International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

An Experimental Study on Strength Characteristics of Concrete by Partial Replacement of Hypo Sludge as Cement and Partial Replacement of Clay Roof Tiles Powder as Sand

M. Venkata Chaitanya[1], S.Rajendra Varma[2], G.Anji Babu[3], B.Bhavana[4], K.Durga Rao[5]

[1]Assistant Professor, Department of Civil Engineering, VSM College of Engineering, Ramachandrapuram – 533255
[2,3,4,5] UG Students, Department of Civil Engineering, VSM College of Engineering, Ramachandrapuram - 533255

ABSTRACT
Concrete is now the most often used building material owing to its excellent compressive strength and long-lasting nature. This project explores the strength characteristics of concrete when subjected to partial replacement of cement with hypo sludge and partial replacement of sand with clay roof tiles powder. The rapid urbanization and industrial development led to increased environmental concerns due to the disposal of waste materials like hypo sludge (a by product of paper mills) and broken clay roof tiles powder. Recycling these materials in construction can contribute to sustainability while reducing the demand for traditional construction materials. We utilized 5%,10% of Hypo sludge as a partial replacement of cement. At 5% replacement we have noticed that the strength of concrete has increased by 9% to the nominal mix of M-25 On further increment in percentage of Hypo sludge the strength of concrete decreases.
Clay roof tiles are typically composed of clay minerals, sand and other additives. They have a high compressive strength, good thermal insulating properties, and are resistant to weathering. When crushed and used as a fine aggregate replacement in concrete, the particles of clay roof tiles contribute to the strength and durability of the concrete mix. The chemical composition and physical properties of clay roof tiles can vary depending on the manufacturing process and the type of clay used . That replacing up to 40% of fine aggregate with crushed clay roof tiles resulted in comparable compressive strength and durability to conventional concrete.

Keywords: Concrete, Hypo sludge, Clay roof tiles powder, Strength Characteristics.

INTRODUCTION
Concrete is the most prominent material used for construction of structures globally. Concrete is a combination of cement, fine aggregate, coarse aggregate with or without admixtures and water of

calculated proportions. Concrete is selected as the ideal material for building since it achieves the appropriate levels of strength, durability,impermeability, fire resistance and absorption resistance.
When aggregate is mixed with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and molded into shape. The cement reacts with the water through a process called concrete hydration[4] that hardens it over several hours to form a hard matrix that binds the materials together into a durable stone-like material that has many uses.[5] This time allows concrete to not only be cast in forms, but also to have a variety of tooled processes performed. The hydration process is exothermic, which means ambient temperature plays a significant role in how long it takes concrete to set. Often, additives (such as pozzolan or super plasticizers) are included in the mixture to improve the physical properties of the wet mix, delay or accelerate the curing time, or otherwise change the finished material. Most concrete is poured with reinforcing materials (such as steel rebar) embedded to provide tensile strength, yielding reinforced concrete.

MATERIAL USED

Cement

A fine grey powder called cement is added to the concrete mix as a binding agent. Water, admixtures, and fine and coarse aggregates are combined with the cement. Cement is valued for its strength, durability, and versatility, making it essential for modern infrastructure. OPC - 53 grade, which is widely used in concrete constructions and is commercially accessible, is what we are employing for this project. For the cement, both laboratory and physical tests are done. There are no lumps in the cement, and its colour is consistent.

Fine Aggregate

Fine aggregate refers to small granular materials used in construction, with particle sizes ranging from 0.075 mm to 4.75 mm. It is an essential component in concrete, mortar, and plaster, as it fills the voids between larger aggregates, improving workability, strength, and durability. Fine aggregates can be natural, such as river sand, sea sand, and crushed stone sand, or manufactured through controlled processes like crushing stones or recycling materials have been processed through a 4.75 mm IS sieve. In this project, river sand with a fineness modulus of 2.91 and zone - II compliance per IS:383(1970) is employed.

Coarse Aggregate

Coarse aggregates refer to irregular and granular materials such as sand, gravel, or crushed stone, and are used for making concrete. In most cases, Coarse is naturally occurring and can be obtained by blasting quarries or crushing them by hand or crushers. It is imperative to wash them before using them for producing concrete. Their angularity and strength affect the concrete in numerous ways. Needless to say, the selection of these aggregates is a very important process. Materials that are large enoughto be retained on the 4.7 mm sieve size usually constitute coarse aggregates and can reach a maximum size of 63mm. Coarse aggregate above 20 mm up to 30 mm used in project.
The Coarse aggregate are obtained from a local quarry is used. The coarse aggregate with a maximum size 20 mm having a specific gravity 2.88 and fineness modulus of 6.78. The loose and compacted bulk density values obtained are 1481Kg/m^3 and 1570 Kg/m^3 respectively, water absorption of 1.10%.

Hypo Sludge

Hypo sludge is generally formed by removal of unwanted substance of paper such as calcium compounds and cellulose fiber from pulp. This called as hypo sludge. Hypo sludge can be mixed with cement to create concrete. Research has shown that using hypo sludge in concrete can enhance workability, contribute to

cost reduction and reducing the overall carbon footprint. The Hypo sludge consist of magnesium and silica particles which would increase the strength of concrete**.**

Clay Roof Tiles Powder

Clay roof tiles are commonly used roofing material in many parts of the world due to their durability, aesthetics, and the thermal insulating properties. The clay roof tiles powder can have several applications, primarily due to its composition, which includes natural clay, silica, alumina. The powder retains properties such as durability, fire resistance, and thermal insulation from the original clay tiles.

Water

Water is one of the most important ingredient in concrete. it plays a virtual role in development of strength in concrete. Hydration of cement in concrete to form hard gel responsible for strength in concrete is impossible without water. Water aids in binding, thus it is important to assess both its quality and amount precisely. Water's PH level should thus be kept between 6 and 8. Water levels are also precisely controlled since excessive water levels might make an area more workable but can also harm a slump. If it is low, the mix's design is harmed. Thus, it is important to maintain the idealwater content.. This is the least expensive but most important ingredient of concrete. A good thumb rule to follow is if water is pure enough for drinking it is suitable for mixing concrete. Tap water at VSM college of engineering is used in this project for mixing and curing of concrete.

EXPERIMENTAL STUDY

Table 1 - Physical Properties of Cement

S. No	Physical Property	Test Result	Requirements as per IS Code Books
1	Specific Gravity	3.148	3.10 - 3.15
2	Fineness	7%	< 10%
3	Initial Setting Time	60 Minutes	> 30 Minutes
4	Final Setting Time	450 Minutes	< 600 Minutes

Table 2 – Physical Properties of Fine Aggregate

S. No	Physical Property	Test Result	Requirements as per IS Code Books
1	Specific Gravity	2.75	2.50 – 3.00
2	Fineness Modulus	2.91	2.20 – 3.20
3	Bulking of Sand	8.00%	Good
4	Water Absorption	2.00%	< 3%

Table 3 - Physical Properties of Coarse Aggregate

S. No	Physical Property	Test Result	Requirements as per IS Code Books
1	Specific Gravity	2.823	2.5 – 3.0
2	Fineness Modulus	2.842	2 – 4
3	Water Absorption	1.68%	0.1% - 2.0%

Table 4 – Physical Properties of Clay Roof Tiles Powder

S. No	Physical Property	Test Result	Requirements as per IS Code Books
1	Specific Gravity	2.823	2.5 – 3.0
2	Fineness Modulus	2.842	2 – 4
3	Water Absorption	1.68%	0.1% - 2.0%

Table 5 – Chemical Composition Hypo Sludge

Constituents	Percentage
Silica	Crystalline White Powder / Granules
Magnesium	Transparent Gel
Calcium Sulphate	0mm - 2mm

TESTS AND RESULTS

Table 6.1 – Slump obtained for M25 Concrete with addition of Hypo Sludge

Hypo Sludge in Concrete Mix (%)	Workability of Concrete (mm)
0	80
5	93
10	96
20	100

Graph 6.1 – Slump obtained for M25 Concrete with addition of Hypo Sludge

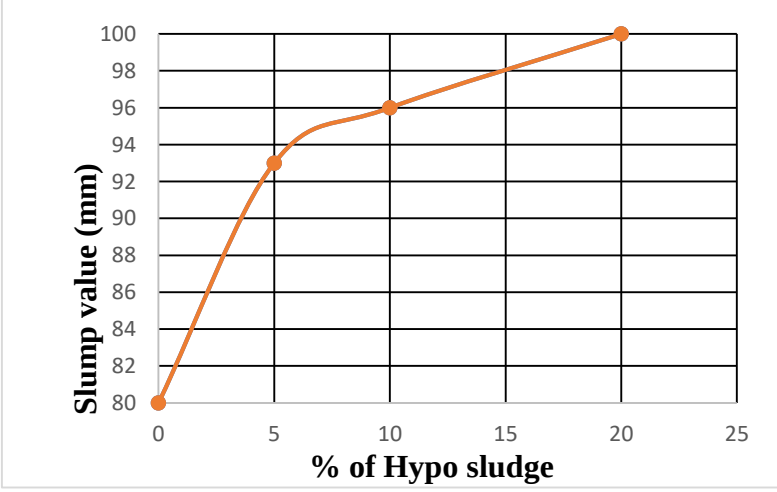


Table 6.2 – Compressive Strength of M25 Concrete with HS & CRTP

		7 Days		14 Days		28 Days	
% of Clay roof tile powder	% of Hypo sludge	MeanLoad (KN)	Strength (N/mm^2)	MeanLoad (KN)	Strength (N/mm^2)	MeanLoad (KN)	Strength (N/mm^2)
0	0	382	17	596.2	26.5	727	32.21
20	5	410.62	18.25	632.02	28.09	794.47	35.31
30	10	323.10	14.36	535.50	23.8	612	27.2
40	20	168.07	7.47	331.42	14.73	474.75	21.1

Graph 6.2 – Compressive Strength of M25 Concrete with HS & CRTP

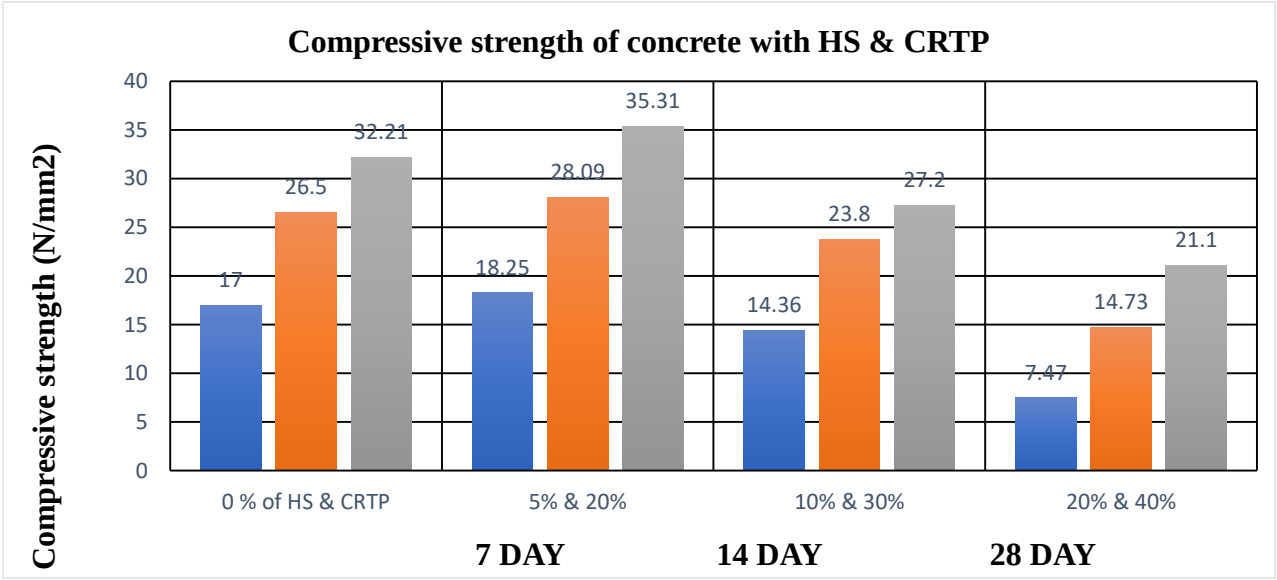
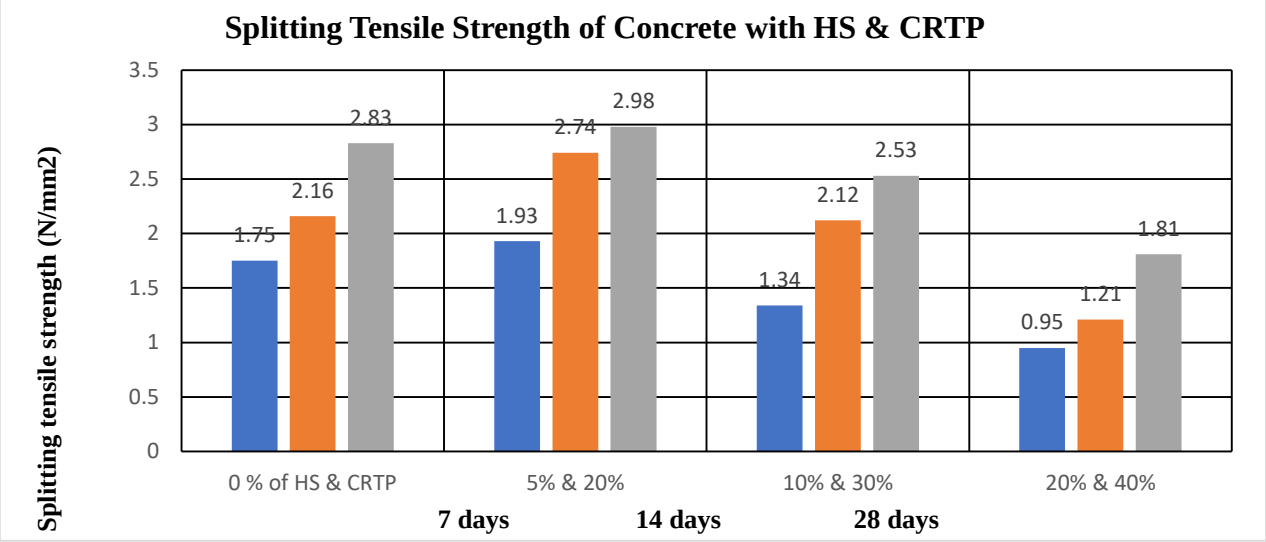


Table 6.3 – Split Tensile Strength of M25 Concrete with HS & CRTP

		7 Days		14 Days		28 Days	
% of Clay roof tile powder	% of Hypo sludge	MeanLoad (KN)	Strength (N/mm^2)	MeanLoad (KN)	Strength (N/mm^2)	MeanLoad (KN)	Strength (N/mm^2)
0	0	382	17	596.2	26.5	727	32.21
20	5	410.62	18.25	632.02	28.09	794.47	35.31
30	10	323.10	14.36	535.50	23.8	612	27.2
40	20	168.07	7.47	331.42	14.73	474.75	21.1

Graph 6.3 – Splitting Tensile Strength of M25 Concrete with HS & CRTP



CONCLUSION

From experimental work and testing of specimen following conclusions have been concluded:

- After 28 days concrete attaining highest compressive strength when 5% of hypo sludge and 20% of clay roof tiles powder is added with increased compressive strength up to 9%.
- After 28 days concrete compressive strength when 10%,20% of hypo sludge and 30%,40% of clay roof tiles powder is added with decreased compressive strength.
- After 28 days characteristic compressive strength of conventional concrete obtained is 32.21N/mm2.
- From These results we conclude that when 5% of hypo sludge and 20% clay roof tiles powder is added gives the highest compressive strength i.e. 35.67 N/mm2.
- Exhibited satisfactory result for splitting tensile strength.
- Partial replacement of these materials can reduce the material cost and gives strength.

REFERENCES

1. Yusuf Ali UET Taxila, Punjab. Pakistan " Sustainable use of paper wastes (Hypo sludge) in concrete design mix ". 2014.

2. Mr.R.Balamuruga & Mr.R.Karthickraja, " An experimental Investigation of partial replacement of cement by Industrial waste (Hypo sludge)", 2014. International journal of engineering research and applications, (IJERA) ISSN ; 2248-9622.
3. N.Jasotha, S.Chockalingam (2018) " Utilization of waste clay roof tiles powder as partial replacement of fine aggregate in concrete". International journal of innovative technology and exploring engineering, 7(1),142-145.
4. S.Sivasankar, R.Saravanan, G.Prakash (2013). "Experimental study on concrete using waste clay roof tiles powder in partial replacement with fine aggregate". International journal of engineering research and applications, 3 (5),1502-1509.

LIST OF IS CODE RECOMMENDATIONS

1. **IS:12269(1987)**, Indian Standard Ordinary Portland cement, 53 Grade Specification.
2. **IS:383(1970)**, Indian Standard Specification for Course and Fine Aggregates from Natural Sources for Concrete.

3. **IS:10262(2019)**, Indian Standard Concrete Mix Proportioning - Guidelines, Bureau of Indian Standards, New Delhi.
4. **IS: 2386(1963)**, Methods of test for aggregates for concrete.
5. **IS:516(1959)**, Methods of test for strength of concrete.