dioxide into the atmosphere, contributing to global warming. Hypo sludge is used as a partial replacement for cement to lower cement content and assist as an eco-friendly building material, reducing environmental pollution from cement businesses. In this study, fly ash and hypo sludge are used in place of cement. Compressive and split tensile strength of concrete as well as the functionality of hypo sludge concrete are studied by adding 0 percent, 3 percent, 6 percent, 9 percent, 12 percent, and 15 percent of hypo sludge. According to the experiment, hypo sludge concrete's compressive strength and split tensile strength rose to the recommended dosage.

Rollakanti et al. (2021) Economic and environmental issues have grown in developing countries as a result of industrialization and the quick expansion of construction activity. In addition to this situation, millions of tonnes of home and industrial trash are building up and posing serious health risks to people and other species. In order to enhance sustainability in construction, research on industrial waste and alternative building materials has focused on substituting some of the cement in concrete. Therefore, this study attempted to investigate the impact of fine sea shell powder and wood ash by replacing some of the cement in concrete of M25 grade. To accomplish this, different mechanical qualities of concrete were assessed by substituting 5%, 10%, and 15% of wood ash and fine seashell powder for ordinary Portland cement, respectively. To ascertain the fundamental characteristics of the materials taken into consideration for this study, and in particular to assess the compressive, flexural, and split tensile strengths of concrete, appropriate laboratory tests were carried out. The 7, 14, and 28-day outcomes of these mixtures were compared to the test results of traditional concrete. According to the examination of the experimental data, wood ash and fine seashell powder have a positive impact on the mechanical qualities of concrete.

Ghaffar et al. (2021) The primary goal of this study is to investigate how adding steel fibres to structural concrete can improve the material's mechanical qualities. The study's goal was to identify and contrast the variations between concrete with and without fibres in terms of its physical characteristics. Compressive and flexural tests, among others, were used in this inquiry. There were a total of eleven batches of concrete that ranged in cement content from 0% to 5%, with intervals of 0.5% by weight. To find out how 'hooked' steel fibres could improve the mechanical properties of concrete, tests were conducted. As the fibre dose rate rises, concrete's workability drastically decreased.

Gopinath et al. (2023) India is a country under development and emerging nations also benefit from cost-effective construction methods and affordable building materials .The garbage is either discarded or diverted toward a landfill. The idea of adding concrete scraps to the concrete used to make the interlocking paver blocks with coir fibre is depicted in this study. In comparison to 0.1% and 0.5% coir fibre, the average compressive strength of paving blocks with 0.3% coir fibre produces the best results. Compressive strength, workability, bulk density, specific gravity, flexural strength, splitting tensile strength, and water absorption tests were analysed in order to build paver blocks with coir fire in various percentages by adding leftover construction materials.

Sekar et al. (2023) Shows in the present investigation, hypo sludge was used as a partial replacement in varied proportions (5, 10, 15, 20, 25, and 30%) of cement in concrete of M30 grade to be assessed. Styrene–butadiene rubber (SBR) latex and basalt fibre (BF) were added to hypo sludge concrete to improve its durability and post-cracking behaviour. From the test results, the optimum dosage of hypo sludge, basalt fibre, and SBR latex was found to be 15%, 0.3%, and 10%, respectively. They find also mechanical properties testing compared with the control concrete, latex-added hypo sludge basalt fibre showed an increase in compressive strength by 17.08%, flexural strength by 14.55% and tensile strength by 14.29%. Microstructural results showed that SBR latex created greater consistency in the interaction of the concrete stages. Results of the tests indicate that the performance of the concrete in terms of its strength was improved by partially replacing the cement in the concrete with hypo sludge.

## 1.3 Methodology and flow chart

### *1.3.1 MATERIAL USED*

#### *1.3.1.1 OPC (ordinary Portland cement)*

In present work, 43 grade OPC cement is used and purchased in local market. It was the current packing, a sealed pack, fresh and free from moisture. For best results, cement should be stored in moisture-less storage. To find out the physical properties of cement.

### *1.3.1.2COARSE AGGREGATE*

Aggregate is in natural or crushed state and also has collective term for sand gravel and crushed stone. Concrete is a mixture cementing material. Natural sand and gravel deposits, crushed rock, slag and mine refuse etc. is main source of aggregate. Aggregate is present in natural condition as well as man manufactured. It is generally extracted from larger rock formation or blasted to reduce size after that crushed stone screening to find different size of aggregate.

### *1.3.1.3 FINE AGGREGATE*

In fine aggregate (sand) particle size passing through 4.75mm BIS sieve BIS:383-1970. In the nature (ATM) sand is naturally occurring with action of weathering seasoning and rock spelled in river. Due to weathering action rock convert in small size of stone that stones moved by river water and it concert in another small size stone and finally convert into sand particle. After that it collected from various placed and also screening it by performed sieve analysis for sand as well as aggregate. According to the Bureau of Indian Standard BIS:383-1970 fine aggregate (sand) divided into 4 Zones (I, II, III&IV) When we go with zone I to zone IV aggregate become finer. After studying I choose II zone fine aggregate sand. After that I determine SP, FM and water absorption before used in the mixed.

### *1.3.1.4 HYPO SLUDGE*

Hypo sludge was dried in the sun light till the moisture exhaust and after that it was grinded. The hypo sludge used in concrete contains 90% particles passing 45-micron sieve. The chemical and physical properties of hypo sludge and its comparison with cement.

### *1.3.1.5 STEEL FIBRE*

Steel fiber was free from moisture as well as corrosion. The steel fiber used in concrete contains 95% particles passing 4.75-microns sieve and its shape and size also same as fine aggregate.

### *1.3.1.6 SUPERPLASTICIZER*

In the current time superplasticizer are frequently used to improve workability in mortar and concrete. Aim of superplasticizer is basically two types: First to improve workability for the design of self-compacting concrete and second is water cement ratio. The plasticizer used as Auracast 405M.

### *1.3.1.7 WATER*

Drinking water were used in present investigation in all specimen. The water which was used in my work, free from organic matter, silt, oil, sugar, chloride and acidic material as per Indian Standard code IS 456-2000.

### *1.3.2 METHOD OF CONCRETE MIX DESIGN AS PER BIS: 10262-2009*

This section deals with the method of mix design for hypo sludge and steel fiber with superplasticizer and also various tests performed on the test samples prepared by these mixes. In this part, several tests such those for compressive strength, split tensile strength, flexural strength, and workability by slump cone test of concrete containing varying percentages of hypo sludge and steel fibre with superplasticizer will be carried out.

The following steps used to design mixed of concrete summarized below: -

- In first step to find out target mean strength from the specified characteristics strength on the level of quality controlled.
- In second step select W/C ratio (Water Cement Ratio) for target strength.
- In third step with the help of slump cone test determine water content.
- The cement content can be determined from the water/cement ratio determined by slump cone test and water content obtained in step (ii) and (iii) respectively and is checked for the water requirements.
- With the help of characteristics of coarse and fine aggregate find out proportion of fine and coarse aggregate.
- The trial mix proportions are determined.
- After verifying compressive strength with the trial mixes tested are made to get there the final mix composition.

***FLOW CHART***

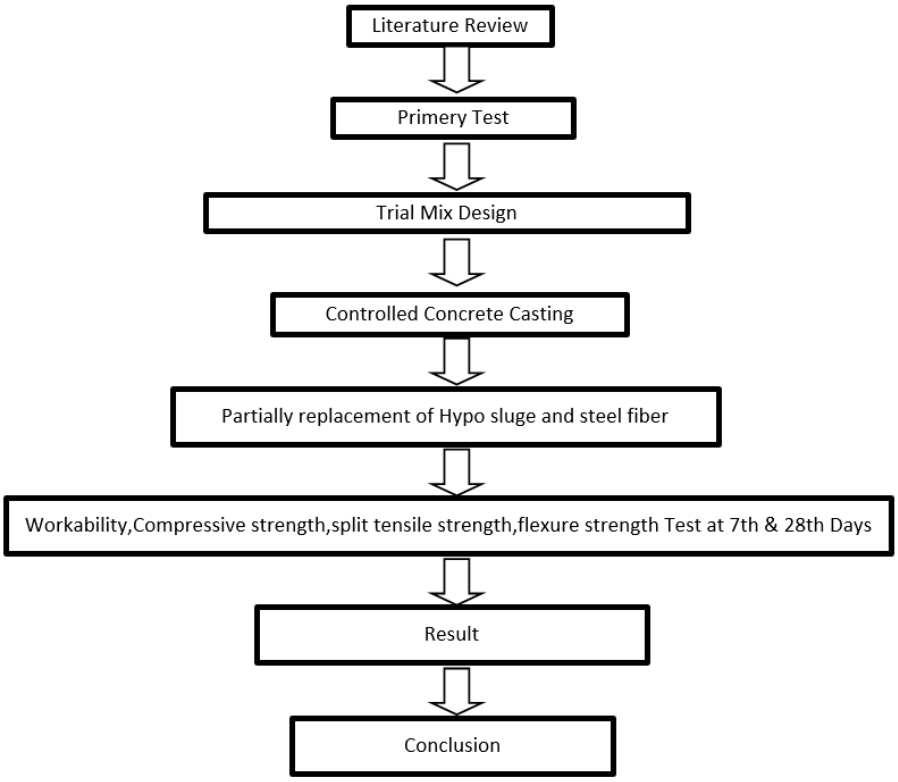


Figure:1

## 1.4 RESULTS AND DISCUSSION

This chapter deals with the test results those conducted on the prepared samples for various test like compressive strength, split tensile strength and flexural strength test. The performance of various mixes containing different percentage of Hypo Sludge and Steel Fiber with superplasticizer is discussed in this chapter. All the tests conducted were in accordance with the methods described in the previous chapter.

### *1.4.1 COMPRESSIVE STRENGTH OF HS AND SF WITH SUPERPLASTICIZER MIXED CONCRETE*

The HS and SF mix concrete strength tests conducted in this research involved the compressive strength test and split tensile strength test. A total of five mixes prepared with cement, sand, coarse aggregate and with different percentage of HS and SF with superplasticizer. The specimens tested has dimensions of 150 mm X 150 mm X 150 mm cubes. The specimens were placed in a curing tank for a period of 7-days and 28-days before tests has been conducted as specified in IS code. When the specimens were examined after they were broken, it has found that the majority of the failures occurred because of the aggregates and cement paste bond not because of the aggregate.

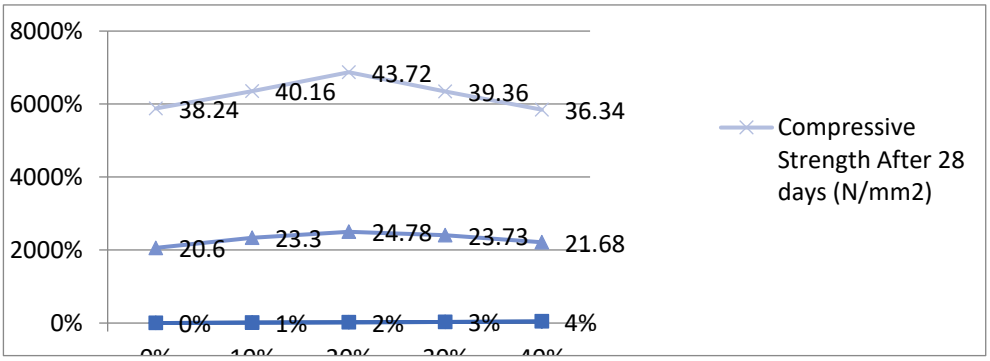


Figure:2 Combine Compressive strength in N/mm2 for all % of HS and SF with Super plasticizer at 7 days and 28 days

By test results it can be seen that compressive strength of Hypo Sludge and Steel Fiber with Superplasticizer concrete can be increased **43.72=44 N/mm$^2$** by adding Hypo Sludge **20%** of the weight of the cement content and Steel Fiber **2%** of the weight of the sand. It is also clear by these results that more than **20%** Hypo Sludge and **2%** Steel Fiber start reducing the compressive strength of concrete therefore the **Mix 3** is the best suitable mix for compressive strength.

**SPLIT TENSILE STRENGTH OF HS AND SF WITH SUPERPLASTICIZER MIXED CONCRETE (IS: 5816-1970)**

The splitting tests are well known indirect tests used for determination the tensile strength of concrete sometime referred to as split tensile strength of concrete. Uniform tensile stress is developed nearly 2/3 of the loaded diameter, due to compression loading. The magnitude of this tensile stress Fsp acting in a direction perpendicular to the line of action of applied loading is given by the formula (IS: 5816-1970).

Figure:3 Split Tensile Strength Test during lab

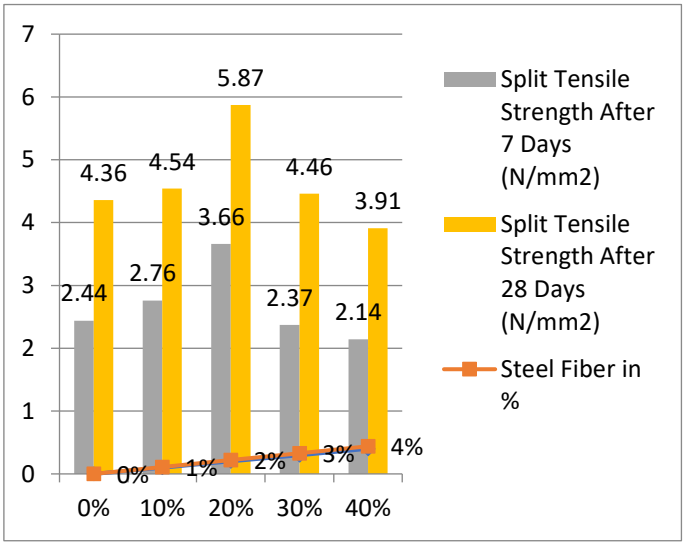


Figure:4 Combine split tensile strength in N/mm2 for all % of HS and SF Superplasticizer at 7 days and 28 days

***RESULT FOR WORKABILITY AT DIFFERENT QUANTITIES OF SUPERPLASTICIZER (IS: 456-2000)***

The workability of Hypo Sludge and Steel Fiber with Superplasticizer concrete can be increased up to 185 mm and farther increased by adding Hypo Sludge of the weight of the cement content and Steel Fiber of the weight of the sand. It is also clear by these results that at the Mix 5 get maximum workability.

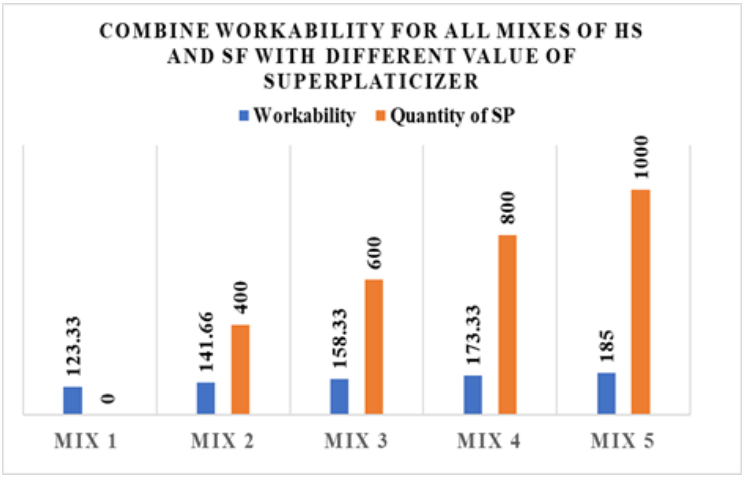


Figure:5 Workability in mm at all % of HS and SF with quantities of superplasticizer in ml

***ESTIMATION BETWEEN CONVENTIONAL CONCRETE AND HS AND SF WITH SUPERPLASTICIZER MIXED CONCRETE***

The cost is low to the normal mix for M-30 grade of concrete and it is increase when increases of proportion of Hypo Sludge and Steel Fiber material in the design mix. The difference between normal mix and design mix is **286.32** ₹ It is saved in per meter cubic of concrete

**Table 4.1 Price list for different material for one kg**

| S. No. | Name of Material | Unit | Rate (Rs) |
|---|---|---|---|
| **1** | **Hypo Sludge** | **Kg** | **5.5** ₹ |
| **2** | **Steel Fiber** | **Kg** | **23.5** ₹ |
| **3** | **Cement** | **Kg** | **5.72** ₹ |
| **4** | **Sand** | **Kg** | **0.65** ₹ |
| **5** | **Aggregate** | **Kg** | **0.60** ₹ |

**Table 4.2 Estimating the cost of material in Rs. with the help of abstract sheet**

| S. No. | Items | Quantity | Unit | Rate | Amount |
|---|---|---|---|---|---|
| 1 | Hypo Sludge | 87.60 | Kg | 5.5 ₹ | 481.80 ₹ |
| 2 | Steel Fiber | 13.73 | Kg | 23.5 ₹ | 322.65 ₹ |
| 3 | Cement | 350.40 | Kg | 5.72 ₹ | 2004.28 ₹ |
| 4 | Sand | 672.58 | Kg | 0.65 ₹ | 437.17 ₹ |
| 5 | Aggregate | 1082.71 | Kg | 0.60 ₹ | 649.62 ₹ |
| 6 | Superplasticizer | 2102.40 | ml | 100 ₹ per liter | 210.20 ₹ |
| **Total** | | | | | **4105.72** ₹ |

## 1.5 CONCLUSION AND SCOPE FOR FURTHER STUDY

After the detail analysis of the test results, we can say that the addition of waste hypo sludge and steel fiber with Superplasticizer significantly affect the 7 day and 28 days compressive strength, split tensile strength and flexural strength of the concrete. From the critical difference, it can be clearly seen that the addition of waste hypo sludge and steel fiber with superplasticizer in certain amount of the weight of cement and sand increases the compressive strength as well as split tensile strength and flexural strength. Experimental results also show similar trend. Hence, the results of statistical analysis are equivalent to the experimental results.

- HS and SF waste material improves the compressive strength, split tensile strength and flexural strength of concrete.
- The workability of Hypo Sludge and Steel Fiber with superplasticizer mixed concrete is 185 mm for fresh concrete with 40% HS and 4% SF addition and the mix with the highest workability is Mix 5.
- After estimation of normal concrete (M-30) and the HS and SF with superplasticizer mixed concrete is found that per m3 concrete save 286.32 ₹.
- The Flexural strength of Hypo Sludge and Steel Fiber mixed concrete is 4 N/mm2 after 7 days and 28 days of curing with 20% HS and 1% SF addition, but it begins to
- decrease with an increase in HS and SF addition, and the mix with the highest flexural strength is Mix 3
- In this present investigation approx 6.97=7% amount of ₹ is saved As compare to normal concrete

**REFRENCES**


1. Abdul Ghaffar, Amit S. Chavan and Dr. R.S. Talwawadi “Steel Fiber Reinforced Concrete” International Journal of Engineering Trends and Technology (IJETT), volume 9, no. 15, pp. 791-797, 2021.
2. BIS: 10262:2009 “Concrete Mix Proportioning Guidelines” Code.
3. BIS: 1199:1959 “Method of Sampling and Analysis of Concrete” Code.
4. BIS: 2386:1963 (Part-I) “Method of Test for Aggregate for Concrete Partial Size and Shape” Code.
5. BIS: 4031:1988 “Method of Chemical Tests for Hydraulic Cement” Code.

6. BIS: 4031:1988 “Method of Physical Tests for Hydraulic Cement” Code.

7. BIS: 456:2000 “Plain and Reinforced Concrete Code of Practice” Code.

8. BIS: 516:1959 “Method of Tests for Strength of Concrete” Code.

9. BIS: 5816:1999 “Splitting Tensile Strength of Concrete Method of Test” Code.

10. BIS: 8112:2013 “Ordinary Portland Cement 43 Grade Specification” Code.

11. Chiranjeevi Rahul Rollakanti, C. Venkata Siva Rama Prasad, Kiran Kumar Poloju, Nasser Marhoon Juma Al Muharbi, Y. Venkat Arun,An experimental investigation on mechanical properties of concrete by partial replacement of cement with wood ash and fine sea shell powder,Materials Today: Proceedings,Volume 43, Part 2,2021,Pages 1325-1330,ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.09.164.

12. Gopinath, S. Preethi, R. Sridhar, P. Vimal Raj, V. Umakanth,Experimental investigation on compressive strength addition of leftover building debris to paver blocks using coir fibre,Materials Today: Proceedings,2023,,ISSN 2214-7853, https://doi.org/10.1016/j.matpr. 2023.04.506.

13. Jilhendra and S. Elavenil “Role of Superplasticizer on GGBS Based Geopolymer Concrete Under Ambient Curing” International Conference on Advances in Material and Manufacturing Engineering (ICAMME), volume 18, pp. 148-154, 2019.

14. Mallikarjuna Reddy and B. Sharada(2021)"Study on the performance of concrete with hypo sludge and fly ash as mineral admixture", AIP Conference Proceedings > Volume 2358, Issue 1 > 10.1063/5.0059180AIP Conference Proceedings 2358, 020006 (2021);https://doi.org/10.1063/5.0059180.