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STUDY ON THE FIBRE REINFORCED CONCRETE USING STEEL SLAG AS THE COARSE AGGREGATE REPLACEMENT

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ABSTRACT: Concrete is the third biggest material devoured by individuals after sustenance and water according to WHO. Concrete assumes a fundamental part in the outline and development of the country's foundation. Practically seventy five percent of the volume of concrete consists of coarse aggregates. These are acquired from common rocks furthermore river beds, accordingly debasing them gradually. Hence the idea of substitution of coarse aggregate with steel slag appears to be encouraging. In this study the experimental investigation is done on the study of the Fibre reinforced concrete using steel slag as the replacement for coarse aggregate. M25 grade of concrete was used. Possible optimum replacement of slag material was found to be 50%.To this optimum replacement of slag material steel fibres are dispersed at different volume fractions. The dimensions of the steel fibres are of length 30mm and diameter 0.5mm and are of crimped type. The results showed that the steel slag can be partially replaced as the coarse aggregate up to 50%.Tests of compressive strength, flexural resistance ,split tensile strength and the Young's modulus tests are carried out on the specimens in which the steel fibres are dispersed in volume fractions of 0.5% , 1% and 1.5% .

Key words: Steel slag, coarse aggregate, steel fibres, etc,.

I. INTRODUCTION

Steel slag is a waste product got from the steel producing industry. It is a non metallic ceramic material structured from the response of flux, such as, calcium oxide with the inorganic non-metallic parts show in the steel scrap. The utilization of steel slag diminishes the need of natural rock as constructional material, thus saving our common rock assets, most extreme use and reusing of by-items and recouped waste materials for monetary and natural reasons has prompted quick improvement of slag use. The fibre dispersion into concrete is one of the technique to improve the building properties of concrete. flexural capacity, toughness, post-failure ductility and crack control as well as the compressive ductility, and energy absorption at early age. Fibres can be delegated metallic, polymeric,etc,. The fibre can be produced using either natural material (asbestos, sisal and cellulose) then again form artificial item (glass, steel, carbon and polymer). Steel fibre is the most usually utilized sort among the different filaments for most structural and non-structural purposes . The financial aspects, producing offices, fortifying impacts and imperviousness to ecological forcefulness are the purposes behind bigger utilization of steel fibre . The steel fibre fixation, introduction and dissemination and also geometry impact the qualities and execution of the concrete. Dr.K.Chinnaraju,V.R.Ramkumar, K.Lineesh, S.Nithya and V.Sathish studied on the steel slag aggregate in 'study on concrete using steel slag as coarse aggregate replacement and eco-sand as fine aggregate replacement' and concluded that increase in replacement level of steel slag above 60% decreases the workability of concrete. When these optimized values were used together, it was found that it gave good strength comparable to conventional concrete and saves material cost upto 40%.
Kavita S Kene, Vikrant S Vairagade and Satish Sathawane studied on the 'Behavior of Steel and Glass Fibre Reinforced Concrete Composites' and concluded that the addition of steel fibres at 0.5 % by volume of concrete reduces the cracks under different loading conditions. The brittleness of concrete can also be improved by addition steel fibres than glass fibres. Since concrete is very weak in tension, the steel fibres are beneficial in axial-tension to increase tensile strength. Max compressive strength and split tensile strength for M20 grade of concrete was obtained by addition steel fibre at volume fraction of 0.5%. Abdulaziz I. Al-Negheismish, Faisal H. Al-Sugair and Rajeh Z. Al-Zaid studied on the 'Utilization of Local Steel making Slag in concrete' and concluded that compressive and flexural strength for slag aggregate is slightly higher than that of gravel concrete when compared. The drying shrinkage of the slag concrete was lower than the gravel concrete. The splitting tensile strength and the Young's modulus strength were also higher than the gravel concrete when compared. jigar p. patel studied on the steel slag in 'Broader use of steel slag aggregates in concrete' Compressive strength, flexural strength and splitting tensile strength for steel slag aggregates concrete were similar to conventional concrete. The results proved that if up to 50 to 75 % of steel slag aggregates are incorporated in the traditional concrete, there would not be much change in the durability of concrete. The slight improvement in strength may be due to shape, size and surface texture of steel slag aggregates, which provide better adhesion between the particles and cement matrix. Proper care should be taken during the aging of steel slag and during the stockpiling of steel slag.

II. EXPERIMENTAL PROGRAM

A. Materials used:

Cement: Cement that was used in here is OPC of grade 53, conforming to I.S-8112- 1989
Natural coarse aggregates: The natural coarse aggregates that are used here are obtained from natural rocks , river beds and

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etc,.

Sand:

Good quality river sand was used as a fine aggregate. Locally available sand, confirming to zone II with specific gravity 2.45, water absorption 2% and fineness modulus 3.18, conforming to I.S. – 383-1970

Steel slag:

The steel slag utilized here is an air cooled slag and is gathered from NELCAST INDUSTRIES located in Gudur town, Nellore city, Andhra Pradesh. Its properties were given in Table 1 and Table 2.

Table:1 Physical properties of steel slag

Property	Value
Specific gravity	2.61
Loose density	1382kg/m3
Compacted density	1520kg/m3
Impact strength	26.6%
Crushing strength	29.8%

Fig 1: Sample of steel slag

Table:2 Chemical composition of Steel slag

Constituent	Composition(%)
Calcium oxide	40-52
Iron oxide	10-14
Magnesium oxide	5-10
Silica	30-35
Manganese oxide	5-8
Aluminium oxide	1-3
Phosphorous oxide	0.5-1
Water absorption	0-3

Water:

Water is required for the purpose of hydration of cement and to give workability during mixing and furthermore setting of concrete. For this study convenient water with pH esteem 7 and adjusting to the determinations of IS456-2000 is utilized for cementing and additionally curing of the specimens.

Steel fibres:

The dimensions of the steel fibres are of length 30mm and diameter of 0.5mm with the L\d ratio of 60.Steel fibres are dispersed in the optimum replacement of the steel slag as the coarse aggregate. The steel fibres are used at a volume fraction of 0.5%,1% and 1.5%

Fig:2 Sample of Steel fibres

The properties of the steel fibres are given in the below table

Table:3 Properties of steel fibres

Fibre	Length (mm)	Type	Vf	L/d ratio
S1	30mm	Crimped	0.5%	60
S2	30mm	Crimped	1.0%	60
S3	30mm	Crimped	1.5%	60

B. Concrete Mix Proportions:

The mixture proportioning was done according the Indian Standard Recommended Method IS 10262- 2009 and with reference to IS 456-2000. The target mean strength was 31 MPa for the OPC control mixture, the total binder content was 380 Kg/m3, fine aggregate was taken 691 Kg/ m3 and coarse aggregate was taken 1170 Kg/m3. The water to binder ratio was kept constant as 0.5. The total mixing time was 5 minutes, the samples were then casted and left for 24 hrs before demoulding. They were then placed in the curing tank until the day of testing cement, sand and coarse aggregate were properly mixed together in the ratio 1:1.82:3.1 by weight before water was added and properly mixed together to achieve homogenous material. Water absorption capacity and moisture content were taken into consideration. Cube and cylindrical and prism moulds were used for casting. The concrete was left in the mould and allowed to set for 24 hours before the specimens were demoulded and placed in curing tank. The specimens with and without fibre were cured in the tank for 7 and 28days.

Table 4:Details of the quantity of the constituent materials

Material	Quantity ($Kg/m^{3)}$)	Proportions
Cement	380	1

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Sand	691	1.82
Coarse aggregates(20mm)	1170	3.1
Water	190	0.5

III. OPTIMISATION OF STEEL SLAG

Optimum replacement of steel slag has been found by the 28 days strength of the cube specimens of size 100mm X 100mmX 100mm. Steel slag was replaced at different proportions such as 0%, 10%, 20%, 30%, 40%, 50%, 60% and 100% respectively. It was found that the optimum level for the replacement of the steel slag was 50%.

S.No	**% Replacement of steel slag**	**7days Compressive strength (Mpa)**	**28 days compressive strength (Mpa)**
1	0	27.9	38.1
2	10	31.4	33.6
3	20	33.8	34.1
4	30	32.1	34.3
5	40	33.8	36.4
6	50	38.5	40.3
7	60	26.9	33.1
8	100	19.2	21.6

Table 5: Compressive strength of the specimens for the optimisation of the steel slag.

It was found that the optimum level for the replacement of the steel slag was 50% and the replacement level over the optimum level was found that the compressive strength was decreasing gradually. It was also observed that the compressive strength of the slag aggregate was slightly higher than that of the control concrete mix when compared with each other.

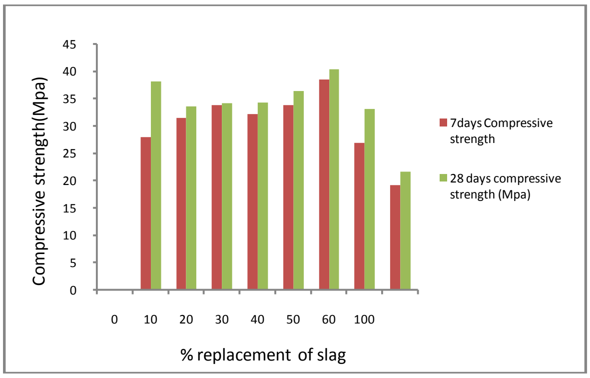

Fig 3: compression value of the optimisation of the steel slag

From the optimisation of the steel slag it was found that the optimum level for the replacement of the steel slag was 50%. Keeping the optimum replacement level of steel slag as constant, the steel fibres are dispersed into the concrete at the volume fractions of 0.5% , 1% and 1.5%. The steel fibres that are used in here are of length 30mm and diameter 0.5mm with the L/d ratio of 60. The type of the steel fibres that are used are of crimped type steel fibres.

Advantages of steel fibres:

Addition of steel fibers into the concrete improves the crack resistance capability of the concrete. ancient rebars area unit usually wont to improve the lastingness of the concrete in an exceedingly specific direction, whereas steel fibers are helpful for multidirectional reinforcement. This is often one among the explanations why steel fiber strengthened concrete with success replaced weld mesh in lining tunnels. Steel fibres are generally used in industrial footings (long steel fibres).

IV. CASTING AND CURING OF SPECIMENS

The dimension of the specimens are of cylenders of size 100mm X 200mm and 150mm X 300mm where the 100mm and 150mm are the diameters of the cylenders,The dimensions of the cube are 100mm X 100mm X 100mm,The dimensions of the prisms are 500mm X 100mm X 100mm.By adding the steel fibres into the concrete the specimens for the compressive strength, split tensile strength, Young's modulus and the flexural strength were being casted at a grade of M25.The specimens were demoulded and kept in curing. The compression test is carried out for 7 days and 28 days and the remaining tests such as flexural strength, split tensile strength and youngs modulus test were carried out for 28 days.

V. TEST RESULTS AND DISCUSSIONS

The compression test is carried out for 7 days and 28 days after the curing and one day of air drying.The flexural strength , split tensile strength and the youngs modulus test is carried out for 28 days of curing and one day of air drying.

Fig 4: Specimens after casting and curing

Table 6: compressive strength of cubes at different volume fractions for Control concrete (0% slag replacement):

S.no	% of steel slag	Vf (%)	7days (Mpa)	28days(Mpa)
1	0%	0.50%	38.4	43.14
2	0%	1%	40.12	46.18
3	0%	1.50%	44.2	49.8

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Table 7: compressive strength of cubes at different volume fractions for 50% slag replacement as coarse aggregate:

S.no	% of steel slag	Vf (%)	7days (Mpa)	28days (Mpa)
1	50%	0.5%	42.4	47.3
2	50%	1%	43.6	50.1
3	50%	1.5%	49.7	53.6

It is found that when compared with each other the compressive strength of the concrete with partial replacement of steel slag as coarse aggregate is slightly higher than that of the control concrete mix.

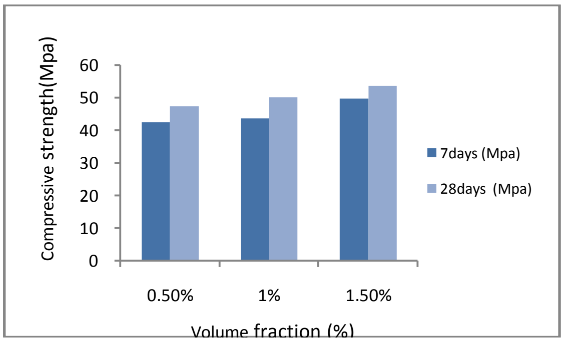

Fig 5: Compressive strength at different volume fractions

Table 8:Strength values(Mpa) at different volume fractions at 0% replacement of steel slag for 28days(control concrete)

Volume fraction(%)	0.50%	1%	1.50%
Flexural strength(Mpa)	5.24	5.98	6.14
Split tensile strength(Mpa)	3.98	4.12	4.64
Young's Modulus(Gpa)	26.02	26.46	27.19

It is found that the compressive strength of the concrete increased with the increase in the volume fraction of the steel fibres The flexural strength , split tensile strength and the Young's modulus test results are give in the table 7 below

Table 9:Strength values(Mpa) at different volume fractions at 50% replacement of steel slag for 28days

Volume fraction(%)	0.5%	1%	1.5%
Flexural strength(Mpa)	6.29	7.41	7.62
Split tensile strength(Mpa)	4.15	5.22	5.98
Young's Modulus(Gpa)	26.2	27.18	28.36

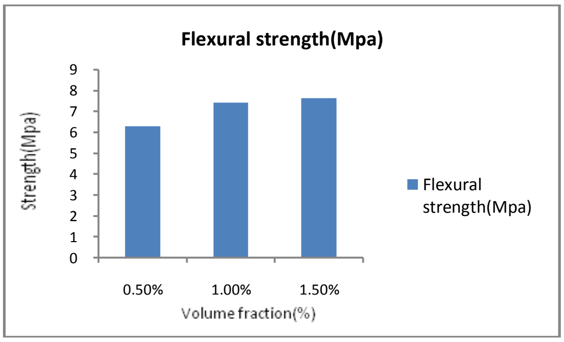

Fig: 6 Flexural strength at different volume fractions for 28days(Mpa)

It was observed that when the volume fraction of the steel fibres was increased in the concrete it resulted in the increase in the flexural strength of the concrete.

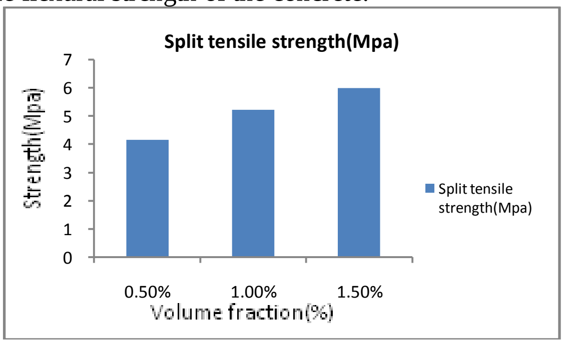

Fig7: Split tensile strength at different volume fractions for 28 days(Mpa)

It was observed that when the volume fraction of the steel fibres was increased in the concrete it resulted in the increase in the splitting tensile strength of the concrete.

VI. CONCLUSIONS

Based on the Impact strength, crushing strength Slag aggregates are allowed to use in concrete .
From the compressive strength findings, 50% replacement of slag aggregates gives more strength when compared with other proportions. When the steel fibres were added to the optimum replacement level of steel slag to produce conventional concrete, it was observed that the compressive strength reached 52.1Mpa for the volume fraction of 1.5%. The concrete mix with 1.5% Vf steel fibres attains maximum flexural strength and split tensile strength. It was observed that the increase in the volume fraction of steel fibres increases the compressive strength, split tensile, Young's modulus and flexural strength of the concrete. This paper concludes that the usage of the steel slag as a coarse aggregate replacement gives us good strength and the same

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time as the steel slag is a waste product of the steel industry using the steel slag in the concrete answers the disposal question of the steel slag. The cost of the concrete can be decreased when steel slag is used as a coarse aggregate replacement in the concrete.

REFERENCES

[1] Abdulaziz I. Al-Negheismish, Faisal H. Al-Sugair and Rajeh Z. Al-Zaid (1996), "Utilization of Local Steel making Slag in concrete", Journal of Environmental science of sustainable society,Vol.1, pp. 39-55.

[2] Maslehuddin. M, AlfarabiM.Sharif, Shameem. M, Ibrahim M, Barry M.S (2002), "Comparison of properties of steel slag and crushed limestone aggregate concretes", Journal of Construction and Building Materials, Vol. 17, pp 105-112.

[3] Juan M Manso, Juan A Polanco, and Javier J Gonzalez (2004), "Electric Arc Furnace Slag in Concrete", Journal of Materials in Civil Engineering, Vol. 16. pp 639-645.

[4] N. Banthia,"Crack Growth Resistance of Hybrid Fibre Composites", Cem. Con. Comp., Volume 25, Issue 1, Pp. 3-9, 2003

[5] A. Bentur and S. Mindess, "Fibre Reinforced Cementitious Composites", Elsevier Applied Science, London, UK. 1990

[6] Kavita S Kene, Vikrant S Vairagade and Satish Sathawane's "Experimental Study on Behavior of Steel and Glass Fibre Reinforced Concrete Composites", Bonfring International Journal of Industrial Engineering and Management Science, Vol. 2, No. 4, December 2012

[7] K. chinnaraju, V. r. ramkumar, K. lineesh, S. nithya, V. sathish's "study on concrete using steel slag as coarse aggregate replacement and ecosand as fine aggregate replacement", international journal of research in engineering & advanced technology, volume 1, issue 3, june-july, 2013 pp 2320 – 8791

[8] AnastasiouE and PapayianniI(2006), "Criteria for the Use of Steel Slag Aggregates in Concrete", Measuring,Bookl of Monitoring and Modeling Concrete Properties.

[9] Juan M Manso, Juan A Polanco, Milagros Losanez and Javier J Gonzalez (2006),"Durability of Concrete made with EAF Slag as Aggregates", Cement and Concrete Composite,pp 528-534.

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