EXPERIMENTAL INVESTIGATION ON THE PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF FINE AGGREGATES THROUGH COPPER SLAG AND COARSE AGGREGATES BY RECYCLED AGGREGATES

Jaspal Singh[1], Harsimranjit Singh[2]
M.tech (Structural Engineering) [1], Assistant Professor[2]
School of Civil Engineering,
Lovely Professional University Phagwara, Punjab, India

Abstract: Thispaper is basically displays to decrease the effect about mechanical waste by partial substitution of fine aggregates with Copper slag and coarse aggregates by recycled aggregates.Copper slag is a those type of waste material produces within smelting process, throughout the manufacturing procedure of copper.The typical managing choices for copper slag are recovering, recycling the metal, producing other elements like asphalt pavements, railroad ballast, road-base construction, tiles, glass, abrasive tools, cutting tools, and roofing granules.For this project work,the level of Copper slag was shifted by 10 %, 20 %, 30 % with fine aggregates and Recycled aggregates replaced by 10 %, 20 % and 30 % with coarse aggregates.M25 grade of concrete with 0.45 w/c ratio is adopted for partial replacement of fine aggregates through copper slag and coarse aggregates with recycled aggregates. Various tests like compressive strength and split tensile strength were conducted after 7 and 28 days by using cubes and cylinders. As compared to normal concrete the compressive strength and split tensile strength had higher strength with 30% replacement of copper slag with 10% recycled coarse aggregates.

Keywords: Copper Slag, Recycled Aggregates, Compressive strength, Split tensile strength.

1.0 INTRODUCTION

Concrete is that type of composite material which has been used to build the different sorts of structures like bridges, dams, roads, pools etc. Aggregates are considered as the main source of concrete which occupy about 60% to 75% of the total volume of concrete mix. Fine aggregate are generally river sand which is generally being dug from the river bed.[3] But the natural resources are depleting day by day due to generating industrial wastes from the various industries. The disposal of industrial wastes in land produces many environment related problems. Hence to overcome with these types of problems the partial substitution for fine aggregates through copper slag and a coarse aggregate through rca not only decrease those effects but also improves the characteristic assets of concrete.[1]Copper slag is one of the mechanical

side-effect caused during the assembling of copper. In each ton of copper creation, a huge amounts of copper slag is produced. It was calculated that around 24.6 million tons of slag are produced in the world copper industry. Despite the fact that copper slag is generally utilized in the sand impacting industry along with the assembling of grating apparatuses, the rest of discarded with no further reuse or recovery.[5]

Today copper slag is produced in the amount of approximately thirty three million tones yearly around the world in which India provides around six to 6.5 zillion tones. Half of the copper slag is often utilized as instead of natural sand of to get concrete and mortar with essential functionality, longevity, durability, and strength. In India research was examined by the Central Road Research Institute (CRRI) proven that copper slag might be utilized in a form of partial substitute for river sand as good substance in concrete as much as half of it in pavement concrete with no damage of flexural and compressive strength and this kind of concretes displayed approximately twenty % higher power compared to that of typical cement concrete of the very same quality. [4]

1.1 RESEARCH OBJECTIVES

1. To calculate the Optimum content of copper slag in concrete.
2. To find out the values of strength properties like Split tensile strength and Compressive strength of the concrete having recycled aggregates and Copper slag
3. To find out some fresh characteristics of the concrete.

1.2 SCOPE OF THE STUDY

According to the accessibility of tools in the lab, the experimental procedure was carried out on cylinders and cubes by mixing some recycled aggregates as a coarse aggregates and copper slag in the form of fine aggregate into the concrete so as to increase the split tensile strength and compression strength test.

2.0 MATERIAL USED& ITS PROPERTIES

The materials used for this research work are:

- Ordinary Portland Cement (53 grade)
- Fine aggregates
- Coarse aggregates
- Copper Slag
- Recycled Coarse aggregates
- Water

2.1Ordinary Portland cement: Cement is a folio, a material used in construction which solidifies, sets, and holds fast another varying material to bond with them altogether. Bond is only here and there utilized individually, but is used to bond rock and sand with each other. Cement mixes with fine aggregates

produces brick workmortar, or with rock and sand, produces concrete.OPC 53 grade of cement of are used for this project work.

Table 2.1: Physical Properties of Ordinary Portland cement

Tests Carried Out	Results	Standard Value for OPC
Consistency (%)	28	-
Specific gravity	3.15	-
Intial Setting Time(min)	93	>30
Final setting Time (min)	210	<600

2.2 Fine Aggregates: By meeting the requirement of zone IV as per IS: 83-1970, local sand is used. It has sieved through 4.75 mm sieve and the greater particles are removed. Specific fine aggregates gravity of 2.64.

Table 2.2: Properties of fine Aggregates

S. No	Characteristics	Values
1.	Specific gravity	2.64
2.	Moisture Content	0.19 %
3.	Total water absorption	1.23 %
4.	Net water absorption	0.84 %
5.	Fineness modulus	2.567

2.3 Coarse Aggregates: Crushed aggregates of 10mm and 20mm size having specific gravity 2.76 & 2.89 respectively were used for this work.

Table 2.3: Properties of Coarse Aggregates

Sr.No	Particulars	Properties

1.	Specific gravity(10 mm)	2.765
2.	Specific gravity (20 mm)	2.894
3.	Moisture content(10 mm)	0.874 %
4.	Moisture content (20 mm)	0.7235 %
5.	Fineness Modulus (10 mm)	6.38
6.	Fineness Modulus (20 mm)	7.54

2.4 Copper Slag: Copper slag is a those type of waste material produces within smelting process, throughout the manufacturing procedure of copper. In this work, copper slag may be utilized for fractional supplanting about fine aggregate over cement grid. Copper slag utilized within this study is purchased from M/S Suvendu Sekhar Sahoo commercial enterprises (India) Ltd. Jagatsinghpur, Odisha, India.

Table 2.4: Physical Properties of Copper Slag

Sr. No	Properties	Parameters
1.	Specific Gravity	3.83 gm/cm^3
2.	Electric Conductivity	4.8 moh
3.	Size	0.2 mm upto 3.0 mm
4.	Chloride Content	< 0.0002 %

2.5 Recycled Coarse Aggregates: Recycled coarse aggregate would the individual's sorts from claiming aggregates which are prepared by pulverizing obliteration cement alternately stones. Development and destroying structures are the fundamental wellspring about reused aggregates.

2.6 Water: Water is required for the hydration of concrete and to give usefulness amid blending and to setting. Consumable faucet water was utilized for the solid planning and for restoring of examples. The ph estimation of water is 7.0.

3.0 MIX PROPORTION

The M 25 concrete grade is utilized in this study for mix proportioning. It's composed according to IS 10262-1982 principles. The blend ratio received was cement: sand: coarse aggregate: water/concrete quantitative connection severally. Blend extent utilized in this examination was 1:1.72:2.83 with water-cement content of 0.45. The trial examination comprised by fluctuating level of copper slag as incompletely supplanted with customary sand. The level of Copper slag was shifted by 10 %, 20 %, 30 % and Recycled

aggregates replaced by 10 %, 20 % and 30 % with coarse aggregates. The solid cubes of 150 X 150 X 150 mm blocks and 500 X 100 mm Cylinders were tried to measures the compressive and split tensile strength.

Table 3.1: Mix Proportion of Concrete cubes

Table 3.6: Mix Proportion of Concrete cubes

Designation	Mix	Water (kg/m^3)	Cement (kg/m^3)	Fine Agg. (Sand) (kg/m^3)	Copper slag	Coarse Agg (kg/m^3)	Recycled Aggregates
M-0	**Normal**	197	437.78	654	--	1133	--
M-1	**10 % CS**	197	437.78	588.6	65.4	1133	--
M-2	**20 % CS**	197	437.78	523.2	130.8	1133	--
M-3	**30 % CS**	197	437.78	457.8	196.2	1133	--
M-4	**10 % RCA**	197	437.78	654	--	1019.7	113.3
M-5	**20 % RCA**	197	437.78	654	--	906.4	226.6
M-6	**30 % RCA**	197	437.78	654	--	793.1	339.9
M-7	**10 % CS 10 % RCA**	197	437.78	588.6	65.4	1019.7	113.3
M-8	**10 % CS 20 % RCA**	197	437.78	588.6	65.4	906.4	226.6
M-9	**10 % CS 30 % RCA**	197	437.78	588.6	65.4	793.1	339.9
M-10	**20 % CS 10 % RCA**	197	437.78	523.2	130.8	1019.7	113.3

M-11	**20 % CS 20 % RCA**	197	437.78	523.2	130.8	906.4	226.6
M-12	**20 % CS 30 % RCA**	197	437.78	523.2	130.8	793.1	339.9
M-13	**30 % CS 10 % RCA**	197	437.78	457.8	196.2	1019.7	113.3
M-14	**30 % CS 20 % RCA**	197	437.78	457.8	196.2	906.4	226.6
M-15	**30 % CS 30 % RCA**	197	437.78	457.8	196.2	793.1	339.9

4.0 EXPERIMENTAL STUDY

4.1COMPRESSIVE STRENGTH TEST

Strength of concrete is affected by several factors viz. type of cement, quality and proportion of copper slag, recycled aggregates and curing temperature. The results of compressive strength are presented in Table 4.1. The test was carried out conforming to IS 516-1959 to obtain compressive strength of concrete at the age of 7 and 28 days.

Table 4.1: Compressive strength of Concrete cubes

Designation	**Mix**	**Compressive strength**	
		7 Days	**28 Days**
M-0	**Control**	17.78	28.2
M-1	**10 % CS**	18.55	30.52
M-2	**20 % CS**	19.85	32.6
M-3	**30 % CS**	22	35.2
M-4	**10 % RCA**	17.40	27.57
M-5	**20 % RCA**	16.75	26.52
M-6	**30 % RCA**	15.68	24.67
M-7	**10 % CS 10 % RCA**	18.18	29.8

M-8	**10 % CS 20 % RCA**	17.48	28.30
M-9	**10 % CS 30 % RCA**	16.57	27.35
M-10	**20 % CS 10 % RCA**	19.18	32.1
M-11	**20 % CS 20 % RCA**	18.56	30.2
M-12	**20 % CS 30 % RCA**	17.51	29.05
M-13	**30 % CS 10 % RCA**	21.3	33.95
M-14	**30 % CS 20 % RCA**	20.42	32.6
M-15	**30 % CS 30 % RCA**	19.12	31.45

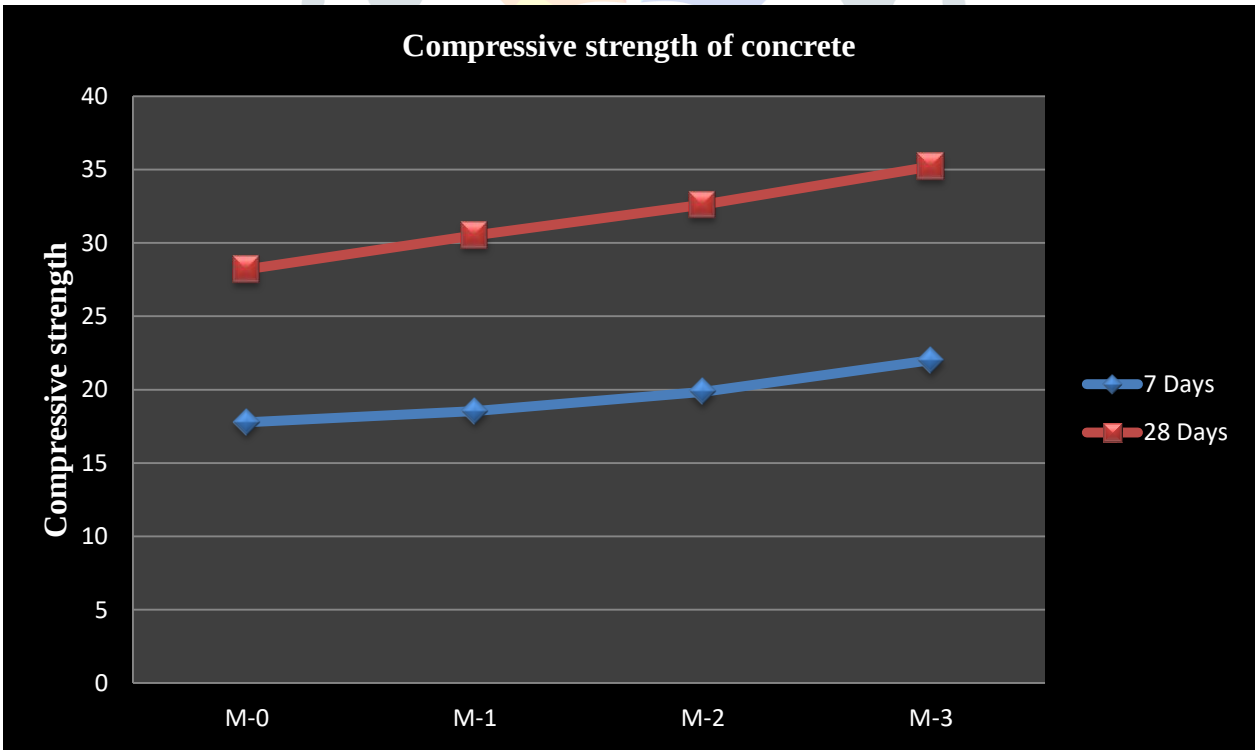

Figure 1.1: Compressive strength of Concrete by using Copper Slag only

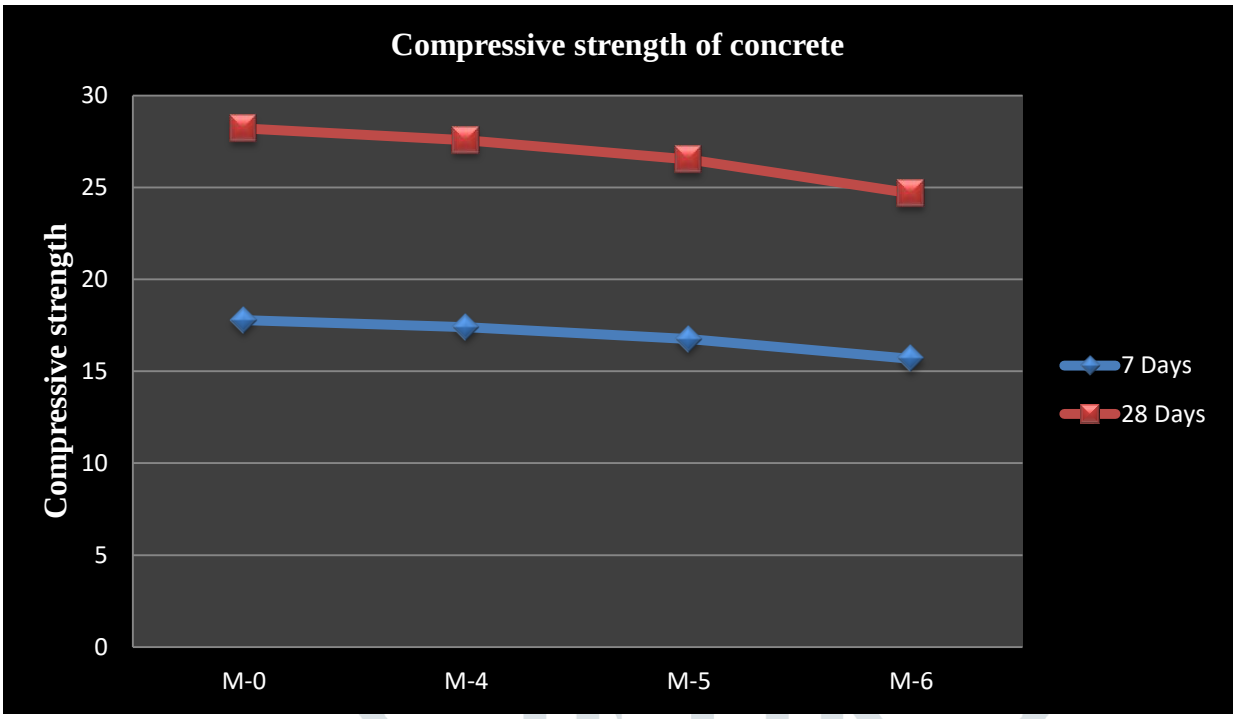

Figure 1.2: Compressive strength of Concrete by using recycled aggregates only

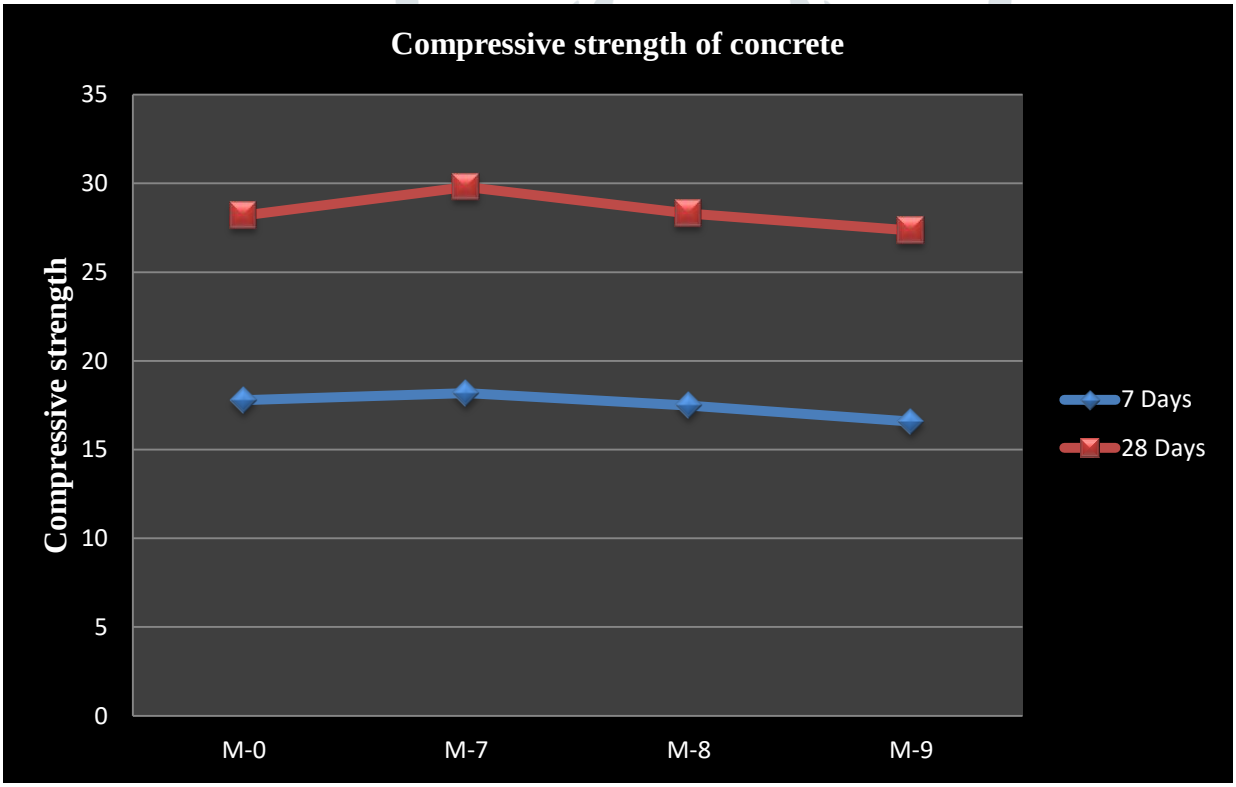

Figure 1.3: Compressive strength of Concrete by using 10 % Copper Slag and 10 to 30 % Recycled aggregates

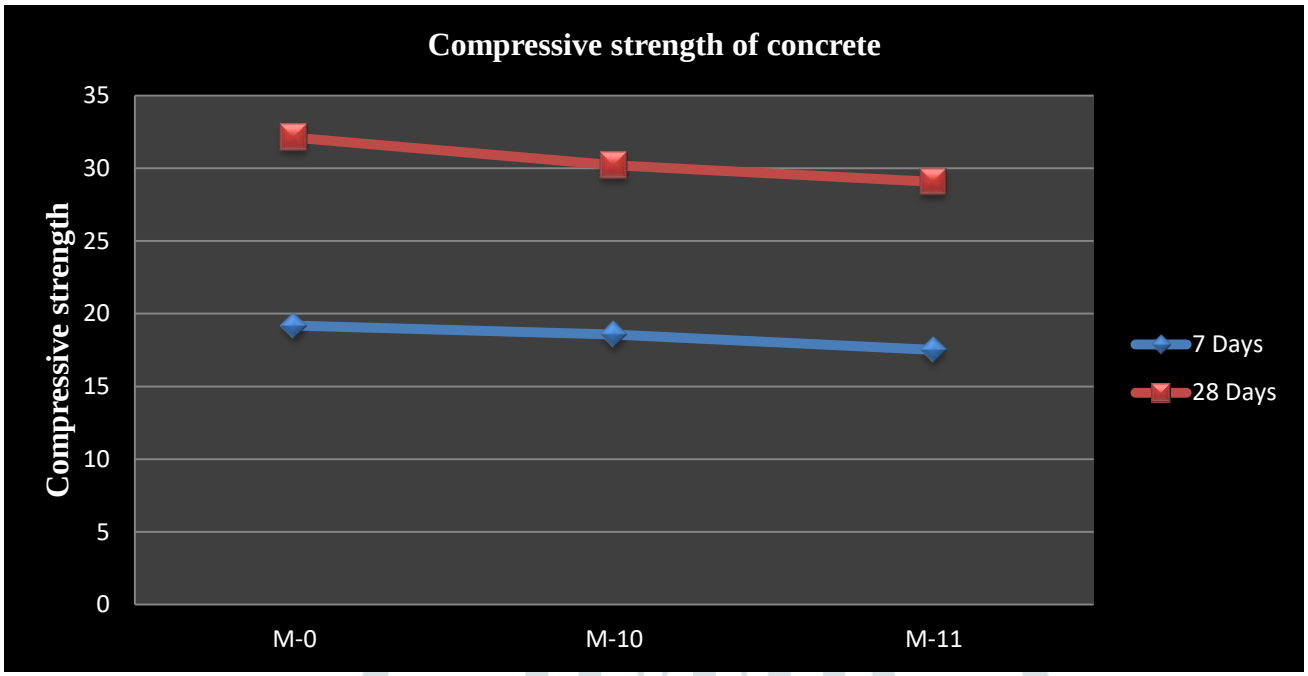

Figure 1.4:Compressive strength of Concrete by using 20 % Copper Slag and 10 to 30 % Recycled aggregates

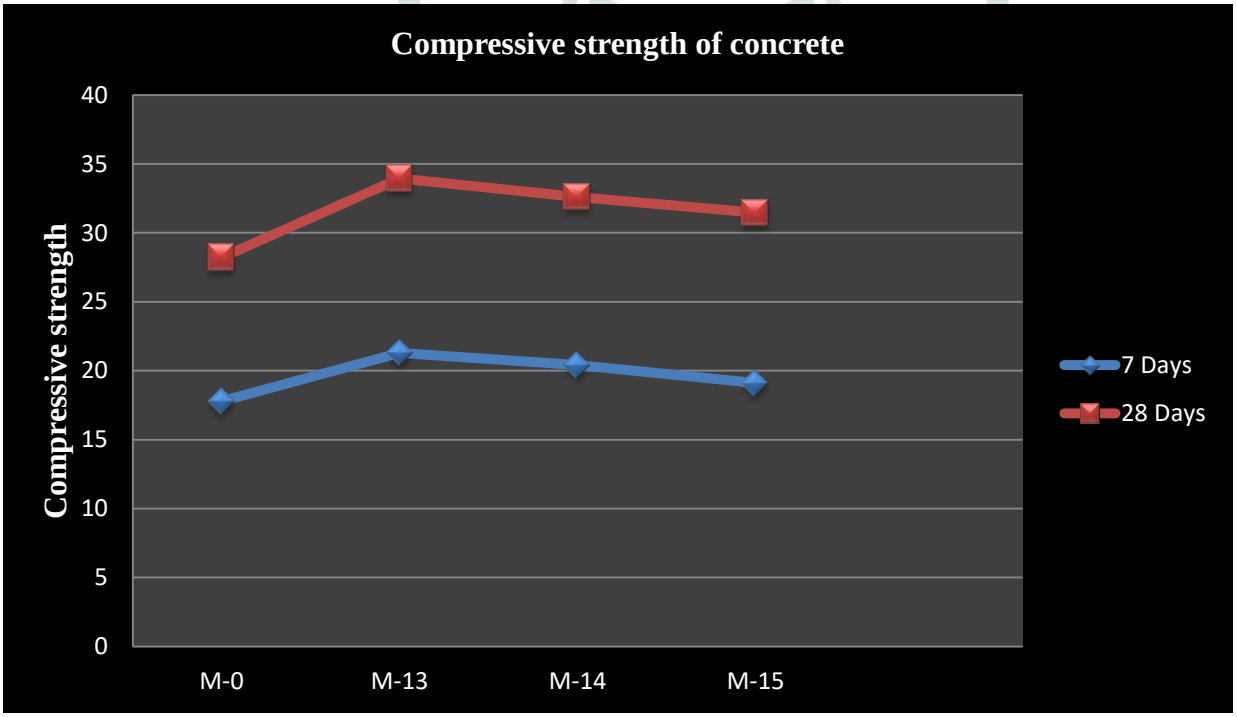

Figure 1.5: Compressive strength of Concrete by using 30 % Copper Slag and 10 to 30 % Recycled aggregates

4.2 SPLIT TENSILE STRENGTH TEST

The test was carried out conforming to IS 516-1959 to obtain Split Tensile Strength of Concrete strength at the age of 7 and 28 days. The cylinders were tested using Compression testing machine (CTM) of capacity 1000 Kn. The results are shown in Table 4.2

Table 4.2: Split tensile strength of Concrete cubes

Designation	Mix	Split tensile strength	
		7 Days	28 Days
M-0	Control	1.564	2.538
M-1	10 % CS	1.635	2.687
M-2	20 % CS	1.782	2.983
M-3	30 % CS	1.859	3.395
M-4	10 % RCA	1.392	2.237
M-5	20 % RCA	1.340	2.135
M-6	30 % RCA	1.254	2.098
M-7	10 % CS 10 % RCA	1.549	2.415
M-8	10 % CS 20 % RCA	1.487	2.343
M-9	10 % CS 30 % RCA	1.356	2.233
M-10	20 % CS 10 % RCA	1.583	2.767
M-11	20 % CS 20 % RCA	1.509	2.652
M-12	20 % CS 30 % RCA	1.407	2.525

M-13	**30 % CS 10 % RCA**	1.848	3.218
M-14	**30 % CS 20 % RCA**	1.781	3.132
M-15	**30 % CS 30 % RCA**	1.675	2.898

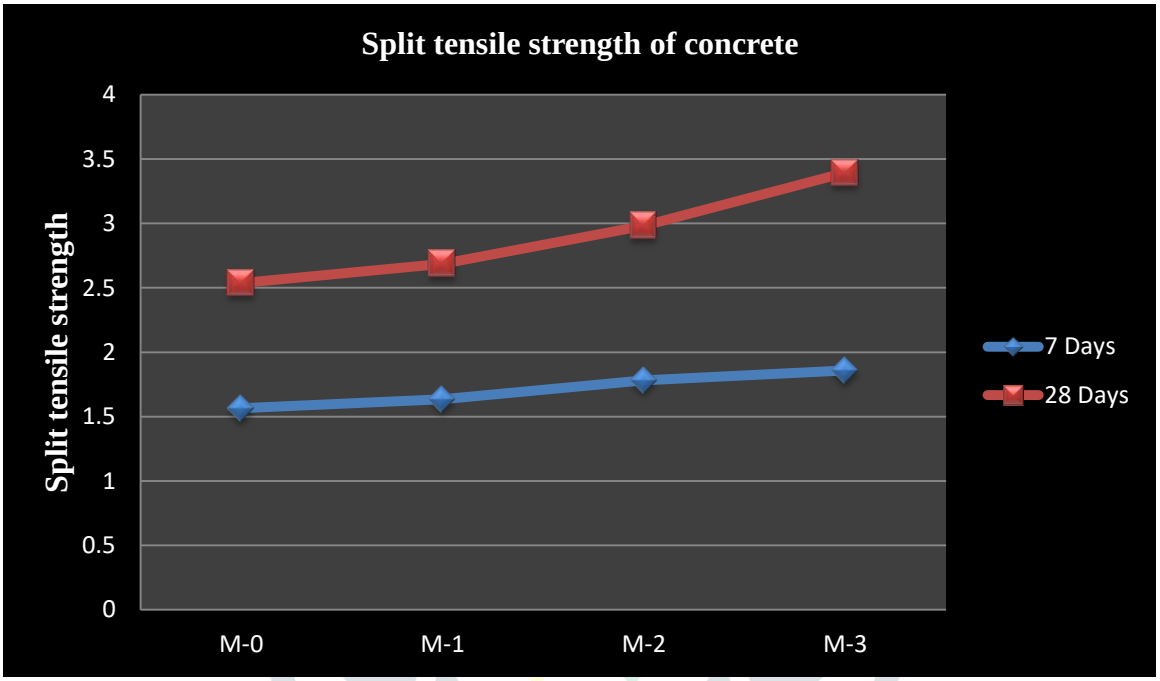

Figure 1.6: Split tensile strength of Concrete by using Copper Slag only

Figure 1.7: Split tensile strength of Concrete by using recycled aggregates only

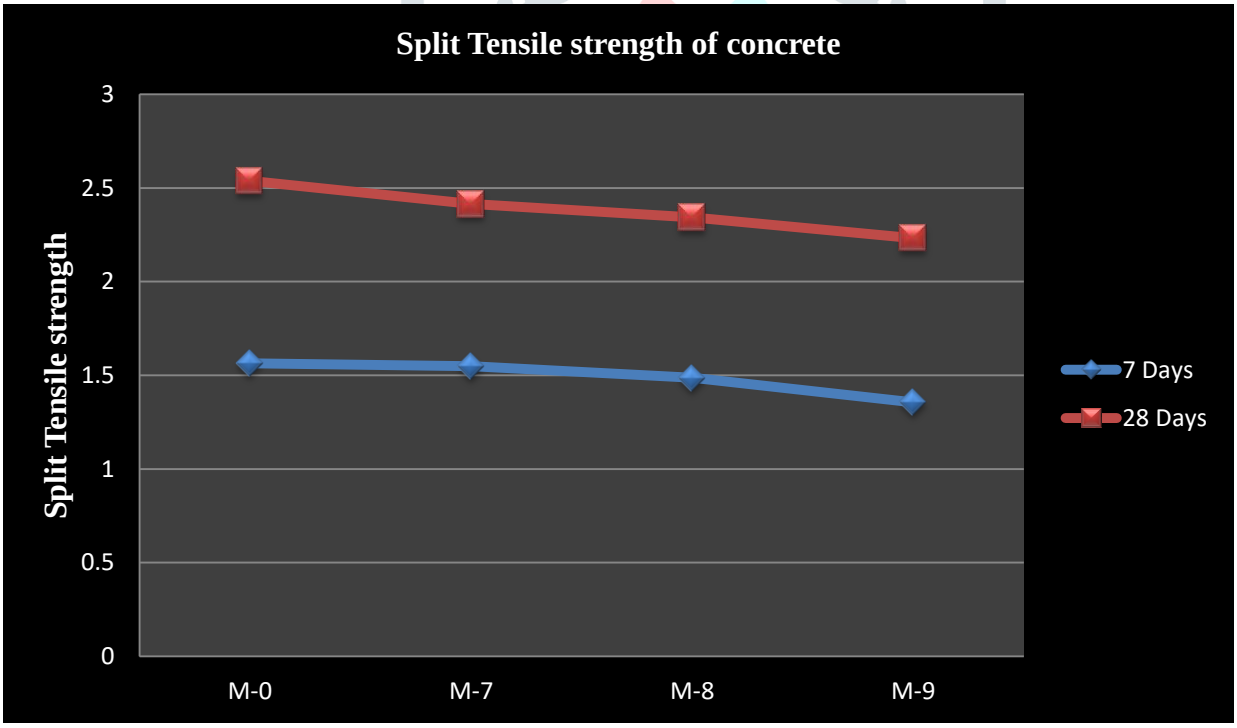

Figure 1.8: Split tensile strength of Concrete by using 10 % Copper Slag and 10 to 30 % Recycled aggregates

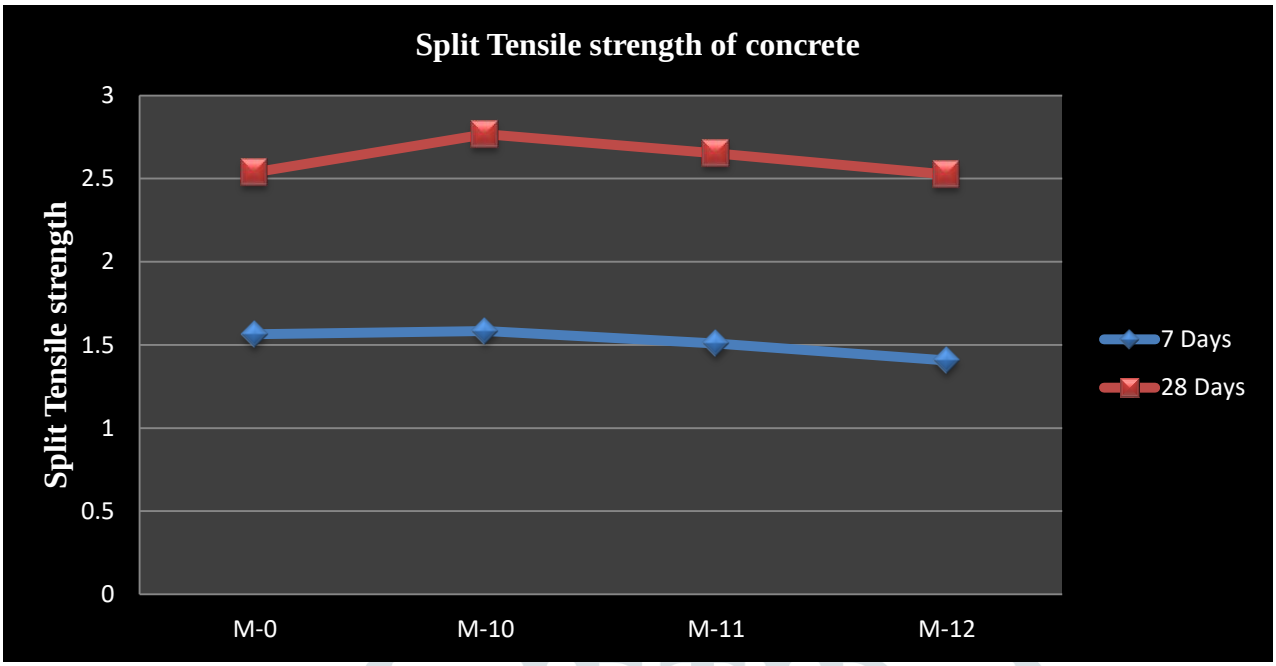

Figure 1.9:Split tensile strength of Concrete by using 20 % Copper Slag and 10 to 30 % Recycled aggregates

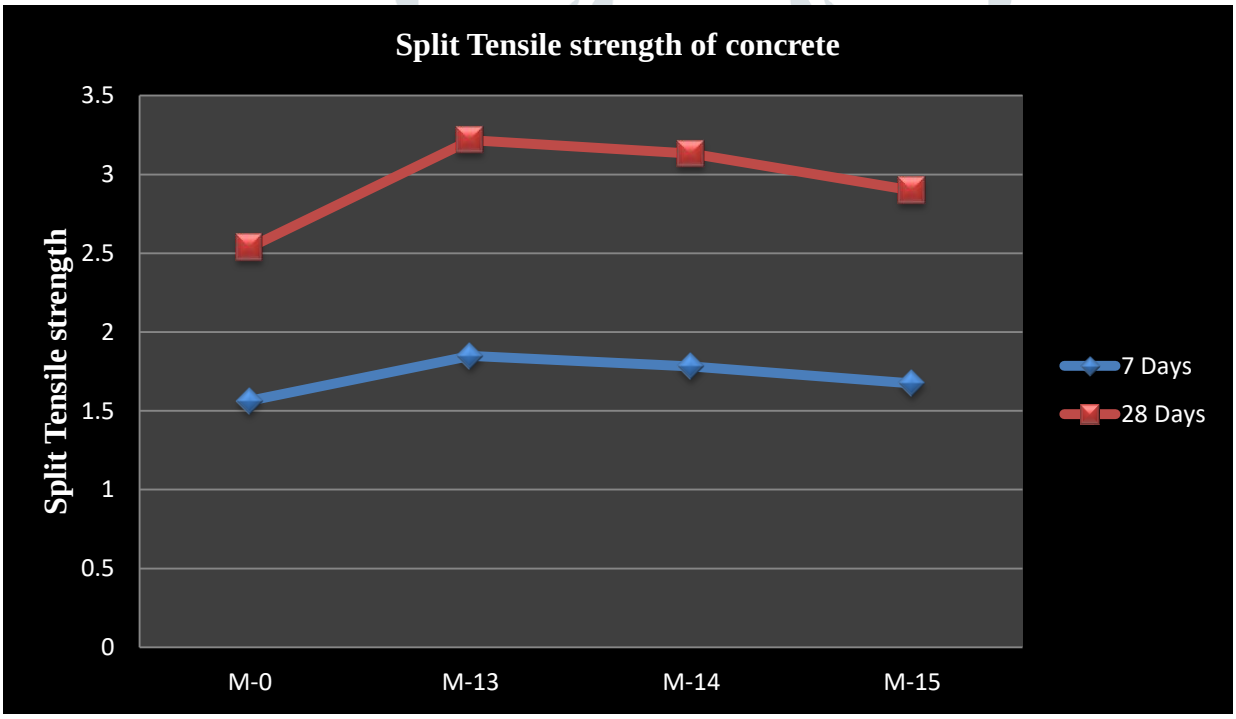

Figure 1.10: Split tensile strength of Concrete by using 30 % Copper Slag and 10 to 30 % Recycled aggregates

Conclusion

Following are the various conclusions drawn after the test performance on cube samples of concrete:

1. Addition of copper slag increases the density and thereby self weight and hence it is suitable for bearing structures like piers, abutments, heavy bridges and also in pavement construction etc,

2. The recycled aggregate can be used in concrete with partial or full replacement of natural coarse aggregate.
3. The compressive strength of concrete increases by the addition of copper slag.
4. The compressive strength of concrete decreases by the addition of recycled coarse aggregates.
5. The optimum percentage of Copper slag is 30 % and 10 % for recycled coarse aggregates.
6. The maximum compressive strength is achieved after the addition of 30 % copper slag and 10 % recycled coarse aggregates for compressive strength.
7. The split tensile strength of concrete increases by the addition of copper slag.
8. The Split tensile strength of concrete decreases by the addition of recycled coarse aggregates.
9. The optimum percentage of Copper slag is 30 % and 10 % for recycled coarse aggregates.

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