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EXPERIMENTAL STUDY ON THE BEHAVIOUR OF CONCRETE BY PARTIAL REPLACEMENT OF RAILWAY CONCRETE SLEEPERS WITH COARSE AGGREGATES AND EGG SHELL POWDER WITH CEMENT

Atul Sharma[1], Sourabh Lalotra[2]

[1] *PG Scholar, Sri Sai College of Engineering and Technology, Pathankot, India*
[2] *Assistant Professor, Sri Sai College of Engineering and Technology, Pathankot, India*

Abstract: In recent years the construction industry throughout the world has supports initiatives to improve sustainability by increasing the use of recycled aggregates in concrete production. This is mainly because of the consumption of quality primary aggregates and some quarters, greater awareness of environmental protection. The industrial waste contains many inorganic and toxic substances far away the acceptable limit which cause an impact on the environment. Scarcity of the const. materials used the natural resources like sand aggregates and stone aggregate. The partial replacement of aggregates is need for the future generation of concrete structures for the environment supportable. The depletion of the natural resources gets exhausted. We have think over the alternate replacement of the materials. In present work the partial replacement of the Egg shell powder with the Cement and the coarse aggregates is partially replaced by the high performance recycled concrete sleepers. Optimum value of strength in compression, split tensile and flexure came at HCS36%ESP12% replacement of the Egg shell powder with the Cement and the coarse aggregates is partially replaced by the high performance recycled concrete sleepers. The workability of mixture increases and after that there is decrease in the workability of the concrete when we increase the percentage of ESP. A series of experiment were carried out to measure the compressive strength, split tensile strength and flexural strength of the concrete. The results showed that the compressive strength, split tensile strength and flexural strength increases with the adding of the high performance concrete sleepers and Egg shell powder.

Keywords: EPS (egg shell powder), HCS (High performance recycled concrete sleepers), workability, compressive strength, Split Tensile strength, Flexural strength.

1. INTRODUCTION

According to European Union statistics from 2012 onwards, construction had become the industrial sector producing the highest amounts of waste. For last 20 yrs, the cognizance of govt. and public institutions of the importance of recycled Const. and Demolition Waste (C&DW) has increased. For all evolve new standards and directive frameworks to cutback, the C&DW disposal in landfills, the recycling ratios are still insufficient, particularly in southern European countries. The on-site recycling of demolition materials is the most competent process of reduced landfill and natural aggregates intake, as well as reducing transportation costs and detrimental environmental affect. Several types of recycled aggregates could be received from C&DW. The ascendant constitution of concrete particles in RCA avert the higher sulphate contents & lower densities which normally caused by the presence of gypsum and masonry particles. Nonetheless, most properties of the RCA are poorer than these of natural aggregates, particularly the properties of water absorption, porosity and crushing value due to old mortar attached to the aggregates. If we talk about egg production then India comes at the fifth position with an annual rate of egg production amounts at 1.61 million tonnes. Both poultry and egg processing units have come predominantly in India. Andhra Pradesh stands at the top among all eggshell producers in India. The maximum egg production in Andhra Pradesh accounts for one third of the country's daily production of 5.5 crores of the State's total production, nearby districts accounted for 3 crore eggs a day, Hyderabad at one and half crore and Telangana district produced 40 lakh. Hyderabad is the city with the maximum number of poultries and hatcheries in Andhra Pradesh. The state is cheering up the large players in the poultry and meat sector to achieve an annual growth rate of 6% in egg production, 10 % in Broiler production, and 2.5 % in meat production for the next 20 years. India exports eggs, egg powder, albumin powder, and frozen egg yolk to Europe, Japan, and other countries.

1.1 HIGH PERFERMANCE RECYCLED CONCRETE AGGREGATES

Natural river sand is incorporated as fine aggregate. Aggregate test results gives specific gravity with value of 2.60 and absorption ratio with a value of 0.95%. The size of the river sand is well dispensed the midpoint of the lower and upper limit of the gradation test requirement in Korea standards. Crushed granite is used as natural coarse aggregate (NA) with the specific gravity of 2.72 and the water absorption ratio of 0.37. The material properties of natural aggregates .The concretes mixtures tested anterior to sleeper production, in order to check that they meet the needs of the Spanish railway technical specification. All concrete mixtures

was produced in Spanish precast concrete plant. The natural aggregate concrete were that already used in HPC for the production of prestressed concrete sleepers, accordingly to the Fuller's dosage method. In order to control the concrete output, the recycled aggregates were nearly saturated, at 80-90% of their water absorption capacity.

1.2 EGG SHELL POWDER

If we talk about egg production then India comes at the fifth position with an annual rate of egg production amounts at 1.61 million tonnes. Both poultry and egg processing units have come predominantly in India. Andhra Pradesh stands at the top among all eggshell producers in India. The maximum egg production in Andhra Pradesh accounts for one third of the country's daily production of 5.5 crores of the State's total production, nearby districts accounted for 3 crore eggs a day, Hyderabad at one and half crore and Telangana district produced 40 lakh. Hyderabad is the city with the maximum number of poultries and hatcheries in Andhra Pradesh. The state is cheering up the large players in the poultry and meat sector to achieve an annual growth rate of 6% in egg production, 10 % in Broiler production, and 2.5 % in meat production for the next 20 years. India exports eggs, egg powder, albumin powder, and frozen egg yolk to Europe, Japan, and other countries. Tamilnadu is at the number one position in the egg production followed by Andhra Pradesh which is at second position in India. Tamil Nadu, with a share of around 20 percent with about two thousand crore eggs produced in the state each year. Maharashtra, Haryana, Punjab, and West Bengal are other leading egg-producing states in India but each has a share of less than 10 percent of the total egg produced in India. The Namakkal district in Tamil Nadu is India's egg export hub and accounts for around 90 % of India's total egg exports.

2. LITERATURE REVIEW

S. K. Singh P. C. Sharma (2012) This paper shows the experimental results of recycled coarse aggregate concrete & results are differentiate with the natural crushed aggregate concrete. The fine aggregate used in concrete, i.e. recycled and received is hundred percent natural. For both type of concrete i.e. M-20 and M-25, water cement ratio, max. size of aggregate and mixed portion are kept constant. The evolution of compressive strength of recycled aggregate concrete at the age of 1,,3,7,14,28, 56, and 90 days; the evolution of tensile & flexural strength at the age of 1,3,7,,14 and static modulus of elasticity at the age of 28 days are look into it. The results showed the compressive, tensile and flexural strengths of recycled aggregate are average 85% to 95% of the natural aggregate concrete. The strength parameters are look into for recycled aggregate concrete and found to be good agreement with BIS specifications.

Sheriff Yehia,Kareem Helal,Anaam Abu Sharakh,Amani Zaher(2015): The paper talk about the propriety of producing concrete with 100 % recycled aggregate to met durability and strength requirements for different apps. Aggregate strength, gradation, absorption, specific gravity, shape and textures are some of the physical & mechanical characteristics that bring to the strength and durability of concrete. Therefore, the experimental program the development of physical and mechanical properties of the recycled aggregate over a period of 6 months. In adding, concrete properties it produced fine & coarse recycled aggregate was assess. Several concrete mixes were prepared with 100 % recycled aggregates and the results was compared to control mix. SEM w start to study the microstructure of selected mixes. The results showed the concrete with received strength and durability can be produced if higher packing density is achieved.

AndrewGonzalez(2016) A analysis of the structural behavior of prestressed concrete sleepers make with high performance concrete, and high performance recycled aggregate concrete(HPRAC) is present in this study. Two types of HPRAC, sleepers tested, using 50 and 100% of recycled concrete aggregate (RCA) is replaced of coarse natural aggregates. The RCA worked in the research, sourced from crushing refuse HPC sleepers. The aim of study is to ascertain through analysis the HPRAC sleepers behaviour satisfied the European min. requirements of std. for prestressed concrete sleepers and compares there experimental behaviours with that of the HPC sleepers. The three types of prestressed concrete sleepers were subjected to static load tests a trail- seat and centre section (positive and negative load. In the centre section tests a comparatively study b/w the experimental results and the values of four assessment methods of crowning capacity carried out.

Amarnath Yerramala Et.Al., (2014) studied the Properties of concrete with eggshell powder as cement replacement, and showed the Compressive strength was higher than control concrete for 5 % ESP replacement at 7 and 28 days of curing ages. Split tensile strength concrete up to 10 % with ESP replacement

Doh Shu Ing And Chin Siew Choo Et Al., (2014) carried out an investigation on egg shell powder as potential additive to concrete, showed aninclusion of eggshell powder in concrete has improved the compressive strength of concrete and with addition of 10% egg shell powder in M25 Grade of concrete

Syed Saad Ali, et.al 2019: In this study, test was done on concrete with partial replacement of cement with ESP in the proportion of (0-20%) and fine aggregate with Copper scum (0-20%). Slump cone value for the copper slag and ESP increases with increasing in the percentage of ESP and copper slag so the concrete was not workable. The value of the Compaction factor test about copper slag and egg shell powder decreases with increase in the percentage of both copper slag and ESP in the concrete. The compressive strength of concrete is find out to be optimum at 10% replacement of copper slag and egg shell powder and is the

optimum value after 7 days curing and 28 days curing. The split tensile strength of concrete is find out to be optimum at 15% replacement of copper slag and egg shell powder for 28 days curing in M30 grade concrete and maximum at 10% replacement of copper slag and egg shell powder for 28 days curing. So, the replacement of 10% to 20% of copper slag and egg shell powder is useful for better strength values in M30 grade of concrete.

3. MATERIALS

3.1 CEMENT OPC is the most ordinary type of cement is generally used around the world as per basic ingredients of concrete, mortar and mostly no specially grout. It is a fine powder produced by heating materials to form clinker. After grinding the clinker, we would add some small amounts of remaining parts of ingredients It comes to different grades of cement, the 53 Grade OPC Cement provides frequently higher strength compared to others. As per the Bureau of Indian Standards (BIS), the grade no. of a cement highlights the min. compressive strength that cement is expected to attained within 28 days. For 53 Grade OPC Cement, the min. compressive strength achieved by the cement at the end of the 28th day shouldn't be less than 53MPa or 530 kg/cm2 .

3.2 FINE AGGREGATES Aggregates consists of two types, fine aggregates and coarse aggregates. Fine aggregates consists of natural stone or crushed particles passing through 4.75mm size sieve. Aggregates which account for one –third percentage of the total volume of concrete, are divided into two separate categories-fine and coarse. Natural gravel and sand are typically dug or dredged from a pit, river, lake, or seabed. The crushing of big boulders, cobbles, quarry rock, and large size gravel also produces crushed aggregate. Aggregates strongly influence concrete's freshly mixed and hardened properties, mixture proportions and economy. There is although always a variation of aggregate properties is expected, characteristics include durability, grading, particle shape and surface texture, abrasion and skid resistance, unit weights and voids, absorption and surface moisture.

3.3 COARSE AGGREGATES The particles which retains on the sieve and are larger than 4.75mm are referred to as coarse aggregates. For making a good mix of concrete aggregates need to be hard, clean and strong particles which are free of coatings of clay or any absorbed chemical and other fine materials that could cause the deterioration of concrete. Coarse aggregates are rounded or irregular gravel stones. It constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder. Coarse aggregates should be carefully handled to avoid dirt contamination. It should be clean and dry.

3.4 EPS [EXPANDE POLYSTYRENE]

S.NO.	PROPERTIES	VALUES
1.	Specific gravity	0.011
2.	Bulk density	6.86kg/m^3
3.	Particle size(spherical)	4- 8 mm dia

Table -1: Properties of eps beads

3.5 HIGH PERFORMANCE RECYCLED AGGREGATES

Test Items	Specifications
Specific Gravity	2.48
Absorption Coefficient	4.53
LA Abrasion Coefficient	32.2

Table -2: Physical properties of HPRC

4. METHODOLOGY

4.1 CASTING In order to test compressive strength of concrete, concrete specimens of standard cubical mould of size 150*150*150mm were casted in eleven different batches having different replacement percentage of Rice Husk Ash and ESP. The specimen used for this test is cylindrical and its dimension is 150mm in diameter and 300mm in length. The test is made on the beam of size 700 mm× 150mm × 150mm.

4.2 CURING all the materials when mixed adequately to achieve homogeneous mixture. After mixing the concrete was checked for required slump and then filled into moulds of required tests. The mould filled with concrete was compacted by table vibrator to achieve proper compaction. Mould surface was finished with trowel and date of casting with mix designation number is marked on it. The concrete specimens were then removed from moulds after 24 hours and then placed in curing tanks for curing process for 7 and 28 days at normal room temperature.

4.3 SLUMP CONE TEST It can be used in site as well as in lab. This test is not applicable for very low and very high workability concrete. It consists of a mould that is in the form of frustum having top diameter of 10cm, bottom diameter of 20cm and height of 30cm. The concrete to be tested if fitted in the mould in four layers. The each is compacted 25 times with the help of tamping rod. After the mould is completely filled it is lifted immediately in the vertically upward direction which causes the concrete to subside

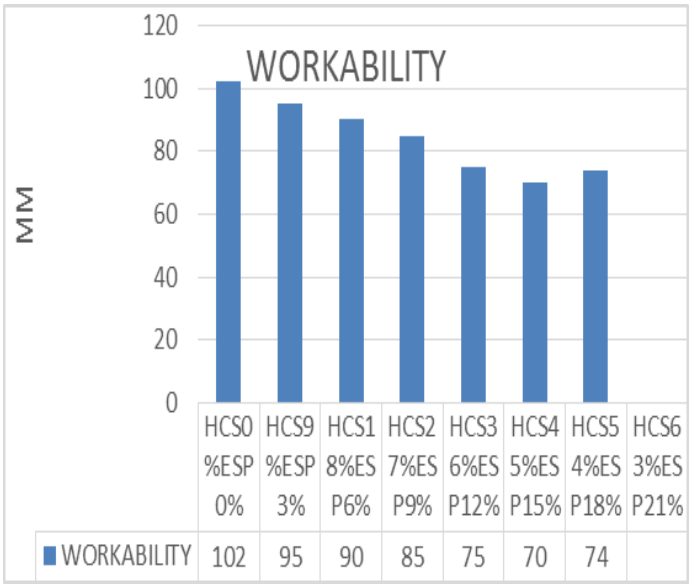

Fig -1: SLUMP CONE TEST

4.4 COMPRESSIVE STRENGTH TEST

Then fresh concrete is filled in mould in 4 layers and after filling each layer tamping should be done 35 times in case of cube and 25 times in case of cylinder by using standard tamping rod. Once the mould is filled then leveled top surface of concrete with trowel. After the day the mould will removed and specimen are dropped in the curing tank under standard temperature of 27±2° c. After 7 and 28 days in this research.

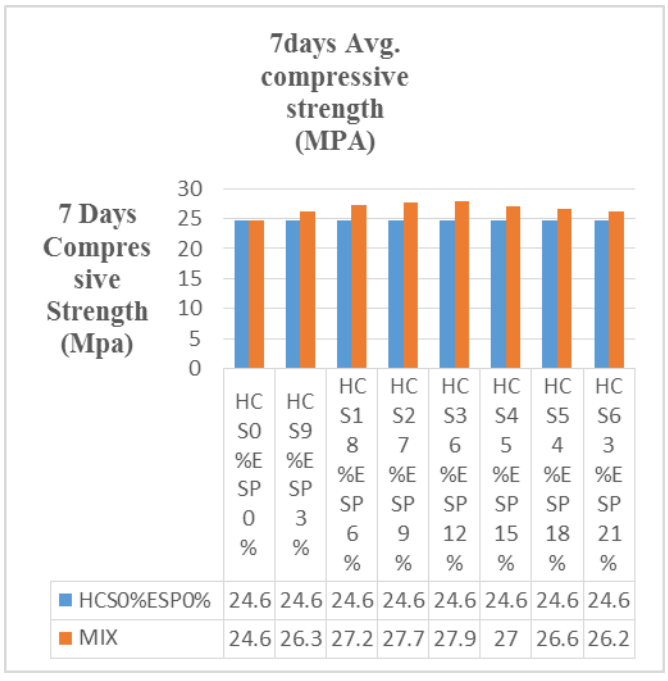

Fig -1: COMPRESSIVE STRENGTH TEST 7 days

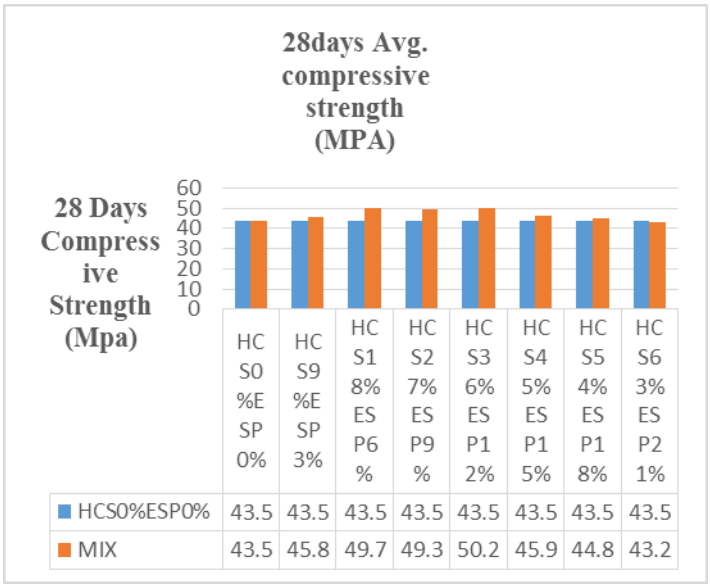

Fig -2: COMPRESSIVE STRENGTH TEST 28 days

4.5 SPLIT TENSILE STRENGTH

The specimen used for this test is cylindrical and its dimension is 150mm in diameter and 300mm in length. The instrument used for this testing is universal testing machine. The fresh concrete is prepared in according to the required grades and respective mix proportion. The fresh concrete is filled in mould in layers and each layer is tamping with standard tamping rod with 25 blows for each layer. After the day the mould is removed and specimen is placed in the curing tank for 7 and 28 days in this research at the temperature 27+ 2°c. Then draw the line on the specimen

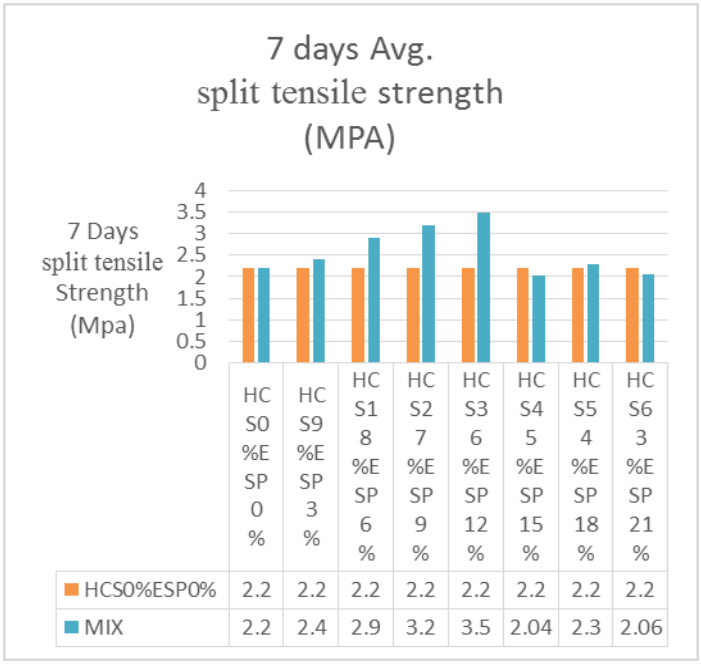

Fig -3 SPLIT TENSILE STRENGTH 7 days

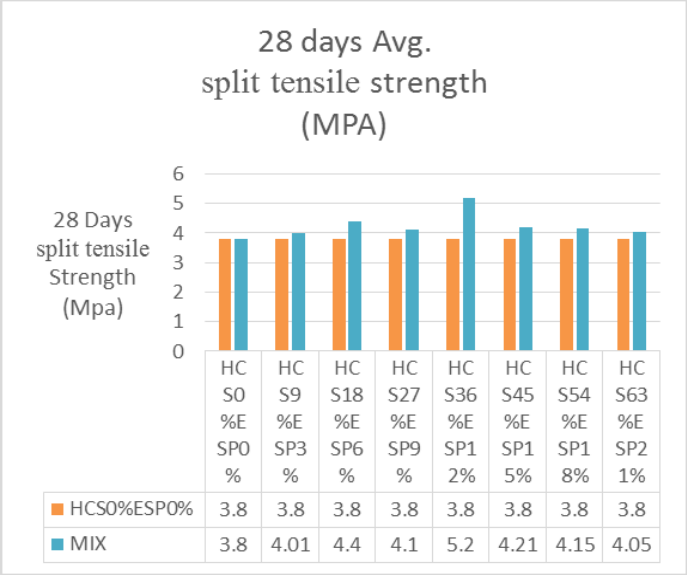

Fig -4 SPLIT TENSILE STRENGTH 28 days

4.6 FLEXURAL STRENGTH TEST

The concrete is prepared at required rate of mass element the mould is filled with concrete in layers and blows 25 times with standard tamping rod. After the day or we can say 24 hours the mould is removed and specimen placed in the water tank for curing at a temperature of 27 + 2 C. depending upon the requirement the test specimen is removed from the water tank and wipe it properly for 7 and 28 days for testing.

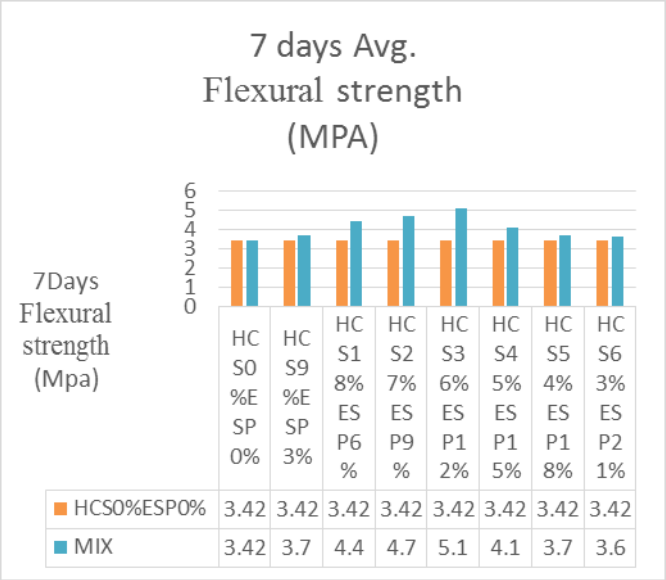

Fig -5 FLEXURAL STRENGTH 7 days

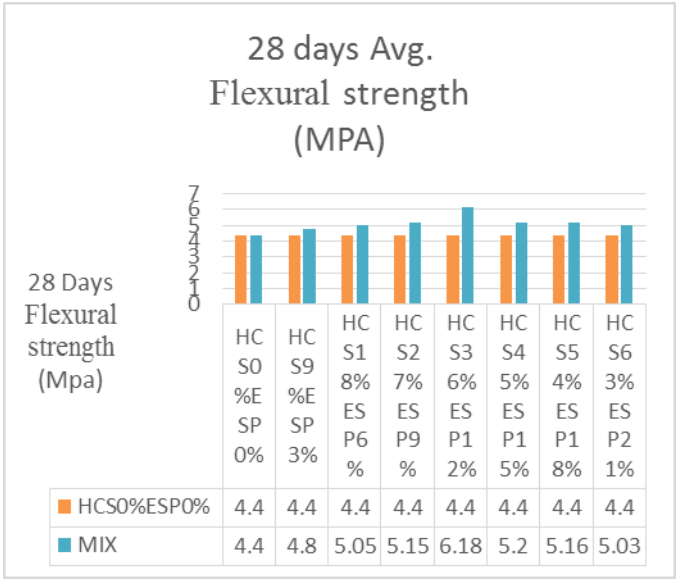

Fig -6 FLEXURAL STRENGTH 28 days

5. CONCLUSIONS

- The outcome of workability by Slump test method concluded that workability reduces with increasing % age of Railway concrete sleepers and Egg shell powder. This may be due to water demand raises with raising % age of ESP.
- The Compressive strength results show that by partial replacement of the Egg shell powder with the Cement and the coarse aggregates is partially replaced by the high performance recycled concrete sleepers, there is increase in compressive strength but aggregates in higher volume decreases strength. After Railway concrete sleepers and Egg shell powder volume addition and replacing Cement, there is decrement of compressive strength.
- The excellent substitution % age of Railway concrete sleepers and Egg shell powder in terms of strength and economy is HCS36%ESP12%. The value of compaction strength obtained at optimum percentage substitution is 50.20MPA which is 15.4023% higher than normal Mix.
- The split tensile strength and flexural strength or modulus of rupture shown same nature as that of compressive strength or toughness strength
- The use of Railway concrete sleepers and Egg shell powder in civil engineering works will reduce environmental pollution, upgrade quality of concrete, and reduce its cost of production.
- The partial replacement of the Egg shell powder with the Cement and the coarse aggregates is

partially replaced by the high performance recycled concrete sleepers has shown +ve impact on split tensile strength up to HCS36%ESP12% substitution.

- The highest value of tensile strength was obtained at HCS36%ESP12% replacement which is 5.2Mpa.
- The flexure strength also showed maximum strength when HCS36%ESP12% is being replaced by partial replacement of the Egg shell powder with the Cement and the coarse aggregates is partially replaced by the high performance recycled concrete sleepers, increased the strength is 6.18MPA at 28th day. Both help in increasing strength at low volume replacement
- The excellent of favourable substitution % age of Railway concrete sleepers and Egg shell powder in terms of strength at 28 days and economy is HCS36%ESP12%.

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