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Performance of Concrete by Replacing Fine Aggregate with Fibre Material

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Abstract -*Concrete uses more of the raw material like sand, gravels, fly ash etc. its usage has been augmented to an enormous quantity where there are likely chances of meeting with the demand of such construction materials. It may also lead to upsurge the cost of the materials drastically. This study has been made as an attempt in improving the technological ailment by using recycled materials for construction. Fibres, materials were selected for partially replacement in concrete. Polypropylene fibre being used for the post cracking purpose in concrete is used here for increasing the mechanical properties of the concrete. The fibre is added at some amount of proportion of total volume of the concrete. This experimental investigation is carried out to evaluate the ability to increase the mechanical properties of the concrete by using polypropylene fibre and to determine the optimum dosage of those ingredients.*

Key Words: Polypropylene fibre, Concrete, Mechanical properties, proportional, construction, etc.

1. INTRODUCTION

The worldwide population at present is 7.4 billion and it is anticipated to reach more than 9 billion by 2050. (US Geological Survey, 2013). Because of the population development, industrialization and development exercises are required to develop in like manner. In view of the factual information of concrete generation, China contributes 2500 million metric Tons and India produces 280 Million metric huge amounts of cement yearly. The interest of concrete in India will arrive at 550-600Million metric Tons for each annum (MTPA) by 2o25. Each ton of cement roughly needs six to seven tons of totals (United States Geological Survey, 2013) in building industry. Enormous improvement in development division requires huge amount of its fixings. The amount of sand utilized for development and modern objects are 40 million tons and 36 million tons separately. The interest of sand has been doubling the yearly measure of dregs conveyed by the waterway. Around the world, the all-out utilization of sand is 15 billion tons for each year, among which the yearly utilization of sand is 40 billion tons for development exercises and 26-30 billion tons for modern reason. For example, building a normal single-family house needs roughly 200 tons of sand. Looking at the interest and accessibility of sand, request is double the accessible source. These days, sand mining is a huge issue that prompts the accompanying effect on condition and society.

1.1 Effect on Condition and Society

Affects the biodiversity of marine and stream.

1. Causes the beach front and inland disintegration.
2. Increase in possibility of flooding.
3. Makes the water turbid.
4. Lowering the water table in certain regions, compounding the danger of dry spell.
5. Erosion of whole shoreline happens.
6. The accompanying strategies can be embraced to diminish the utilization of sand.
7. Optimize the utilization of existing structures and frameworks.
8. Utilization of Industrial results like copper slag, steel slag, ferrous slag and soon.
9. Recycled fabricating materials and quarry residue can be utilized as a substitute for sand.
10. Artificial sand can be supplanted halfway or completely called Manufactured sand (M Sand).

1.2 Material characterization of copper slag

Numerous literary works demonstrated that copper slag is one of the other to fine total and it has the likelihood to create decent concrete, completed the Pozzolana requirement. The specific gravity is higher of copper slag, thickness differs from 3.16 to 3.87 g/cm3 dependent on the measure of iron substance. Copper slag because of its lustrous surface traits low water ingestion which enables the surplus amount of free water to stay in the concrete for better hydration to process. Copper slag content is shows better result with expansion property.

Compressive strength increases about 70% with increase of copper slag amount but the quality of structure or component is decreased with increase in expansion parameter. (Jayapal Naganur et al 2014) uncovered that when copper slag utilized for longer relieving periods (for example 56 and 90 days), a large portion of the examples demonstrated no adverse quality inversion.

The microstructural attributes of copper slag when supplanted with sand and cement ad-libs the hydration procedure brings about the decrease of pores, diminished water ingestion, later erosion rate. Draining of overwhelming metals is beneath as far as possible even under threatening conditions (Brindha et al. 2010). Slag cement demonstrated higher erosion rates than control concrete in all substitutions. Supplanted concrete examples uncovered lesser protection from corrosive assault when contrasted with control

1.3 Polypropylene Fiber

Polypropylene is a for example, Titanium Chloride. In addition, polypropylene is additionally a result of oil refining forms. A large portion of the polypropylene utilized is exceptionally clear and geometrically normal (for example isotactic) inverse to undefined thermoplastics, for example, Polystyrene, Poly Vinyl Chloride (PVC), Polyamide, and so forth., those radicals are put arbitrarily (for example atactic). Run of the mill picture of fibrillated polypropylene fiber is appeared in Figure.

1.4 Utilisation of Waste from Construction Industry

• The Construction Industry of India is exceptionally work serious, of our nation represents roughly half of the capital expense in progressive five Year Plans.

• Development movement prompts age of strong squanders, which incorporate sand, rock, solid, stone, blocks, and waste products. The government is worry about proper disposal of these rubble or debrisor any their material because these are increasing sharply.

• The slag created from the copper industry is having a pozzolanic property that can be used in cement to deliver great mechanical and strength attributes. Substantial interest for waterway sand and accessibility of a rich amount of copper slag both intensified to use the copper slag rather than sand in the development industry.

• Nowadays there are different reason of increment of waste, these waste required lot of energy to reuse it, and reusing increases lower consumption of energy like fuel.

• The most significant issue to reuse the waste.

• The reusing process was first of all established in the Germany after the Second World War because in that time the demolition waste was increased in huge quantity.

• Some country are better to use the waste from industries such as USA. The most of the stone waste was used by the Germany and Denmark. The use of waste creates lot energy saving and improve the economic condition.

• The increment of material increased the strength of foundation in urban area which is also responsible for use of waste.

• The waste generated age is approximate forty to sixty kilogram per square meter but at the time of the regeneration of waste it decreased with some amount.

• The most of the waste is generated due to the demolition structure. The demolition of normal waste and higher waste were between individually 500 and 300 kg/sq.m. normal creates

• In concrete the waste generated in two ways first is by the aggregate or second is by amount of hardened cement plaster. Sometime the earthen soil or top soil is disturbed and is not useful. This type of soil can be used as filler material in road or embankment construction.

• Various part of structure also creates east like brick and some component like beam column etc. one of most part is masonry that can be used again and again.

• The waste metal was used after softening and converted into new solid materials.

• In concrete the waste generated in two ways first is by the aggregate or second one is by amount of hardened cement plaster. Sometime the earthen soil or top soil is disturbed and is not useful. This type of soil can be used as filler material in road or embankment construction.

Copper slag conveys all the freer water content because of its low water retention limit. Cement made with 6o% of copper slag or more shows a decrease in quality because of this surplus water present in concrete. Expansion of polypropylene fiber in concrete uses the surplus water to tie the fiber with mortar blend which makes great holding among cement and total lattice. Copper and copper amalgam items are utilized in building development,

electrical and electronic items, transportation hardware and generation of apparatus and gear

2. Materials and Mix Design

In light of the size, total is separated as coarse total and fine total. Coarse total have molecule size more prominent than 4.75mm while fine total has not as much as that. The property of total depends on shape, surface, size degree, dampness content, explicit gravity, sufficiency and mass unit weight. Material are required for mix design are as follows:

Cement, Fine Aggregate, Water, Super Plasticizer, copper Slag, Polypropylene Fiber,

2.1 Mix Design

Mix Design for M30 concrete has been arrived according to IS: 10262-1982. General Mix proportion for control concrete is given in below Table.

Water	Cement	Sand	Coarse Aggregate
148.8kg/m3	363 kg/m3	620kg/m3	1343 kg/m3
0.41	1	1.71	3.71

2.2 Total Mix proportion with mix identification

S. N0	Mix ID	cs	PPF	c	FA	cs	CA	WC	PPF
		%		kg/m3					
1	M0P0	0	0	363	620	0	1343	148.8	0
2	M0P1	0	0.2	363	620	0	1343	148.8	1.82
3	M0P2		0.4	363	620	0	1343	148.8	3.64
4	M0P3		0.6	363	620	0	1343	148.8	5.46
5	M0P4		0.8	363	620	0	1343	148.8	7.28
6	M20P0	20	0	363	495	177	1343	148.8	0
7	M20Pl		0.2	363	495	177	1343	148.8	1.82
8	M20P2		0.4	363	494	177	1343	148.8	3.64
9	M20P3		0.6	363	493	176	1343	148.8	5.46
10	M20P4		0.8	363	492	176	1343	148.8	7.28
11	M40P0	40	0	363	371	354	1343	148.8	0
12	M40Pl		0.2	363	371	354	1343	148.8	1.82
13	M40P2		0.4	363	371	354	1343	148.8	3.64
14	M40P3		0.6	363	370	353	1343	148.8	5.46
15	M40P4		0.8	363	369	352	1343	148.8	7.28

2.3 Number of Specimens

Sl No	Description of tests	Number of Specimens
1	Concrete cube compressive strength at 7, 28 and 56 days curing for all replacements of copper slag up to 1oo% and polypropylene fiber up to 0.8% volume fraction. Size 150mm x 15omm x l00mm cube	180
2	The compressive strength of cement mortar at 7, 28 days curing for all replacements of copper slag up to l00% and polypropyJene fiber up to 0.4% volume fraction. Size l00mm x l00mm x l00mm cube	90
3	The tensile strength of concrete at 28 days curing for all replacements of copper slag up to 100% and polypropylene fiber up to 0.8% volume fraction. Size 15omm diameter and 300mm length cylinder	20
4	Flexural strength of the plain concrete beam at 28 days curing for all replacements of copper slag up to 100% and polypropylene fiber up to 0.8% volume fraction. Size l00mm x l00mm x 500mm pee beam	20

Cement of M30 evaluation and bond mortar of proportion 1:3 has been received in breaking down the accompanying qualities to ponder the usage of copper slag and polypropylene fiber.

Fresh concrete properties.

Mechanical properties.

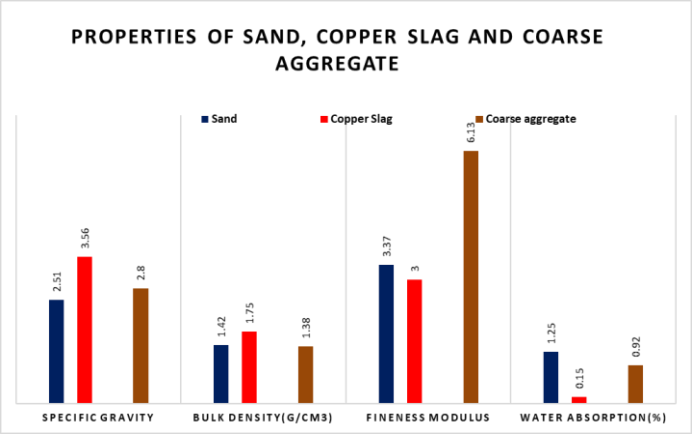
3. Outcomes / Results

Droop test and compacting variable test are utilized for the examination of crisp concrete properties. Smaller scale auxiliary qualities are analyzed through SEM pictures and XRD designs. Mechanical conduct is assessed by testing compressive quality of bond mortar at 7 and 28 days, compressive quality of cement at 7, 28, 56, 90 and 180 days, flexure and split rigidity of plain cement at 28 days, flexural execution of full-scale strengthened concrete pillars, cyclic conduct of fortified concrete bars and effect quality of cement at 28 days. Toughness conduct is examined by water retention, porosity, Sorptivity, corrosive assault, sulfate assault and chloride infiltration of cement at 28 and 90 days.

Effect of Copper Slag in Concrete

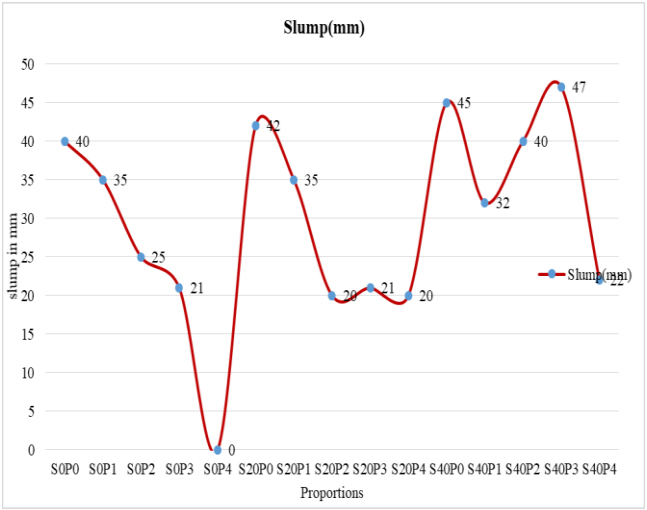
Explicit gravity of any material legitimately relates the particular weight or mass thickness of the material.

Type of aggregate	Specific gravity	Bulk density (g/cm3)	Fitness modulus	Water absorption (%)
Sand	2.51	1.42	3.37	1.25
Copper Slag	3.56	1.75	3.00	0.15
Coarse Aggregate	2.80	1.38	6.13	0.92

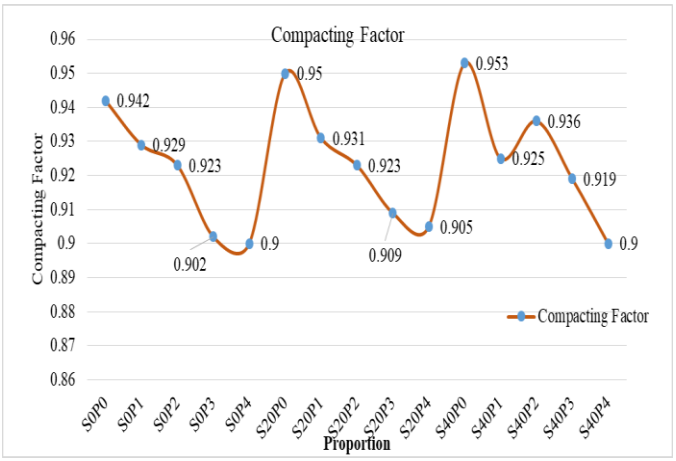


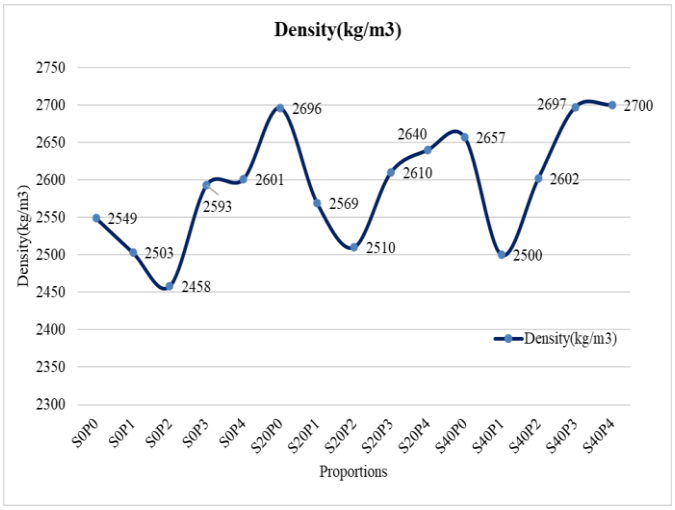
Slump, density and compacting factor

Proportions	Slump (mm)	Density (kg/m3)	Compacting Factor
SoPo	4o	2549	o.942
SoP1	35	25o3	o.929
SoP2	25	2458	o.923
SoP3	21	2593	o.9o2
SoP4	o	26o1	o.9oo
S2oPo	42	2696	o.95o
S2oP1	35	2569	o.931
S2oP2	2o	251o	o.923
S2oP3	21	261o	o.9o9
S20P4	20	2640	0.905
S40P0	45	2657	0.953
S40P1	32	2500	0.925
S40P2	40	2602	0.936
S40P3	47	2697	0.919
S40P4	22	2700	0.900



The Concrete made with 0.8% PPF has sufficient of lumped mass of strands shows trouble in taking care of because of the deficient mortar. The level of compaction is dictated by utilizing compacting variable test. It is the proportion of somewhat compacted to the completely compacted weight of cement. Compacting component estimations of Copper slag-PPF cement are going from 0.90 to0.95 while the compacting variable of control cement is 0.942. Because of high explicit gravity, copper slag concrete communicates its own compaction which results in voids free concrete.





While PPF added to cement possesses a particular volume brings about loss of weight in mostly compacted cement. Thus there is a slight reduction in compacting factor when PPF is added to the concrete.

At any rate this distinction doesn't make any impact since the alluring compacting factor for physically compacted level chunks, physically compacted fortified concrete shafts and intensely strengthened areas with vibration is 0.90 to0.95. The equal droop esteems similar to the above benefits of compacting elements are beginning from 50mm to 100m.

Hardened concrete Properties

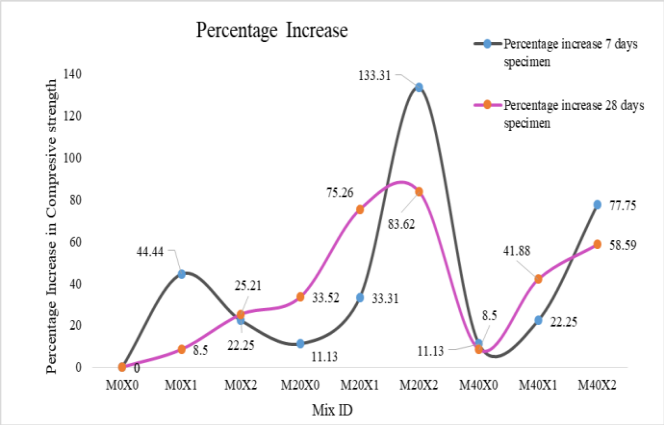
• Compressive quality test on bond mortar blocks at 7 and 28 days.

• Compressive quality test on concrete blocks

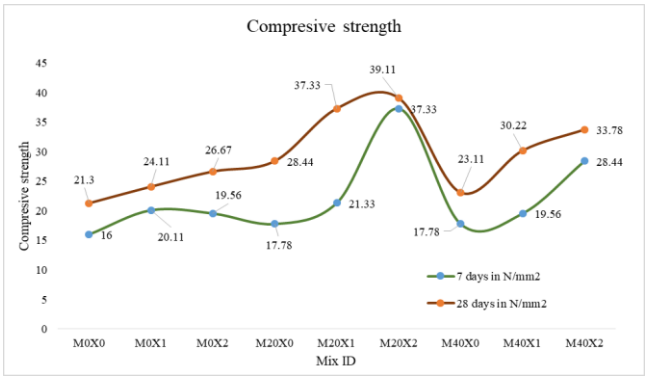
• Tensile quality test on concrete compartments

• Flexural quality test on plain bond concrete bars.

At 7 days the blend M100X2 shows 44% higher compressive quality than reference blend. Regardless of whether the sand is completely supplanted with copper



slag it invigorates 11% higher compressive than control concrete. When contrasted with control concrete, M20X2 mortar blend shows 133.31% addition of compressive quality at 7 days. This is because of the imprisonment of mortar blend gave by the expansion of PPF in concrete. The compressive quality of concrete mortar at 28 days for M20X0 blend and M80X2 blend are 39.11N/mm2 and 37.33 N/mm2 individually. It suggests that the substitution of 20% and 80% copper slag invigorates 83% and 75% higher compressive than control blend. Copper slag substitution without PPF has expanded compressive quality of 11.13% while the expansion of PPF further improves the compressive quality by 25.57%. Not using any and all means, the compressive quality of any blend extents doesn't fall beneath the control blend.



Compressive Strength

Mix ID/ Day	Compressive strength		
	Curing period in days		
	7	28	56
M0P0	31.11	37.20	38.20
M0P1	31.30	37.80	38.20
M0P2	31.90	38.20	39.10
M0P3	32.40	38.90	40.90
M0P4	32.90	39.60	42.00
M20P0	31.90	39.63	40.90
M20P1	32.70	40.53	41.80
M20P2	35.71	42.41	43.60
M20P3	33.78	40.74	42.70
M20P4	31.68	38.60	42.10
M40P0	34.65	41.10	44.40
M40P1	35.85	42.81	45.30
M40P2	36.00	46.67	51.10
M40P3	32.74	43.70	47.60
M40P4	29.72	41.00	44.20

Tensile Strength

The test is a technique deciding the elasticity cement wherein a pressure power is applied to a round and hollow example along its longitudinal hub. The split rigidity of cement is surveyed with 40 quantities of tube shaped example of size 150 mm breadth and 300mm tallness. Table shows the split elasticity of cement and its variety over control concrete. Figure plots the variety of split rigidity of cement

Split Tensile strength of concrete and its variation.

1. Split elastic trial of cement revealed that the most extreme split rigidity of 3.537 N/mm2 has been seen at C40P4 blend, which is 31.58% more noteworthy than the reference blend.

2. Maximum flexural quality of plain cement at 28 days for C40P2 blend is 9.58 N/mm2 which is 26.05% expansion contrasted with control concrete.

3. Flexural execution of Reinforced Cement Concrete bar uncovered that the copper slag can be utilized around 40% with polypropylene fiber of 0.4% with no injurious impact on solid execution.

In general copper slag substitutions, the split rigidity of cement is expanded from 16% to 32% when contrasted with control blend. In every arrangement of copper slag substitution, PPF volume part of 0.8% records the most noteworthy split elasticity. Thus the expansion of PPF in copper slag concrete improves the split elasticity of cement than the concrete with copper slag alone.

Flexural quality of plain concrete

Flexural quality is generally called as modulus of break which is increasingly significant in concrete asphalt structure.

Proportion ID	Flexural strength	variation
C0P0	7.6	-
C0P1	7.61	0.13
C0P2	8.23	8.29
C0P3	8.23	8.29
C0P4	7.82	2.89
C20P0	8.26	8.68
C20P1	8.82	16.05
C20P2	9.25	21.71
C20P3	8.53	12.24
C20P4	7.90	3.95

Reduction in flexural strength of concrete is found in 100% copper slag replacement and that is due to the substantial fluidity in concrete.

4. CONCLUSIONS

Mechanical Properties

- Copper slag can be utilized in the spot of fine total as its unique degree is like sand. Strengthening procedure isn't required by methods for pounding.
- Causes the beach front and inland disintegration.
- Increase in possibility of flooding.
- Makes the water turbid.
- Lowering the water table in certain regions, compounding the danger of dry spell.
- Erosion of whole shoreline happens.
- The accompanying strategies can be embraced to diminish the utilization of sand.

Mix ID	Tensile-strength	Percentagevariation
C0P0	2.688	0
C20P1	2.546	-5.28
C20P2	2.829	5.25
C20P3	3.112	15.77
C20P4	2.688	0
C40P1	2.546	-5.28
C40P2	2.829	5.25
C40P3	3.112	15.77
C40P4	3.537	31.58

- Optimize the utilization of existing structures and frameworks.
- Utilization of Industrial results like copper slag, steel slag, ferrous slag and soon.
- Recycled fabricating materials and quarry residue can be utilized as a substitute for sand.
- Artificial sand can be supplanted halfway or completely called Manufactured sand (M Sand).
- According to IS:383-1970, degree of 40% of copper slag supplanted to sand fits with zone II. Copper slag 20%, 60%, 80% and 100% fulfills Zone I foundation which shows that the molecule sizes are coarser than sand.
- Copper slag improves the functionality up to 60% substitution. Past 60% substitution, isolation and seeping in cement happens that is vanquished by the expansion of PPF, which uses the overabundance water and directs the water content in concrete.
- In concrete mortar, the most extreme compressive quality at 28 days is 39.11N/mm2 for 20% copper slag and 0.4% PPF, which is 83% higher than control blend.
- In concrete mortar, even 80% copper slag has created a compressive quality of 37.11N/mm2 at 28 days, which is practically 75% more prominent than the compressive quality of control blend.
- Even if the sand is completely supplanted with copper slag it can invigorate higher compressive than control concrete. The quality worth doesn't fall beneath the objective mean quality just as the compressive quality of control concrete. In that perspective, the copper slag alone can contend as a substitute material to sand.
- Split elastic trial of cement revealed that the most extreme split rigidity of 3.537 N/mm2 has been seen at C40P4 blend, which is 31.58% more noteworthy than the reference blend.
- Maximum flexural quality of plain cement at 28 days for C40P2 blend is 9.58 N/mm2 which is

26.05% expansion contrasted with control concrete.

- Flexural execution of Reinforced Cement Concrete bar uncovered that the copper slag can be utilized around 4o% with polypropylene fiber of o.4% with no injurious impact on solid execution.

Scope for Future Work

- Survey of writing and research discoveries of this trial work proposes the accompanying future works
- This test work is completed to use the copper business result to the greatest degree in development actives alongside manufactured fiber in M30 grade. The level of substitution can be expanded by embracing an appropriate mix of admixtures like fly debris, silica smolder and soon.
- Copper slag is supplanted with characteristic sand. These days, M sand is famous in the development field. Thus the impact of cement with incomplete substitution of copper slag and M sand can be concentrated to procure most extreme advantage of maintainable condition.
- Copper slag can be examined for usage in assembling of empty squares, blocks and asphalt squares.
- The waste is generated from metal factory at the time of destruction as funnels, courses, and light sheet material utilized.
- Same as road materials are also creates problems when it is not possible to reuses it but the main problem of road waste is scrapping or digging. Nowadays the waste is utilized in road construction like plastic waste or paper

REFERENCES

[1] IS: 10262-1982 Concrete Mix Design.

[2] IS: 383 Sieve Analysis.

[3] IS: 456-2000 Table 5, Water Cement ratio.

[4] Abdelhamid Guettala (2016), "Substitution of the natural sand by crystallized slag of blast furnace in the composition of concrete" Alexandria University of Alexandria Engineering Journal.

[5] R.K. Mishra, R.K. Tipathi, Vikas Dubey (2016)," Early age shrinkage pattern of concrete on replacement of fine aggregate with industrial by-product" Journal of radiation research and applied sciences.

[6] Shanmugasundaram (2016), " An experimental study on mechanical properties on fibre reinforced concrete using polypropylene and marble powder" International Journal of Science Technology and Engineering (IJSTE), Vol 3, Issue 6.

[7] "Comparison of flexural property between high performance polypropylene fibre reinforced lightweight aggregate concrete and steel fibre reinforced light weight aggregate concrete, Constructions and Building Materials 157(2017) 729-736.

[8] Kutalmus Recep Akca, Ozgur Cakr, Mertin Ipek(2017), "Properties of polypropylene fibre reinforced concrete using recycled aggregates", Constructions and Building Materials 98(2015) 620- 630.

[9] Hector Cifuentes, Fidel Garcia, Orlando Maeso, Fermando Medina (2013), "Influence of the properties of polypropylene fibres on the fracture behavior of low- , normal- and high-strength FRC", Constructions and Building Materials 45(2013)130-137.

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