Application of by Product of a Steel (Steel Slag) As Fractional Additional of Mixture Coarse Aggregate in Concrete

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ABSTRACT
As we already know that human's population are increasing day by day and in order to meet their various transportation-al and housing needs construction is going on at a very faster rate and there might be a chance that usage of natural coarse aggregate become less because natural mountains are being damaged due to drilling or by blasting. In this investigation an attempt is being made to find a solution in which original strength and durability can be obtained by usage of by-product of steel (Steel Slag). The purpose of this investigation is to examine analytically, the "APPLICATION OF STEEL SLAG AS FRACTIONAL ADDITIONAL OF COARSE AGGREGATES" examined by replacement of natural coarse aggregates by different ratio of steel slag at 20,40,60,80 and 100 % by using the mix design of class A concrete and its strength was more than 4500 psi .The specimen standard cylinders size and beams (8 inch,8 inch and 21 inch) size were used and they were tested at 7,14 and 28 days interval .It was properly water cured .Various concrete tests were being performed ,In order to find out the actual behaviour of concrete and the tests were compressive, split, flexural and slump test. The test graph shows that there is a wide variation in compressive, split, flexural and slump strength of natural coarse aggregate replaced by steel slag for 7,14 and 28 days.

Keywords: Steel Slag, Aggregates, Concrete, Compressive Strength, Flexural Strength.

INTRODUCTION

Concrete is considered as a supremely important and the biggest building material of this planet earth. For development effort, there is no second and third alternative material available and only concrete is being used everywhere around the globe. Hence its usage is considered as one of the universally accepted as a basic building material and there is a lot of construction is going around, which increased its demand and there is an estimated usage of concrete that is concrete being used at almost 5 billion tons per annum, universally none of any material being used so far for development effort and it makes biggest raw material ever used in any manufacturing production for development works.

As we already know that natural raw materials reserves are going vacant and a need is being created that if natural resources are going down then how we can use produce concrete the problem is solved by a researcher, in which they use certain replacement within concrete composition which not only solved raw material but it also strength and durability without natural raw materials. For this investigational study, Concrete mix design of 4500 psi was prepared and Steel slag was used as a specimen at 0,20,40,60,80 and 100 %. replacing course aggregates. Compression, Split, Flexural and slump test were performed and Concrete Cylinders, Concrete beams were casted and they were tested at 7,14 and 28 days. Then their result was discussed.

LITERATURE REVIEW

A by-product of a steel (steel slag) has been used to store pavements for culminating around one hundred years. Since it was found that the change from the production of steel might be compacted and built into a thing that took after beat vibration, particular starter s similar compressive quality central and divided logbook groundwork was finished to pick the help of this left-over thing. It was available that, all things considered, survive, genuine ended, vesicular, set exteriors to give the particle work, and if really smoothed, the high relentless quality fundamental for respectable valuable blacktops. The misuse of steel slag is all around involved as a piece of the coarse total segment of the blend at a rate of twenty (20) percent (%) to seventy-five (75) percent (%), subordinate upon the use of the blend (Kalpana and Pradheepa, 2014).

Mulled over that it supported not shake hard to a method with the solid made with a by-product of a steel (steel slag) totals. In addition, an elite of the basic perspectives in the stone hard combination is the number of air vacuums out of sight. Airborne vacuums influence the H20 to submerge the gaps, which thusly diminish high inner nerves and along these lines, diminish cut back measure part in the structure. Value of concrete does not have any true-blue modification in a setting of increment of slag mean. Compressive nature of numerous combinations demonstrates utilitarian differentiation in around ten (10) percent (%). The constituent of slag controls the alteration in predominance" Kotahi and Malathay (2013,29).

Presented that prevailing to driving all the starter investigating it, it was watched that thirty (30) percent (%) dislodging of fine aggregate with by-product of a steel (steel slag) by-product of a steel (steel slag) finished up being phenomenal in weight quality, anyway the strong having by-product of a steel (steel slag) and fine aggregate in for all intents and purposes indistinguishable degrees wound up being to be inefficient. The compressive thought of the strong development as the proportion of replacement augments up to thirty (30) percent (%). Over that proportion of replacement, the regular compressive quality diminishments. Accordingly, the perfect rate of substitution suggested is thirty (30) percent (%) in which the quality got is 27 N/mm2 for 20 N/mm2 audit of security. The worth of progress depends on the costs of protest or substance. Since by-product of a steel (steel slag) is without open of value, the Price of strong decreases, as the rate of substitution increases. In this manner, when dynamically the recurrence of substitution would be higher than naturally their future increment in esteem would likewise happen (Kaviya and Geeta,2014).

The displacing of Mixture of rocks (coarse aggregate) with a by-product of a steel (steel slag) has extended the compressive quality, split determination and flexural nature of the bond. The perfect percentage of a by-product of a steel (steel slag) as far as anyone knows was sixty (60) percent (%). The change in the percentage of a by-product of a steel (steel slag) in strong shows higher strength to harming and sulphate strike. Accurate, when this improved regard will be used, its qualities would be an excellent blowing quality and more excellent strong

when showed up particularly in association with standard bond and extra things material price up to 10% (Thangaselvi, 2015).

Conferred that the perfect estimation of compressive quality can be ace by twenty (20) percent (%) replacement of steel slag like manner, the perfect approximation of flexural quality with twenty (20) percent (%) replacement of by-product of a steel (steel slag) was 4.93339 N/mm2 and the perfect approximation of split versatility with twenty (20) percent (%) replacement of by-product of a steel (steel slag) was 2.959999 N/mm2 for 19.999 N/mm2 outline of bond" (Abrol et al,2016).

MATERIALS USED

Steel slag
In this research the steel slag is taken from FF steel, Hayatabad, Phase 7, Peshawar. Nowadays steel is being used everywhere in various forms universally in various form. The steel slag is one of the outgrowth productions of steel, which is made during the departure of hot, Boiled steel from scums in steel-production factories. The slag is formed, when molten steel boiled and formed a shape of molten liquid in a furnace, it is a mixture of silicates and oxides, which come in a solid form after cooling freezing Steel is tough and resist any type of load. Steel has one good quality that it can   resist any type of load and due to this quality it have a greater demand in industries. As we already know that 30 % of useful steel is obtained while 70 % wasteful steel is being dumped into various places. Which creates a lot of environmental and hazard problem universally. There should be a mechanism develop for steel slag waste, whether it's by product should be used or dumped in such a place that it can be less harmful for human and others

Mix design of concrete
The mix design of a concrete is prepared according to American Concrete Standard (ACI) and it have a strength more than 4500 psi strength

Table 1. Mix design of 4500 psi

Blend	Cement (Binding Material)	By product of a steel (steel slag)	Mixture of small particles of grains(sand) (Kg)	Mixture of rocks (coarse aggregate)	H_2O
Cs	500	0	830	1052	187
Cs 20%	500	210.4	830	841.6	187
Cs 40%	500	420.8	830	631.2	187
Cs 60%	500	631.2	830	420.8	187
Cs 80%	500	841.6	830	210.4	187
Cs 100%	500	1052	830	0	187

Cs=Control Sample without replacement of coarse aggregate with Steel Slag
Cs 20%= Control Sample replacing 20% of coarse aggregate with Steel Slag
Cs 40%= Control Sample replacing 40% of coarse aggregate with Steel Slag
Cs 60%= Control Sample replacing 60% of coarse aggregate with Steel Slag
Cs 80%= Control Sample replacing 80% of coarse aggregate with Steel Slag
Cs 100%= Control Sample replacing 100% of coarse aggregate with Steel Slag

METHODOLOGY

Compressive Test
The compression strength trial was performed according to ASTM C 39 on seven, fourteen (14) and Twenty-eight (28) days. On a specific day, compression trial was performed for each chamber. A mechanism was defined that for each chamber that a smooth layer was applied to it

in order to make its surface smooth and level. Chambers was placed in a compressive testing Devices and its weight was determined for each chamber after its breaking. The compression weight for each chamber was obtained by dividing weight at which a chamber breaks by the region of a chamber.

Compressive quality = stack/area= F/A

Figure 1: Cylinder are going to be crushed in a compression testing machine

Different cement blends consuming diverse rates of steel slag/squanders by means of fractional substitution of coarse total stood tried for seven (7), fourteen (14) and twenty-eight (28) days of curing quality. The fine total be situated supplanted by shifting rates of steel slag/squanders, for example, twenty (20) percent (%), forty (40) percent %), sixty (60) percent (%), eighty (80) percent (%) and hundred (100) percent (%). An aggregate of 45 chambers was thrown for the compressive quality trial and 3 trial s were tried for every substitution in addition day. The normal of these three (3) chambers, when tried at their separate age, was then taken as concrete compressive quality. The blend extent was 1,1.78,1.36,0.52 with a folio proportion of 0.39.

Table 2. Comparison of 7,14 and 28-days compressive strength with percent expansion respectively

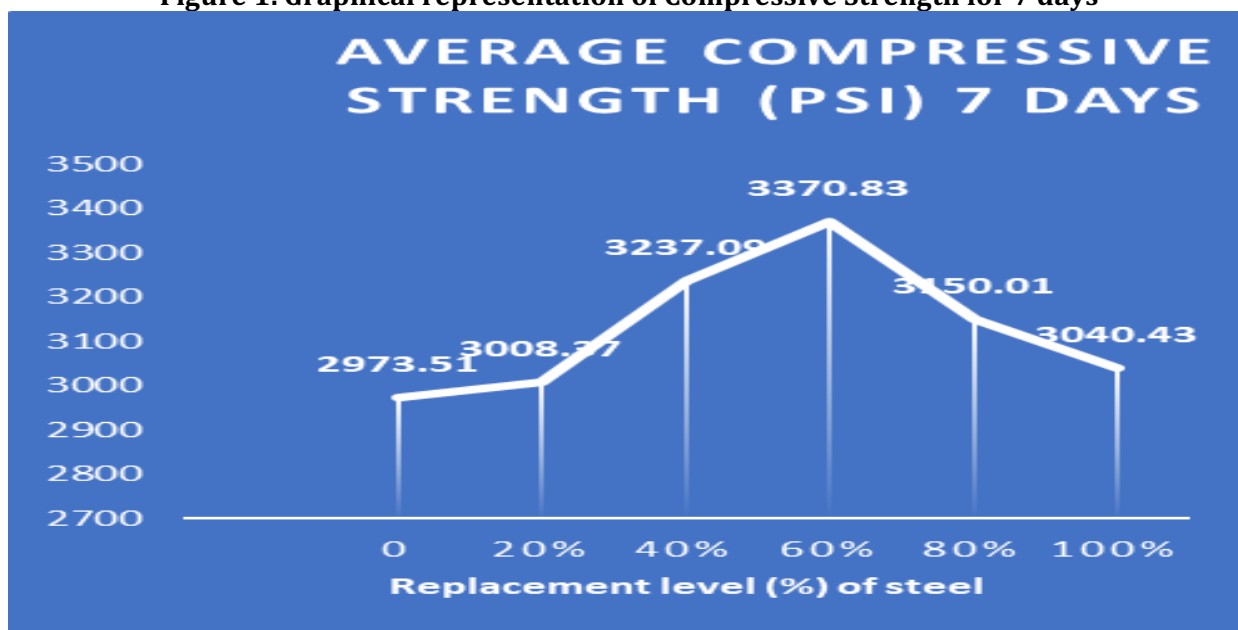| Distinctive types of blend	Substituent Equal	Seven (7) days	Percent (%) expansion
CS	0	2973.51	-
Cs 20%	20	3008.37	1.16
Cs 40%	40	3237.09	7.07
Cs 60%	60	3370.83	3.97
Cs 80%	80	3150.01	7.02
Cs 100 %	100	3040.43	3.61

Compressive Strength for 7 days

According to above table ,The compressive test was done for Twenty ,Fourthly ,Sixty ,Eighty and Hundred percent (%) at seven day In which coarse aggregate was replaced by steel slag by above percent .At zero percent replacement ,The compressive strength is 2973.51 and there is no percent replacement because its consider first in all .Secondly ,At twenty percent replacement ,Its

strength is 3008.37 and its 1.16 increase in its strength then zero percent replacement ,Thirdly ,At forty percent replacement ,Its strength is 3237.09 and it is 7.07 % more than twenty percent replacement .Fourthly ,At sixty (60) percent, Its compressive strength test is 3370.83 and its percent increase is 3.97% less than the fourthly (40) replacement .Fifth, At eighty (80) replacement. Its compressive strength test is 3150.01 and its percent increase is 7.02. Which is more than sixty (60) % replacement but less then fourthly (%) replacement. Six, at hundred (100) replacement, its compressive strength is 3040.43 and it is 3.61. Which is less then eighty, sixty, fourth percent but more than twenty percent replacement.

Hence sixty percent replacement is higher in compressive strength then other replacement

Figure 1. Graphical representation of Compressive Strength for 7 days

Above graph shows that it gives 3370.83 strength, which is higher in strength then all replacement

Table 3. Compressive Strength for 14 days

Distinctive types of blend	Substituent Equal	Fourteen (14) days	Percent (%) expansion
CS	0	3570.08	-
Cs 20%	20	3623.75	1.49
Cs 40%	40	3857.03	6.05
Cs 60%	60	4027.23	4.23
Cs 80%	80	3765.93	-6.94
Cs 100 %	100	3545.66	-6.22

According to above table ,The compressive test was done for Twenty ,Fourthly ,Sixty ,Eighty and Hundred percent (%) at fourteen day In which coarse aggregate was replaced by steel slag by above percent .At zero percent replacement ,The compressive strength is 3570.08 and there is no percent replacement because its consider first in all .Secondly ,At twenty percent replacement ,Its strength is 3623.75 and its 1.49 increase in its strength then zero percent replacement ,Thirdly ,At forty percent replacement ,Its strength is 3857.03 and it is 6.05 % more than twenty percent replacement .Fourthly ,At sixty (60) percent, Its compressive strength test is 4027.23 and ,Its percent increase is 4.23 % less than the fourthly (40) replacement .Fifth, At eighty (80) replacement .Its compressive strength test is 3765.93 and its percent increase is -6.94.Which is more than sixty (60) % replacement but less then fourthly (%) replacement .Six, At hundred (100)

replacement ,Its compressive strength is 3545.66 and it is -6.22 .Which is less then eighty ,sixty, fourth percent and twenty percent replacement.
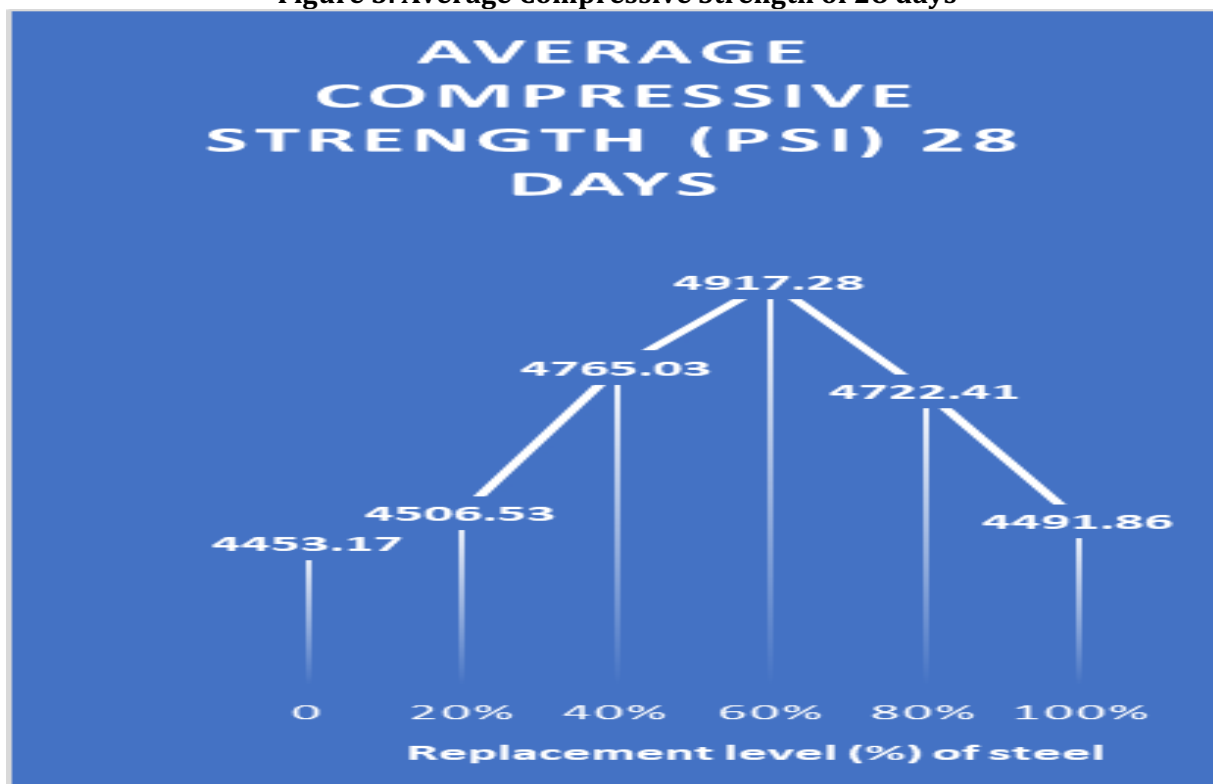
At fourteen days, its sixty percent replacement is higher in compressive strength then other replacement

Figure 2. Graphical Representation of Compressive strength for fourteen days
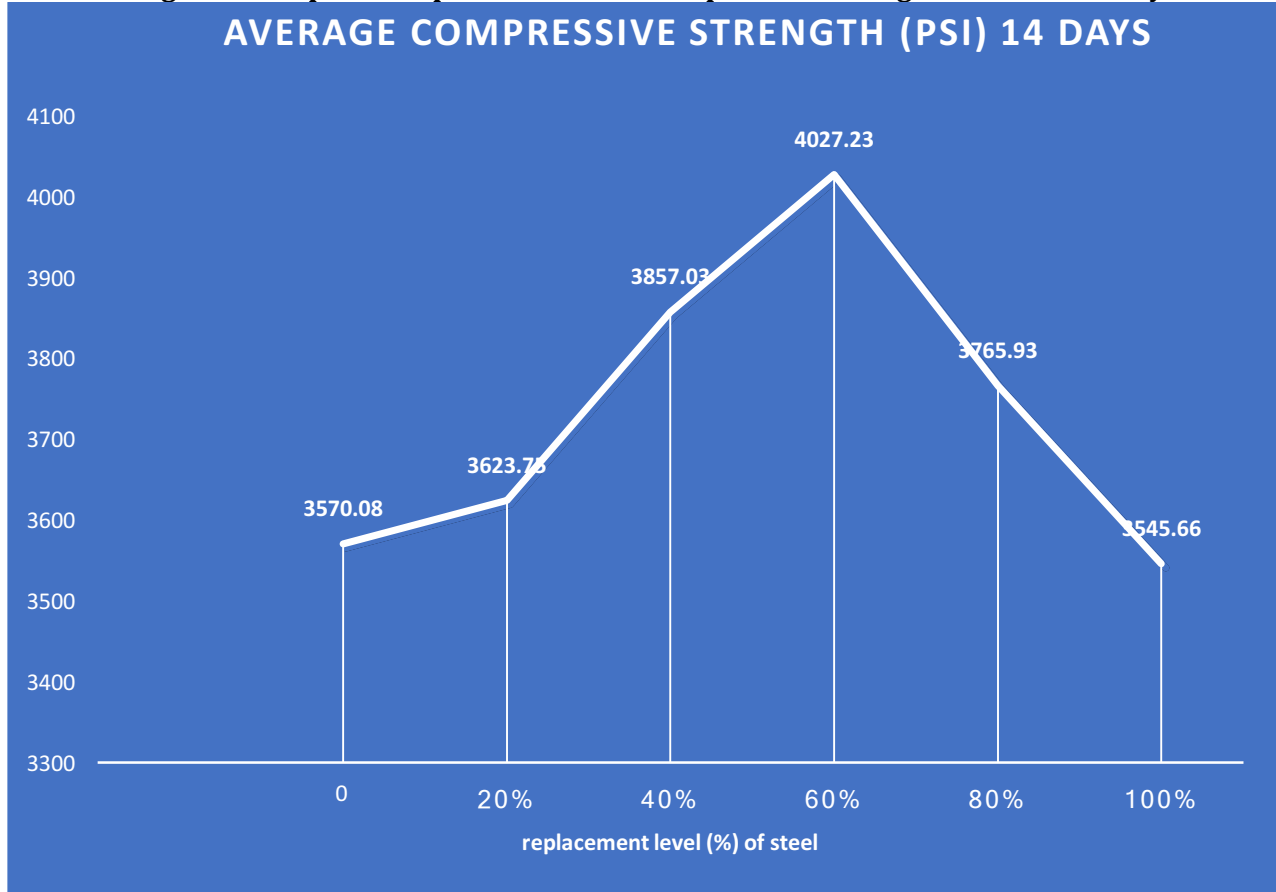
According to figure 1.3 its graphical representation of average compressive at fourteen days is 4027,23 at sixty percent replacement, which is higher than then other replacement.

Figure 3. Average Compressive Strength of 28 days

According to figure 1.4 its graphical representation of average compressive at twenty-eight days is 4917.28 at sixty percent replacement, which is higher than then other replacement.

Table 4. Compressive Strength for 28 days

Distinctive types of blend	*Substituent Equal*	*Twenty eight (28) days*	*Percent (%) expansion*
CS	*0*	*4453.17*	*-*
Cs 20%	*20*	*4506.53*	*1.19*
Cs 40%	*40*	*4765.03*	*5.43*
Cs 60%	*60*	*4917.28*	*3.097*
Cs 80%	*80*	*4722.41*	*-4.13*
Cs 100 %	*100*	*4491.86*	*-5.14*

According to above table ,The compressive test was done for Twenty ,Fourthly ,Sixty ,Eighty and Hundred percent (%) at Twenty eight (28) day In which coarse aggregate was replaced by steel slag by above percent .At zero percent replacement ,The compressive strength is 4453.17 and there is no percent replacement because its consider first in all .Secondly ,At twenty percent replacement ,Its strength is 4506.53 and its 1.19 increase in its strength then zero percent replacement ,Thirdly ,At forty percent replacement ,Its strength is 4765.03 and it is 5.43 % more than twenty percent replacement .Fourthly ,At sixty (60) percent, Its compressive strength test is 4917.28 and ,Its percent increase is 3.097 % less than the fourthly (40) replacement .Fifth, At eighty (80) replacement .Its compressive strength test is 4722.41 and it's percent increase is -- 4.13.Which is less than all replacement .At hundred (100) replacement ,Its compressive strength is 4491.86 and it is -5.14 .Which is less then all replacement at twenty-eight days, its sixty percent replacement is higher in compressive strength then other replacement.

Split Tensile Strength

As we know that concrete is weak in tension and strong in compression due to which concrete is presumably will face ductile breaking in field condition. In this manner, it ends up critical to decide the solid split rigidity. Split rigidity of the solid example was governor led by ASTM C

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496 trial technique. This trial is utilized to locate the elasticity of cement. The rigidity of the solid is decided in a roundabout way from a split barrel trial. The rigidity of the barrel computed by the below equations.

S = 2f/πDL
f = split rigidity
P = stack"
D = measurement of a barrel
L = traverse of the chamber

Figure 4. Cylinder is going to be crushed in a lab

Table 5. Split Cylinder Strength Test for 28 days

Distinctive types of blend	Substitution Equal	Split tensile strength (psi)
Cs	0	474.26
Cs 20 %	20	483.21
Cs 40 %	40	513.86
Cs 60 %	60	529.61
Cs 80 %	80	481.43
Cs 100 %	100	469.67

According to above table facts and figures Split Cylinder test was done on different concrete composition specimen varies from Twenty (20) percent to Hundred (100) percent % steel slag. In them concrete composition having sixty (60) percent have highest value in all of them.

Figure 5. Graphical representation of split for twenty-eight (28) days
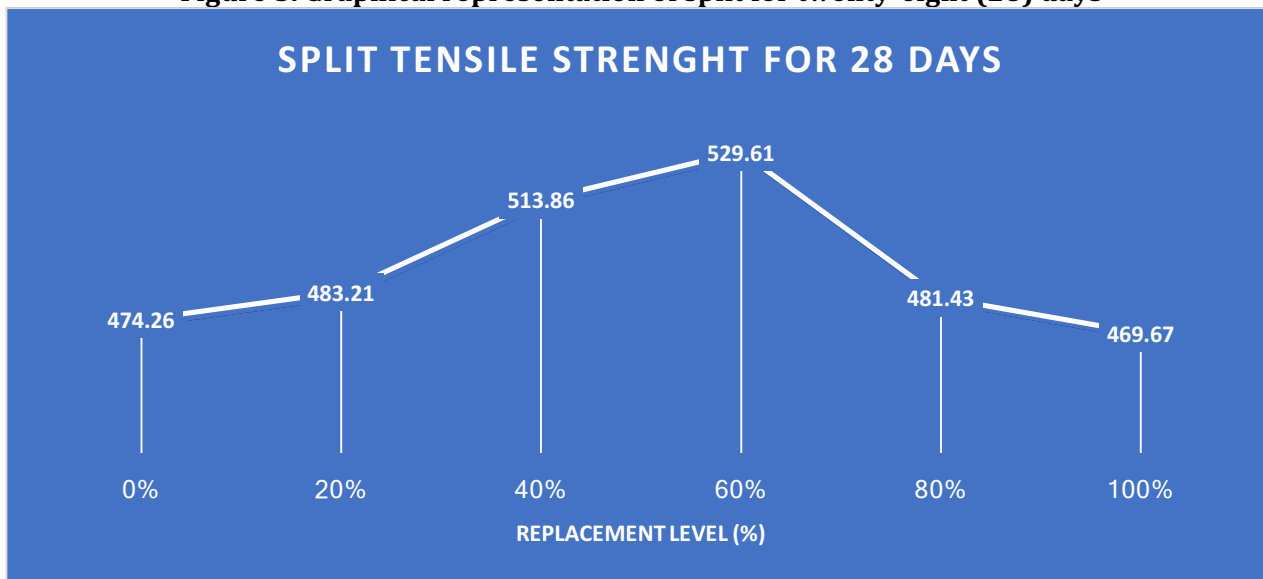
The sixty (60) percent steel slag gives 529.61

The different cement blends having distinctive rates of steel slag /squanders as incomplete substitution of coarse total was tried for 28 days of curing quality. The coarse total was supplanted with differing rates of steel slag/squanders i.e. twenty (20) percent (%), forty (40) percent (%), sixty (60) percent (%), eighty (80) percent (%) and hundred (100) percent (%). An aggregate of 18 barrels were threw for the part schedule trial and 3 trials were tried for every substitution and day time. The normal of these three (3) barrels. When tried at their individual age was then taken as solid split rigidity.
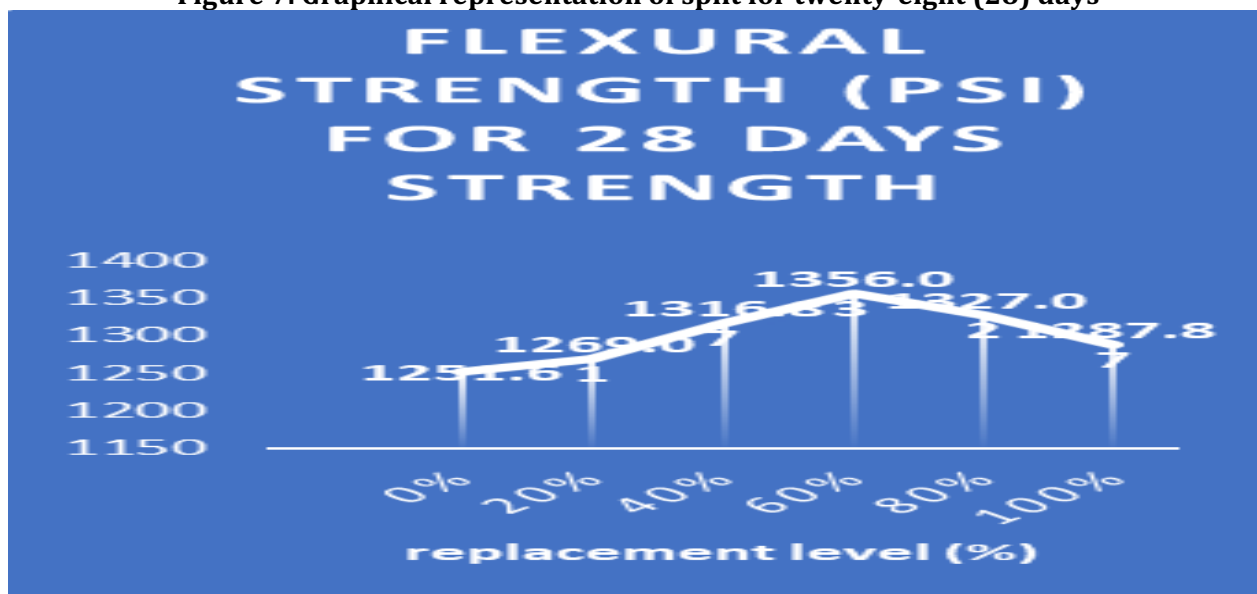
Flexural Test
The flexural trial is performed so as to discover bond quality that how much a material can oppose a quality. This trials are performed on a said material until the point when it fizzles and it is best to be utilized for in-flexible material. The flexural trial was performed by ASTM C78.

Figure 6. Flexural test is going on a beam in a laboratory

Table 6. Shows Flexural Strength for 28 days

Type of Mix	Extra Level	Flexural strength (psi)
Cs	0 %	1251.60
Cs 20 %	20%	1269.01
Cs 40 %	40%	1316.87
Cs 60 %	60%	1356.03
Cs 80%	80%	1327.02
Cs 100%	100%	1287.87

Figure 7. Graphical representation of split for twenty-eight (28) days

According to above table, the flexural strength test of a beam for Twenty, Fourthly, Sixty, Eighty and Hundred percent (%) at Twenty-eight (28)　day in which coarse aggregate was replaced by steel slag by above percent The flexural strength test for twenty-eight (28) days for sixty percent replacement is 1356.03 and which is highest then other replacement.

According to above figure, the flexural strength test of a beam for Twenty, Fourthly, Sixty, Eighty and Hundred percent (%) at Twenty-eight (28)　day in which coarse aggregate was replaced by steel slag by above percent The flexural strength test for twenty-eight (28) days for sixty percent replacement is 1356.03 and which is highest then other replacement.

Slump Test
In order to select or know workability of new solid, the droop trial was done and during that test was performed river liquid to bond ratio was kept in proportion and it was kept uniform for all the blend and mixes, for example, thirty-nine (39) percent (%)

Table 7. Shows comparison of slump values

	Cs 0%	Cs 20%	Cs 40%	Cs 60%	Cs 80%	Cs 100%
Combination	0%	20%	40%	60%	80%	100%
Fall rate	1.2"	1.25"	1.4"	1.50"	1.65"	1.9"

Figure 8. Shows comparison of slump value
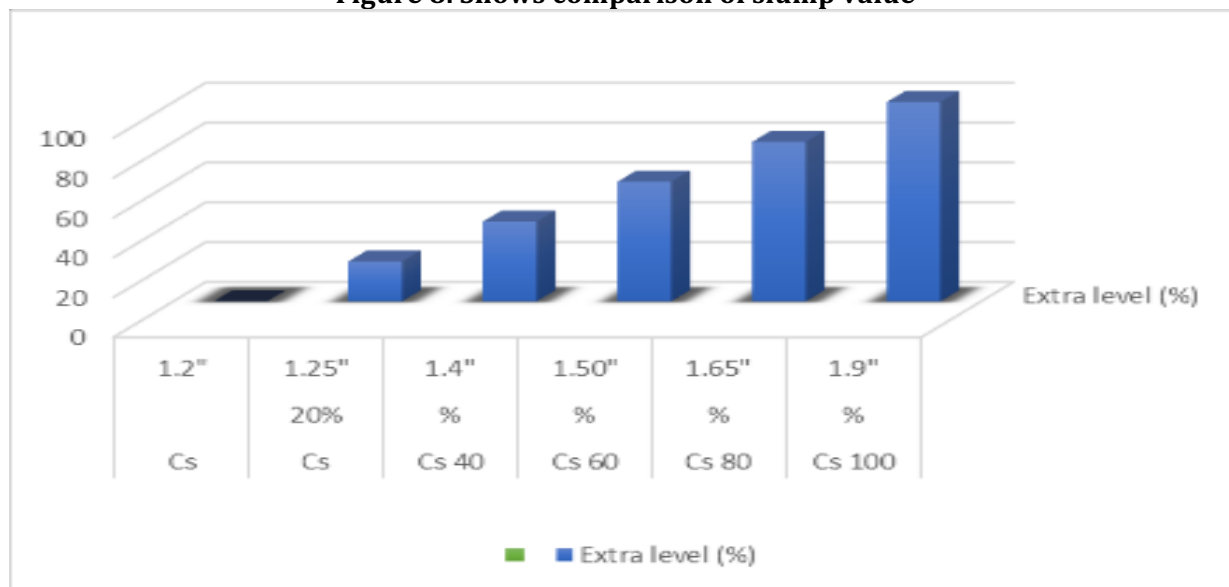
The slump was obtained and which was within limits of 1 inch to 2 inches, which is according to limit defined   by ACI 21.

Bulk of concrete

The thickness of a considerable number concerning chambers was composed with and without by-product of a steel (steel slag) were resolved and after that, they were thought about for conclusion.

Table 8. Item weight concerning cement through various rates concerning steel slag/squanders for seven days

Distinctive types of blend	Substitution Equal	Seven (7) days
Cs	0	147.83
Cs 20%	20	148.54
Cs 40%	40	149.31
Cs 60%	60	150.07
Cs 80%	80	150.69
Cs 100%	100	150.73

Figure 9. Graphical Representation for seven (7) days
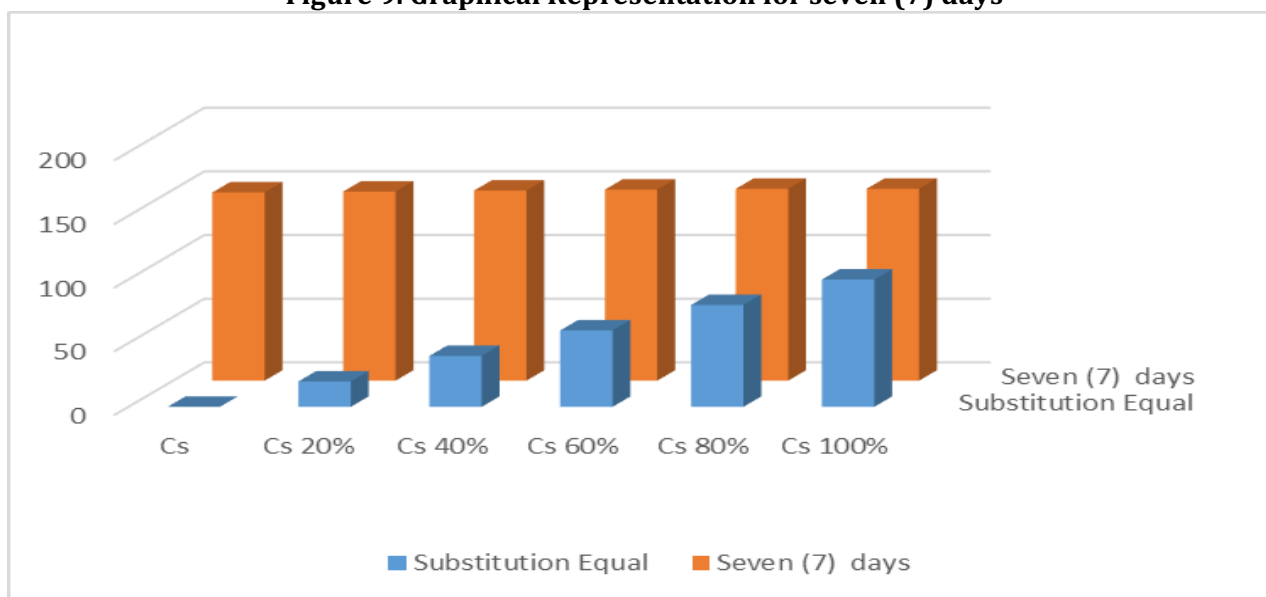
Table 9. For Fourteen days (14)

Distinctive types of blend	Substitution Equal	Fourteen (14) days
Cs	0	147.79
Cs 20%	20	148.59
Cs 40%	40	149.29
Cs 60%	60	150.05
Cs 80%	80	150.72
Cs 100%	100	150.81

Figure 10. Graphical Representation for Fourteen days (14)
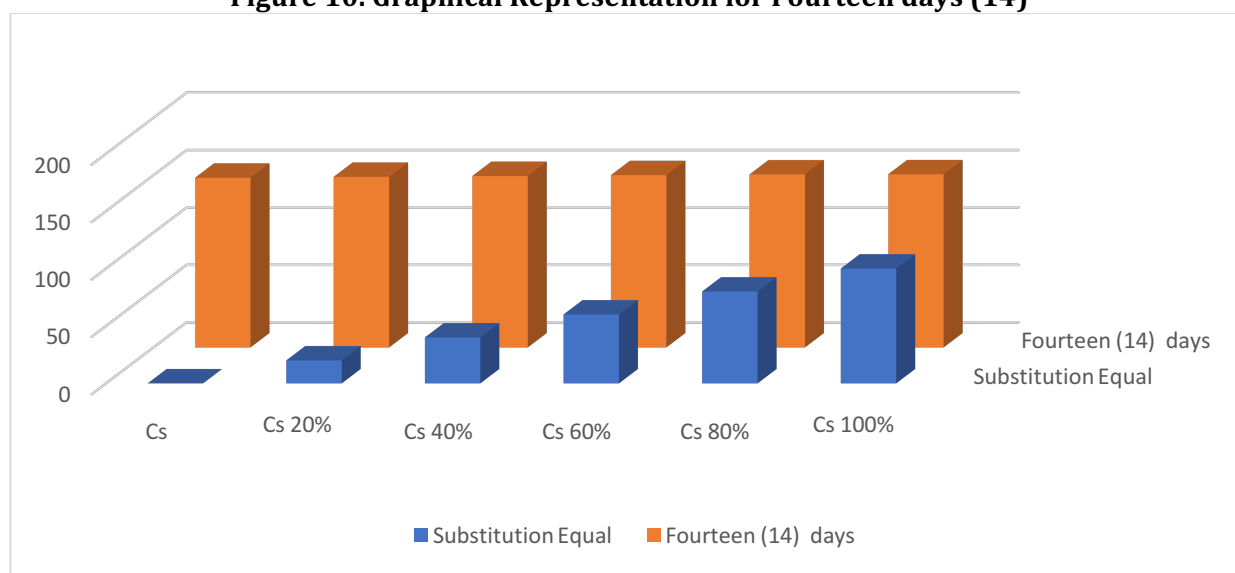
Table 10. For Twenty-Eight days (28)

Distinctive types of blend	Substitution Equal	Twenty-Eight (28) days
Cs	0	147.81
Cs 20%	20	148.57
Cs 40%	40	149.27
Cs 60%	60	150.10
Cs 80%	80	150.73
Cs 100%	100	150.92

Figure 11. Graphical Representation for Twenty-eight days
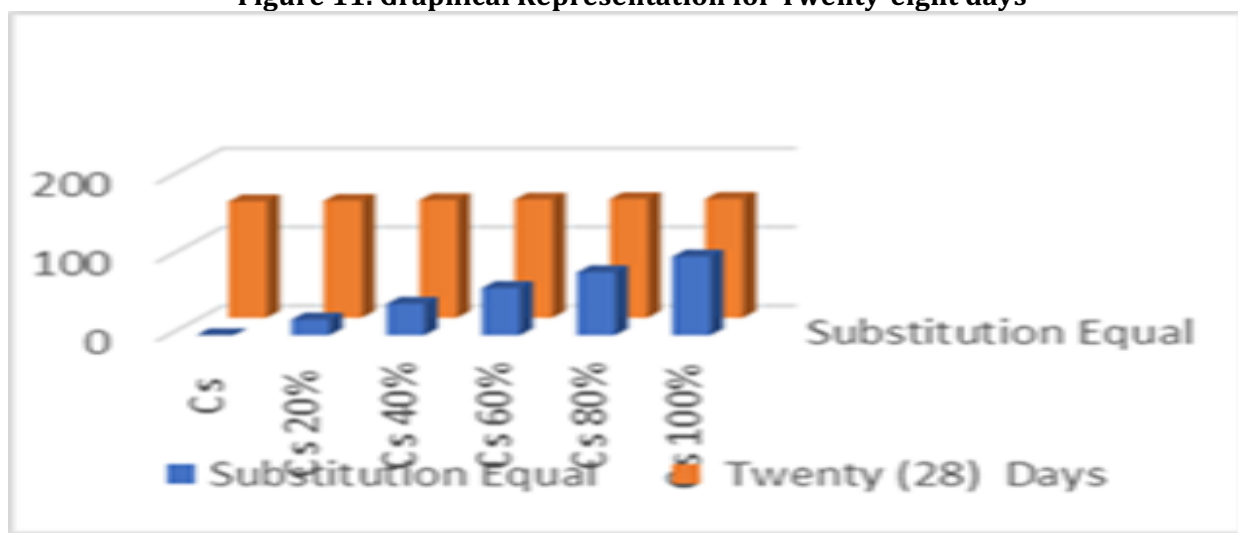
Price investigation

Price investigation is improved the situation the distinctive cement compost and without steel slag. The Price examination is composed per cubic meter of solid blend 1,1.78,1.36,0.52. The after-effect governor blend and solid blend composed with various rates of steel slag/squanders are appeared in the accompanying Schedule

Table 11. Showing Percent Price saving with different percentage usage of Steel Slag/waste concrete

Successive Whole no	Classification	Cost according to Volume Rupees	Allowance amount Unwasteful
1	Control Sample	22,386	
2	Cs 20%	22,856.0	98%
3	Cs 40%	99,050	23%
4	Cs 60%	23,648.40	419%
5	Cs 80%	24,069.20	98%

Reputation procedure of Steel Slag usage

It is very common phenomena that a lot of by product steel is being obtained from steel manufacture and they ae being dumped into various place. In order to use that by-product of steel. There are various methods introduced, which not only re use that by product of steel in a useful material but it provides a good usage of steel waste from being dumped into various places

Various usage of Steel Slag

At present steel slag is used at various places due to its excellent characteristics and properties and on it basis it can be used at various places

1) All types of residential, commercial and industrial projects
2) Dams and other mass concrete works
3) Water retaining structures
4) Concrete roads and flyovers
5) Most suitable for marine constructions
6) Pre-cast concrete product
7) Foundations and piles construction

Benefit of steel slag

The advantages of steel slag are given below

1) Its per unit cost of production is less
2) It has resistance for chloride & sulphate attacks
3) It become compatible with every type of admixtures
4) It have better resistance against alkali-silica reaction
5) Its environmentally friendly.

Figure 12. Graphical Representation of a Percent Price saving with Steel slag/wastes concrete
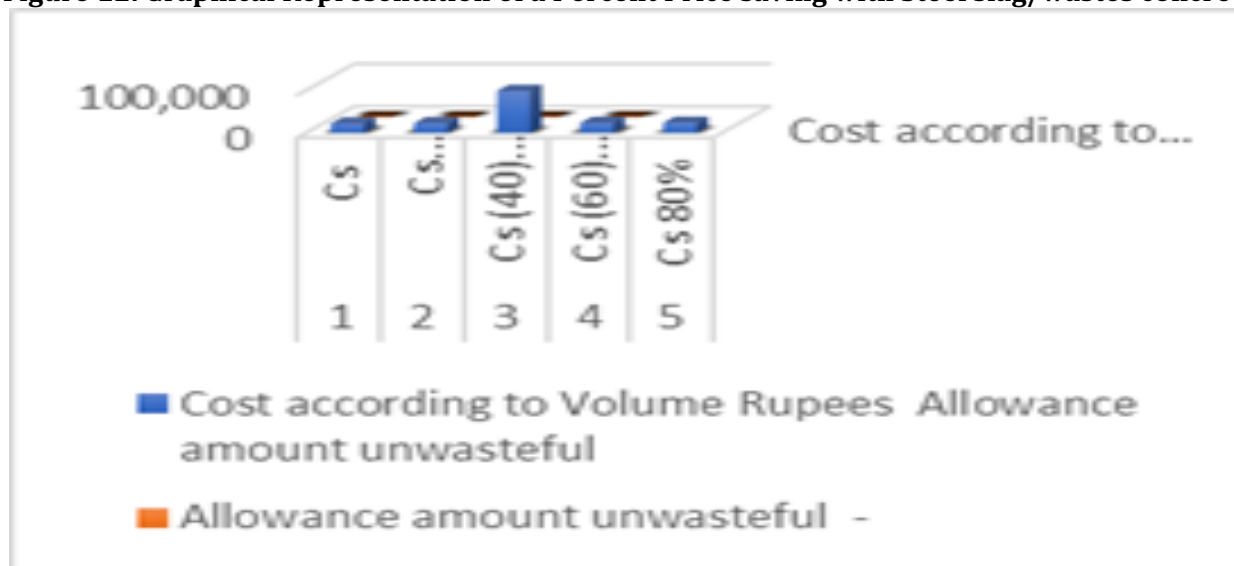
Shortcomings of Steel slag

1) It has an environmental impact
2) It is difficult to be dumped
3) It have very sharp edges on its surface

RESULT AND CONCLUSION

In the light of the analyses done on the investigation of utilizing steel slag/squanders as an incomplete substitution of coarse total the accompanying perceptions are composed.

- The most astounding thickness accomplished with steel slag/squanders concrete with 100% substitution is marginally more than the thickness of governor trial.
- Workability/droop was expanding with expanding substance of steel slag.
- The compressive quality began to increment as the steel slag/squanders expanded with 60% substitution level.
- The most extreme increment in split elastic trial was seen with sixty (60) percent (%) substitution of steel slag/squanders which is 11.67 % and it is   extra than the governor trial
- The Price of cement with forty (40) percent (%) substitution of steel slag/squanders is diminished up to twenty-three (23) percent (%).
- Exploitation of these sort of mechanical squanders in cement can help lessen the ecological effect of these squanders

ENDORSEMENT

- The utilization of by-product of a steel (steel slag) in concrete is prudent and can be utilized as an incomplete substitution of fine total up to 100%.

- The application of by-product of a steel (steel slag) in concrete is cost-effective and it can be used as a fractional addition of Mixture of rocks (coarse aggregate) near to about 100%.

RECOMMENDATION AIMED AT FORTHCOMING TASK

In this examination, by product of a steel (steel slag) was supplanted with Mixture of small particles of grains(sand) in concrete. Albeit compressive quality trial and split trial were performed yet at the same time some examination work should be finished.

- The supplanting of by-product of a steel (steel slag) with fine total might be checked.
- By product of a steel (steel slag) solid strength should be checked at various %ages of steel slag.
- Cement Grout composed with by product of a steel (steel slag) may likewise be checked.

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