International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

"Experimental Investigation of Egg Shell Powder as Partial Replacement with Cement and copper slag with fine aggregate in Concrete"

JAY GOHIL[1], JAY GOHEL[2]

[1]PG Student Department of civil Engineering R.K. University, Rajkot, India
[2]Assistance professor Department of civil Engineering R.K. University, Rajkot, India

---

Abstract - Concrete is always expected to be stronger and more durable than in the past while being cost and energy efficient. Moreover, the major advantages that concrete possesses over the construction materials have to be conserved. The possibility of being fabricated practically anywhere, the ability to make the form imposed by the shape of a mound and a low cost of components and manufacture. These factors have driven advances in improving the performance of concrete over years and continue to do so the need for improving the performance of concrete and concern for the environmental impact arising from the continually increasing demand for concrete has led the growing use of alternative material components.

An experimental investigation will be conducted to study the properties of concrete containing copper slag as a partial replacement of fine aggregates in the concrete mix design. Various strength tests will be conducted on such concrete of M00 grade and M25 grade to know the compressive strength, split tensile strength, flexural strength by varying proportions of copper slag (CS) with fine aggregates by (0% CS + 0% ESP), (10% CS), (10% ESP), (20% ESP), (30% ESP), (40% ESP), (50% ESP), (10% ESP), (10% CS + 10% ESP), (20% CS + 10% ESP), (10% CS + 20% ESP), (30% CS + 20% ESP), (20% CS + 30% ESP), by weight. The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing copper slag as a partial replacement of fine aggregates.

***Key Words*: Copper Slag, Egg shells powder, compressive strength, M20, M25 etc**

1. INTRODUCTION

Concrete is a composite material composed of water, coarse granular material (the fine and coarse aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. Concrete is widely used for making architectural structures, foundations, brick or block walls, pavements, bridges or overpasses, highways, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Concrete is used in large quantities almost everywhere mankind has a need for infrastructure.
Concrete is used more than any other manmade material in the world. In addition, concrete is the 2nd most consumed substance in the world-behind water. The industry alone is worth over $37 billion, and it employs more than 2 million employees in the United States. About 10 billion tons of concrete are produced every year.

1.1 Copper slag

Copper slag is a by-product of copper extraction by smelting. During smelting, impurities become slag which floats on the molten metal. Copper slag is used in the concrete as one of the alternative materials. It is the waste product of copper from various industries. The safe disposal of this waste is a lack, costly and causes environmental pollution. The construction industry is the only area where the safe use of waste material (copper slag) is possible. When it is introduced in concrete as a replacement material, it reduces the environmental pollution, space problem and also reduces the cost of concrete

Table 1: Chemical Analysis of Copper Slag

Chemical Analysis	
Element	**Analysis Range (%)**
Cu	0.60-0.70
FeO	42-48
SiO2	26-30

Al2O3	1.0-3.0
SiO2	0.2-0.3
CaO	1.0-2.0
Chloride	0.001-0.002
Fe3O4	1.0-2.0

Table 2: Sieve Analysis of Copper Slag

Sieve Analysis		Range
-4	3	2.00-4.0 %
-3	2.36	3.0-12.0 %
-2.36	1	40-55 %
-1	0.5	15-30 %
0.5	0.212	6-12 %
	<-0.212	0.2-1.0 %

Table 3: Physical Properties of Copper Slag

Physical Properties		
Sr. No	**Details**	**Range**
1	Hardness	6.0-7.0
2	Specific Gravity	3.51
3	Bulk Density	1.9-2.4
4	Granular Shape	Angular, Sharp Edges, Multi face
5	Electrical Conductivity	2 mS/m
6	Moisture	Nil

1.2 Egg shell powder

Eggshells are agricultural throw away objects produced from chick hatcheries, bakeries, fast food restaurants among others which can damage the surroundings and as a result comprising ecological issues/contamination which would need appropriate treatment. In the ever-soaring tasks to change waste to wealth, the efficiency of adapting eggshells to advantageous application constitutes a concept worth-accepting. It is systematically acknowledged that the eggshell chiefly consists of compounds of calcium. Okonkwo has proficiently proposed that eggshell comprises 93.70% calcium carbonate (in calcium), 4.20% organic matter, 1.30% magnesium carbonate, and 0.8% calcium phosphate. It is estimated that roughly 90 million tonnes of hen egg are generated throughout the world every year. In India 77.7 billion eggs are produced in the year 2010-2011.Tamil Nadu, amassing a share of around 20 per cent, is ranked second with almost 2,000 core eggs created in the state every year. The next in the list of prominent egg producing states in India comprise Maharashtra, Haryana, Punjab and West Bengal.

2. Mixed Design

The mix design for M20 and M25 grade of concrete is described below in accordance with Indian Standard Code IS: 10262-2009.

Table 4: M20 Mixed Design

Mix Proportion			One Batch	Unit
1	Volume of Concrete	1	0.104	**m^3**
2	Water Cement Ratio	0.4	0.0416	
3	Cement	378	39.404	Kg
4	Water	197.16	20.553	Kg
5	**Aggregate**			
6	Fine Aggregate	551.25	57.465	Kg

7	Coarse Aggregate	1236.2	128.868	Kg
8	**% Of Used Copper Slag**			
	10%	55.125	5.746	Kg
	20%	110.25	11.493	Kg
	30%	165.375	17.239	Kg

Table 5: M25 Mixed Design

Mix Proportion			**One Batch**	**Unit**
1	Volume of Concrete	1	0.104	**m^3**
2	Water Cement Ratio	0.5	0.052	
3	Cement	383.2	39.947	Kg
4	Water	191.6	19.973	Kg
5	**Aggregate**			
6	Fine Aggregate	800.94	83.494	Kg
7	Coarse Aggregate	1087.75	113.39	Kg
8	**% Of Used Copper Slag**			
	10%	80.094	8.349	Kg
	20%	160.188	16.698	Kg
	30%	240.282	25.048	Kg

3. Result and Discussion

Table 6: Test result of Compressive strength test, Spilt tensile strength test and Flexural strength for M20 Grade

Test Result of M20	**Compressive Strength (N/mm^2)**				**Split Tensile Strength (N/mm^2)**		**Flexural Strength (N/mm^2)**	
	7 Days	Avg. 7days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days
Normal Concrete	15.29	**16.990**	21.25	**21.663**	3.01	**3.100**	2.98	**3.037**
	17.65		21.20		3.09		3.01	
	18.03		22.54		3.19		3.11	
CONCRETE WITH CS +ESP								
Specimen-1 (10%CS)	16.90	17.046	21.10	21.543	3.05	3.104	3.08	3.103
	17.21		23.31		3.14		3.12	
	17.03		20.22		3.11		3.09	
Specimen-2 (10%ESP)	17.23	16.423	21.22	**21.686**	3.12	**3.123**	3.16	3.067
	16.39		21.41		3.10		2.97	
	15.65		22.43		3.15		3.06	
Specimen-3 (10%CS+ 10%ESP)	18.26	17.620	22.49	21.960	3.22	**3.243**	3.093	3.139
	17.90		21.31		3.15		3.14	
	16.70		22.08		3.36		3.17	

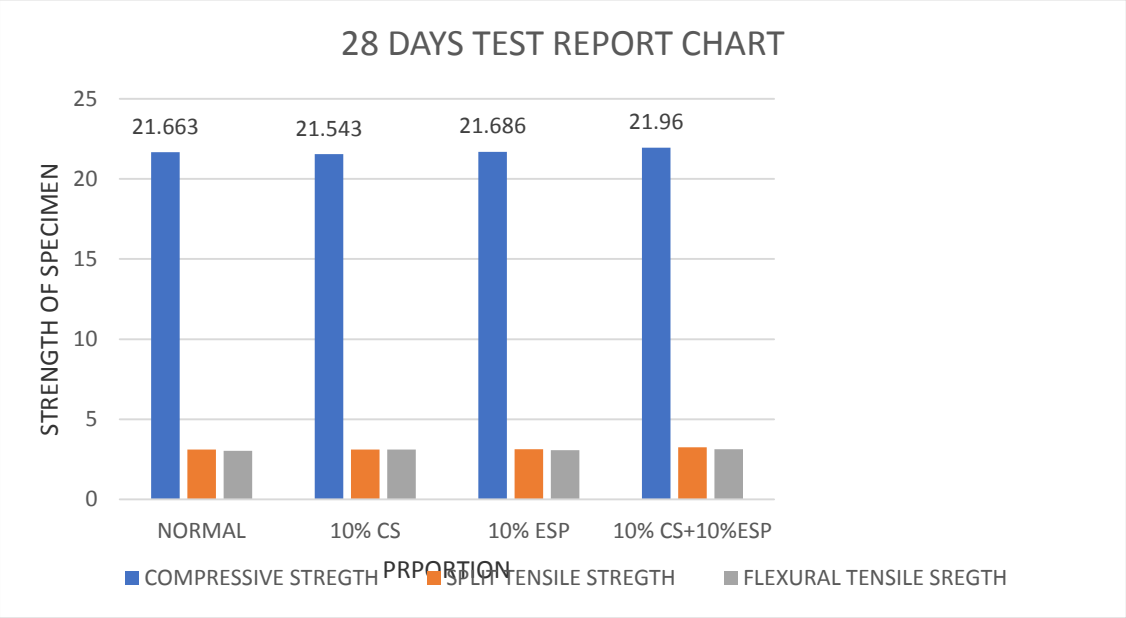

Chart 1: Strength Comparison chart for M20 Grade

Table 7: Test result of Compressive strength test, Spilt tensile strength test and Flexural strength for M25 Grade

Test Result of M25	Compressive Strength (N/mm²)				Split Tensile Strength (N/mm²)		Flexural Strength (N/mm²)	
	7 Days	Avg. 7days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days
Normal Concrete	18.023	**17.577**	25.631	**25.232**	3.47	**3.4806667**	3.521	**3.5596667**
	17.56		24.816		3.56		3.548	
	17.148		25.249		3.412		3.61	
CONCRETE WITH CS +ESP								
Specimen-1 (10%CS)	17.471	17.8397	21.80	22.333	3.649	3.561	3.592	3.5025
	18.512		24.69		3.565		3.4365	
	17.536		20.51		3.469		3.479	
Specimen-2 (10%ESP)	17.236	18.0257	25.34	25.353	3.553	3.4853333	3.523	3.5316667
	18.856		26.298		3.567		3.448	
	17.985		24.421		3.336		3.624	
Specimen-3 (10%CS+ 10%ESP)	17.112	17.1437	25.452	24.54	3.415	3.481	3.542	3.5126667
	16.896		24.287		3.496		3.519	
	17.423		23.89		3.532		3.477	

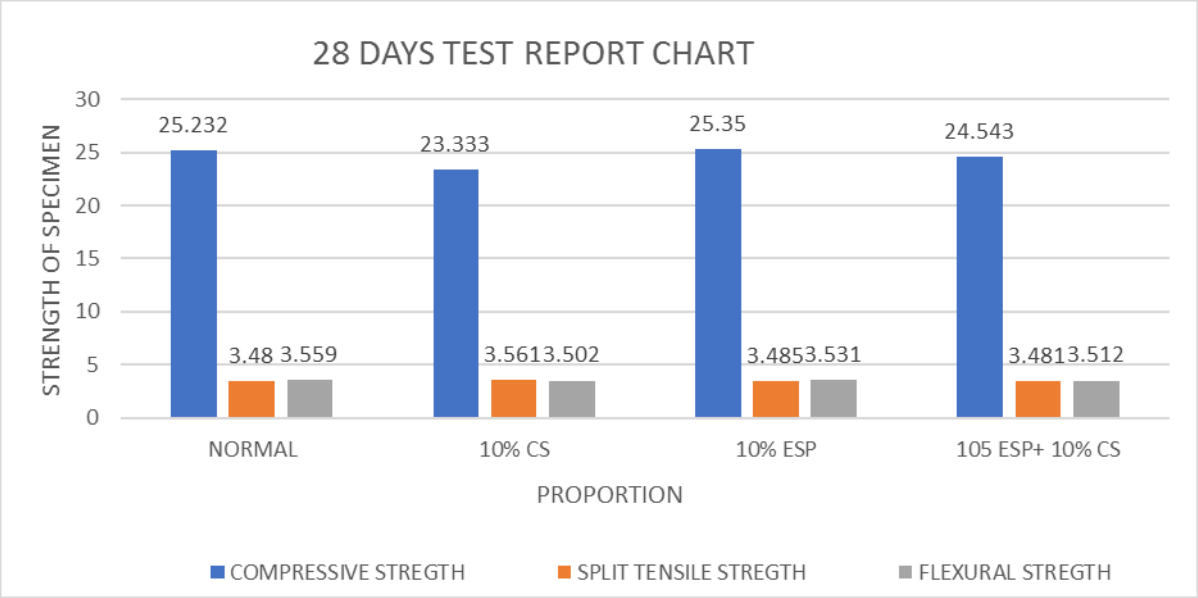

Chart 2: Strength Comparison chart for M25 Grade

Table 8: Test result of Compressive strength test, Spilt tensile strength test and Flexural strength for M20 Grade

CONCRETE WITH ESP (M20)								
	Compressive Strength (N/mm²)				Split Tensile Strength (N/mm²)		Flexural Strength (N/mm²)	
	7 Days	Avg. 7days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days
Specimen-1 (10% ESP)	17.23	**16.423**	21.22	**21.686**	3.12	**3.123**	3.16	**3.067**
	16.39		21.41		3.10		2.97	
	15.65		22.43		3.15		3.06	
Specimen-2 (20% ESP)	14.62	**14.870**	22.49	**21.96**	3.17	**3.198**	3.09	**3.139**
	15.14		21.31		3.19		3.14	
	14.85		22.08		3.22		3.17	
Specimen-3 (30% ESP)	15.24	**15.083**	21.68	**22.003**	3.11	**3.13**	3.02	**3.105**
	14.62		22.34		3.15		3.19	
	15.39		21.99					
Specimen-4 (40% ESP)	15.23	**15.230**	23.01	**22.230**	3.19	**3.15**	3.06	**3.095**
	15.78		21.54		3.11		3.13	
	14.68		22.14					
Specimen-5 (50% ESP)	14.02	**14.500**	20.26	**20.903**	2.89	**2.94**	2.68	**2.745**
	14.47		21.37		2.99		2.81	
	15.01		21.08					

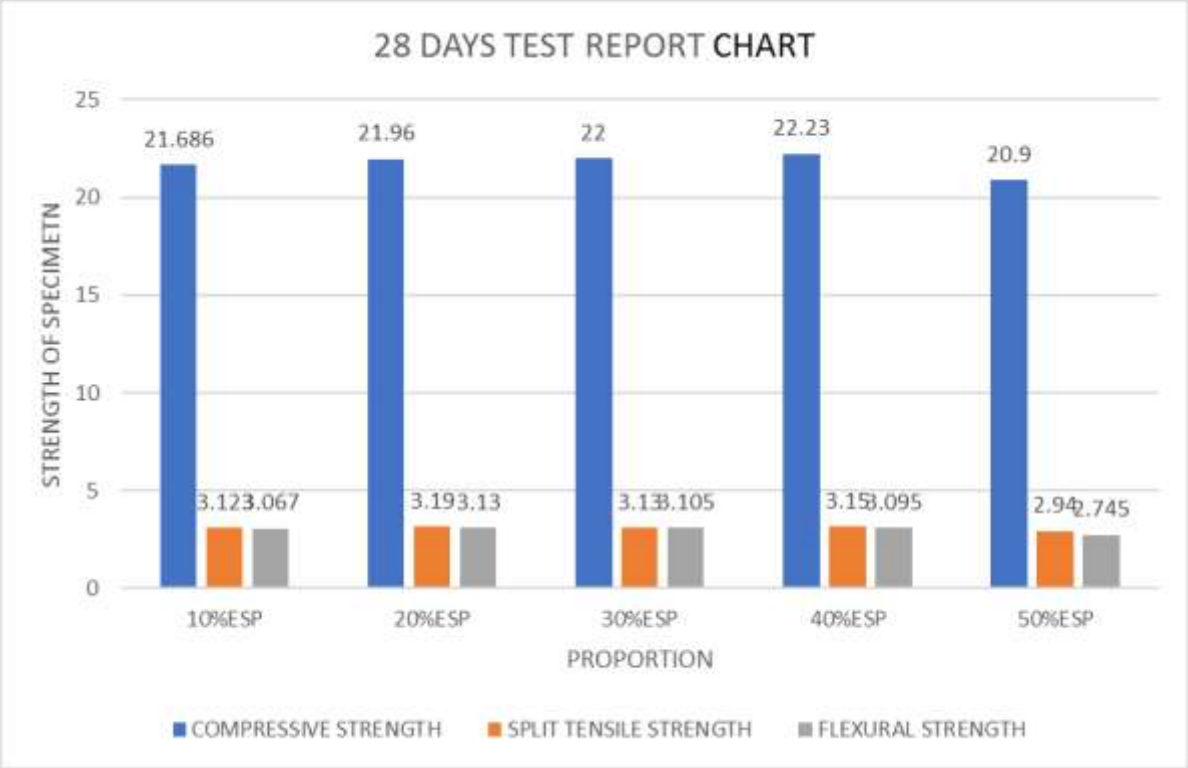

Chart 3: Strength Comparison chart for M20 Grade

Table 9: Test result of Compressive strength test, Spilt tensile strength test and Flexural strength for M20 Grade

CONCRETE WITH CS +ESP (M20)								
	Compressive Strength (N/mm²)				Split Tensile Strength (N/mm²)		Flexural Strength (N/mm²)	
	7 Days	Avg. 7 days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days	28 Days	Avg. 28 Days
Specimen-1 (10%CS +20%ESP)	14.25	**14.9667**	22.39	**22.27**	3.22	**3.2433333**	3.31	**3.2466667**
	15.36		21.43		3.15		3.19	
	15.29		21.99		3.36		3.24	
Specimen-2 (20%CS +10%ESP)	15.21	**15.24**	20.87	**22.440**	3.09	**3.1233333**	3.1	**3.1887**
	15.69		22.81		3.26		3.29	
	14.82		23.64		3.02		3.1761	
Specimen-2 (30%CS +20%ESP)	15.62	**15.3687**	23.08	**23.023**	2.94	**2.995**	3.05	**3.03**
	14.92		23.51		3.05		3.01	
	15.566		22.48					
Specimen-2 (20%CS + 30%ESP)	14.09	**14.4133**	21.47	**21.323**	2.81	**2.685**	3.12	**3.11**
	14.43		20.56		2.56		3.1	
	14.72		21.94					

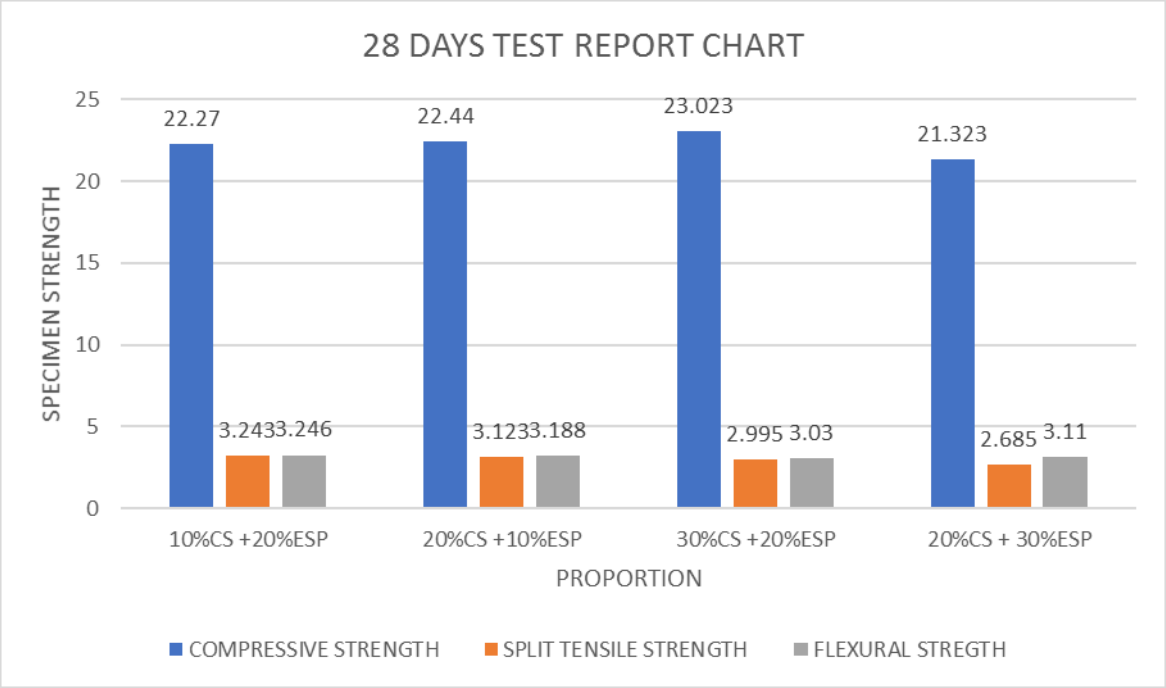

Chart 4: Strength Comparison chart for M20 grade

Table 10: Test result of Compressive strength test, Spilt tensile strength test and Flexural strength for M25 Grade

CONCRETE WITH ESP (M25)				
COMPRESSIVE STRENGTH (N/mm²)				
	7 DAYS	AVG. 7DAYS	28 DAYS	AVG. 28 DAYS
SPECIMEN-1 (10%ESP)	17.23	18.025	25.34	25.353
	18.85		26.29	
	17.98		24.42	
SPECIMEN-2 (20% ESP)	17.56	17.8533	25.023	25.461
	17.89		25.89	
	18.11		25.47	
SPECIMEN-2 (30% ESP)	17.19	16.46	25.41	24.86
	16.99		24.67	
	17.54		25.6	
SPECIMEN-2 (40% ESP)	16.91	16.1	24.31	24.4067
	17.21		25.32	
	17.09		23.59	
SPECIMEN-2 (50% ESP)	16.54	16.22	24.22	24.2933
	16.47		23.68	
	17.03		24.98	

CONCRETE WITH CS +ESP (M25)				
COMPRESSIVE STRENGTH (N/mm²)				
	7 DAYS	AVG. 7DAYS	28 DAYS	AVG. 28 DAYS
SPECIMEN-1 (10%CS +20%ESP)	17.98	17.9167	25.51	25.8367
	18.21		25.25	
	17.56		26.75	
SPECIMEN-2 (20%CS +10%ESP)	17.65	17.7233	25.15	25.1267
	18.24		25.41	
	17.28		24.82	
SPECIMEN-2 (30%CS +20%ESP)	16.51	16.9533	24.26	24.5573
	17.24		24.222	
	17.11		25.19	
SPECIMEN-2 (20%CS + 30%ESP)	17.2	16.72	23.65	24.3
	16.43		24.81	
	16.53		24.44	

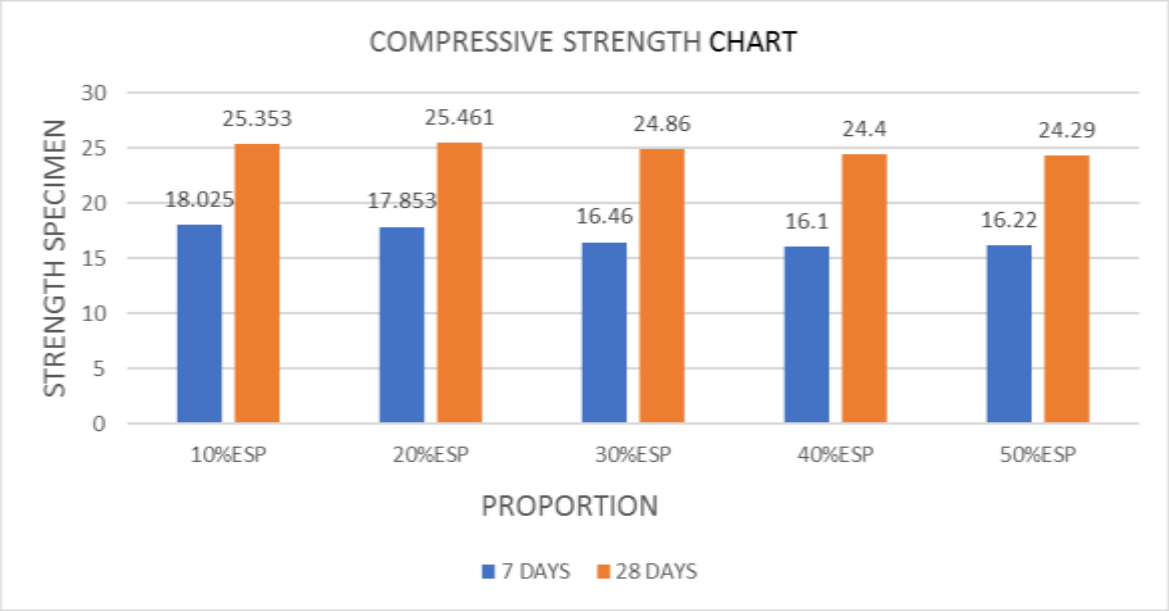

Chart 5: Strength Comparison chart for M25 Grade

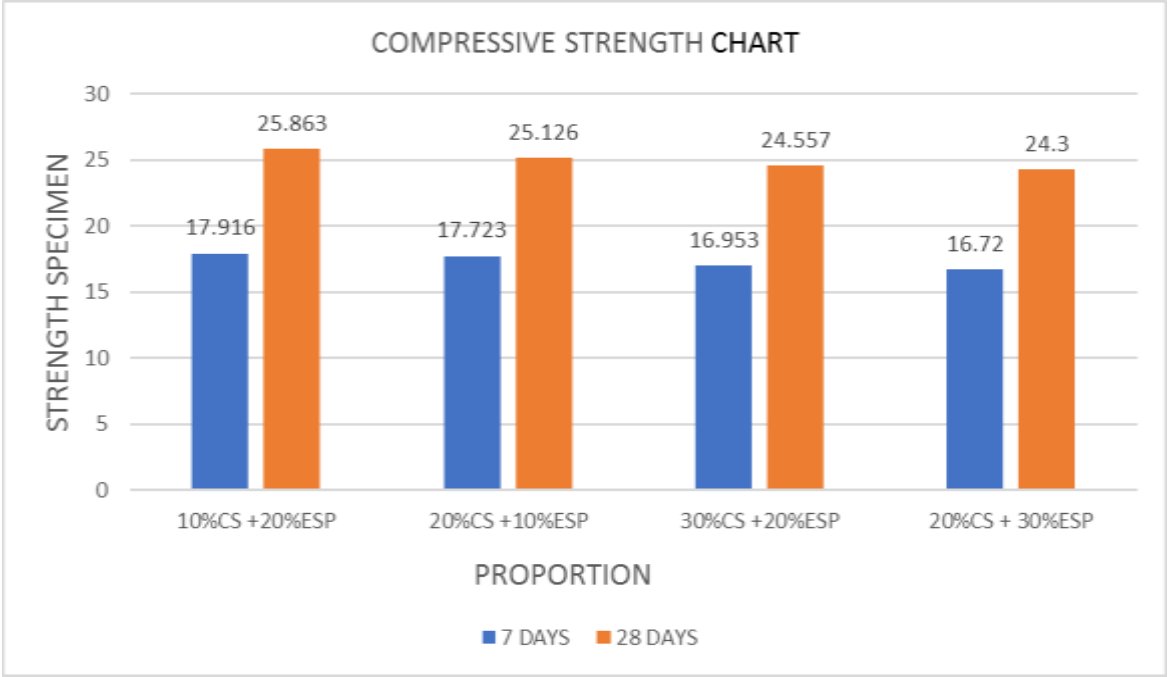

Chart 6: Strength Comparison chart for M25 grade

4. CONCLUSIONS

- An first phase of dissertations, the compressive strength of M20 grade and M25 grade of concrete with using various proportion of Egg shell powder and Copper slag sand like (10% CS), (10% ESP) and (10% CS + 10% ESP).and found that for M20 grade of concrete with increase of percentage of waste material increase of compressive strength for (10% ESP) and (10% CS + 10% ESP) is 21.686 Mpa and 21.960 Mpa respectively but for (10% CS) it will decrease by 21.543 Mpa with respect to the Normal concrete compressive strength 21.663 Mpa.
- For M25 grade compressive strength for proportion (10% ESP) is increases by 25.353 Mpa. For (10% CS) and (10% CS + 10% ESP) is decreases by 23.333 Mpa and 24.534 Mpa respectively. With respect to normal concrete compressive strength 25.232 Mpa.

- For flexural strength of M20 grade of concrete with using various proportion of CS and ESP, linearly increase of strength for (10% ESP), (10% CS) and (10% CS + 10% ESP) by 3.067Mpa, 3.103 Mpa and 3.139 Mpa respectively. With respect to normal grade of flexural strength 3.037 Mpa.
- For flexural strength of M25 grade of concrete with using various proportion of CS and ESP, linearly decreases of strength for (10% ESP), (10% CS) and (10% CS + 10% ESP) by 3.531Mpa, 3.502 Mpa and 3.512 Mpa respectively. With respect to normal grade of flexural strength 3.559 Mpa.
- So, for M20 grade compressive strength by using various above proportion we get maximum spit tensile strength for (10%CS+ 10%ESP) is 3.243 Mpa. With respect to the normal grade strength 3.100 Mpa.
- So, for M25 grade compressive strength by using various above proportion we get maximum spit tensile strength for (10%CS) is 3.561 Mpa. With respect to the normal grade strength 3.480 Mpa.
- A second phase of dissertations, the compressive strength of M20 grade and M25 grade of concrete with using various proportion of Egg shell powder like increase of 10%,20%, 30%, 40% and 50%. Because we observed in first phase that with increase of percentage of egg shell powder strength will increase.
- So that for M20 grade increase of percentage of Egg shell powder strength will increase continuously up to 40% replacement is 22.230 Mpa with respect to normal concrete strength 21.663 Mpa.
- For M25 grade of concrete with using various proportion of ESP and got maximum strength at 20% replacement is 25.461 Mpa with respect to the normal grade concrete 25.232Mpa.
- The compressive strength of M20 grade and M25 grade of concrete with using various proportion of Egg shell powder and Copper slag sand like (10%CS +20%ESP), (20%CS +10%ESP), (30%CS +20%ESP), (20%CS + 30%ESP).
- So, for M20 grade compressive strength by using various above proportion we get maximum compressive strength for (30%CS +20%ESP) is 23.023 Mpa. With respect to the normal grade strength 21.663 Mpa.
- So, for M25 grade compressive strength by using various above proportion we get maximum compressive strength for (10%CS +20%ESP) is 25.836 Mpa. With respect to the normal grade strength 25.232 Mpa.
- For M20 grade of concrete flexural strength and spilt tensile strength with proportion (10%CS +20%ESP) is 3.246 Mpa and 3.243 Mpa respectively with respect to the normal grade strength 3.037 Mpa and 3.100 Mpa respectively.

5. REFERENCES

- IS: 10262 – 2009 Concrete Mix Proportioning
- IS: 383 -1970 Coarse and Fine Aggregates
- IS: 4031 (Part 1) –1996 Method of Physical Tests for Cement
- IS: 2386 (Part 1&3) –963 Method of Test for Aggregates for Concrete
- IS: 1199 – 1959 Method of Sampling and Analysis of Concrete
- IS: 516 – 1959 Method of Texts for Strength of Concrete
- IS: 5816 – 1999 Splitting Tensile Strength of Concrete
- Abhinav shyam, Abdullah anwar, syed aqeel ahmad "experimental study on the behaviour of copper slag as partial replacement of fine aggregate in concrete" volume 5 issue iv, april 2017 ic value: 45.98 issn: 2321-9653 (ijraset)
- Bandhavya g.b, sandeep k, bindhushree g.b "an experimental study on partial replacement of cement with egg shell powder in concrete" volume: 04 issue: 06 | june -2017 p-issn: 2395-0072 (irjet)
- Pudi vasudeva acharyulu1 and tangellamudi sri vijaya durga " effect of copper slag and egg shells powder by partial replacement of fine aggregate and cement on strength properties of the m30 and m40 concrete. Volume 05 issue 16 june 2018 (ijr)
- D.gowsika1, s.sarankokila2, k.sargunan experimental investigation of egg shell powder as partial replacement with cement in concrete international journal of engineering trends and technology (ijett) – volume 14 number 2 – aug 2014
- Pankaj1 & parveen singh2 experimental investigation on concrete using copper slag as partial replacement of fine aggregate vol-3, issue-2, 2017 issn: 2454-1362 (ijir)