AN EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE MADE WITH RECYCLED AGGREGATES AND SUPER ABSORBED POLYMER AS SELF CURING AGENT

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Abstract: Curing is the process of maintaining proper moisture content particularly within 28 days to promote optimum cement hydration immediately after placement. Curing plays a major role in developing the concrete microstructure and pore structure. Due to the scarcity of water proper curing is becoming increasingly difficult now days. The self curing concrete means that no external curing required for concrete. The concept of self curing is to reduce the water evaporation. As defined by ACI, "Self or internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water." Self curing distributes the extra curing water (uniformly) throughout the entire 3-D concrete microstructure so that it is more readily available to maintain saturation of the cement paste during hydration, avoiding self-desiccation (in the paste) and reducing autogenously shrinkage. The grade of concrete selected was M20, M30 and M40. The self curing materials used are Super Absorbent Polymer (SAP) and the application of wax based membrane curing compound on the remoulded concrete specimens. The effect of variation in strength parameters i.e., compressive strength, splitting tensile strength and flexural strength were studied for different dosage of self curing agent (ranging 0 % – 2 % weight of cement) and compared with that of conventionally cured concrete.

Index words - Concrete, Curing, Self-curing, Agent Super Absorbent Polymer.

1.INTRODUCTION

Concrete is a mixture of cement, aggregates and water with or without suitable admixtures. To attain desirable strength and other properties, curing is necessary. Curing is the process of maintaining the proper moisture content to promote optimum cement hydration immediately after placement. Proper moisture conditions are critical because water is necessary for the hydration of cementitious materials. The concept of self curing is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete. Scarcity of potable water increases day by day. The use of self curing agent is very important from the point view that water resources are getting valuable every day. Moreover requirement of water for concreting is also high (i.e.,) 1m3 of concrete requires 3m3 of water for construction, most of which is needed for curing purpose only.
It can be divided into two categories.
i) The "Water-adding" technique.
ii) The "Water-retaining" technique.
The first provides concrete with water or moisture continuously or frequently through water ponding, fogging, sprinkling, steaming or covering with saturated material. The second prevents excessive temperature and water loss from concrete by means of sealing materials, such as plastic sheets, or by application of membrane-forming curing compounds to the freshly placed concrete. Among "Water-adding" technique, ponding or immersion is considered as the most effective method for facilitating cement hydration.

2. LITERATURE REVIEW

- **Sona K. S et.al** (2015) [5] studied Internal curing technique that can be used to provide additional moisture in concrete for effective hydration of cement. The effect of variation in strength parameters i.e., compressive strength, split tensile strength, flexural strength and durability were studied for different dosage of self curing agent and compared with that of conventional cured concrete. The optimum dosage of **SAP** for maximum compressive strength split tensile strength, flexural strength was found to be 0.5% of weight of cement for M25 and M30.AlsodeterminrSelf curing concrete was the best solution to the problems faced in the desert region and faced due to lack of proper curing

- **Dayalan J** had used super absorbent polymers as a self-curing agent in concrete. He was added 0.0-0.48% of super absorbent polymer by weight of cement for M25 grade concrete. He was found that super absorbent polymer 0.48% by the weight of cement provides higher compressive, tensile as well as flexural strength than the strength of conventional mix.
- **Dhir*et. al*.** reported that during the development of internally cured concrete, it was found that one particular self-curing admixture produce a number of effects with respect to particular physical properties and powder X-RAY diffraction characteristics. Two computers models, at low dosages, good strength and improved permeability characteristics were observed. At high dosages it appears that the admixture has a detrimental effect on the concrete's compressive strength due to an alteration of the natural of calcium hydroxide and the C-S-H gel structure was alter beneficially producing a highly impermeable concrete it is Suggested that although a lowering of strength did occur at high dosage, a much lower permeability of given strength could be obtained.
- **Tarun R. Naik *et. al*.** Influence of microstructure on the physical properties of self-curing concrete has been studied. The potential benefits from concrete using lightweight aggregate include: Better thermal properties, Better fire resistance, improved skid-resistance, reduced autogenous shrinkage, reduced chloride ion penetrability, improved freezing and thawing durability, an improved contact zone between aggregate and cement matrix and less micro-cracking as a result of better elastic compatibility.

3 MATERIALS AND PROPERTIES

3.1 Cement

Cement is a binder, a substance used in construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used solely but is used to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. It is a powered adhesive and cohesive substance which when mixed with fine aggregate, coarse aggregate and water form a paste which on curing for certain period turns in to mass of hard stone. Proper selection of cement is utmost important as the strength of concrete mostly depends on it. In this study, Ultratech53 grade Ordinary Portland Cement conforming to IS: 12269–1987 was used for the entire work. The cement was purchased from single source and was used for casting of all specimens. The physical properties of cement are furnished in Table 1

Table 1 Physical Properties of Cement

S.No	Characteristics	VALUE
1	Specific Gravity	3.17
2	Normal Consistency	31%

3.2 FINE AGGREGATE

The natural sand taken for this investigation is the locally available natural river sand. It was collected and cleaned for impurities, so that it is free from clayey matter, salt and organic impurities. Particles passing through IS sieve of 4.75

mm conforming to grading zone-II of IS: 383-1970 was used in this work. Properties such as gradation, specific gravity, fineness modulus, bulk density had been assessed. The physical properties of sand are furnished in

Table 2.Physical Properties of Fine Aggregates

S.No	Physical Properties	Fine Aggregate
1	Size and Zone	4.75 mm down
2	Specific gravity	2.55
3	Water Absorption	1.4%
4	Moisture Adsorption	2%
5	Fineness modulus	3.95

3.3 RECYCLED AGGREGATE

Locally available machine Crushed angular granite, retained on 4.75mm I.S. sieve of maximum size of 20mm confirming to I.S: 383-1970 was used in the present experimental investigation. It is free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate is tested for its various properties such as specific gravity, fineness modulus, elongation test, flakiness test, sieve analysis, bulk density in accordance with in IS 2386 – 1963. The physical properties of Coarse Aggregate are furnished in Table 3.

Table 3 Physical properties of Coarse Aggregate

S.No.	Physical Properties	RCA
1	Water absorption (%)	7.63
2	Specific gravity	2.60
3	Bulk Density (kg/ m^3)	1469.8

3.4 WATER

Water used for mixing and curing shall be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth (or) other substance that may be deleterious to bricks, stone, concrete, or steel. Potable water is generally considered satisfactory for mixing.

Water acts as a lubricant for the fine and coarse aggregates and acts chemically with cement to form the binding paste for the aggregate and reinforcement. Less water in the cement paste will yield a stronger, more durable concrete; adding too much water will reduce the strength of concrete and can cause bleeding. Impure water in concrete, effects the setting time and causing premature failure of the structure.

3.5 SUPER ABSORBENT POLYMER (SAP)

The common SAPs are added at rate of 0–0.6 wt % of cement. The SAPs are covalently cross-linked. They are Acryl amide/acrylic acid copolymers. One type of SAPs are suspension polymerized, spherical particles with an average particle size of approximately 200 mm; another type of SAP is solution polymerized and then crushed and sieved to particle sizes in the range of 125–250 mm. The size of the swollen SAP particles in the cement pastes and mortars is about three times larger due to pore fluid absorption. The swelling time depends especially on the particle size distribution of the SAP. It is seen that more than 50% swelling occurs within the first 5 min after water addition.

3.6 MIX PROPORTIONS

Various mix proportions of M 20 M30 and M 40 are shown in below tables.

Table: 4 Mix Proportion of M20 with SAP

Mix	CC	1	2	3	4
SAP % of	0%	0.5%	1.0 %	1.5%	2.0%

cement					
SAP (Kg/m^3)	0	1.9	3.8	5.7	7.6
Cement (Kg/m^3)	383	383	383	383	383
Fine aggregate (Kg/m^3)	585.65	585.65	585.65	585.65	585.65
Coarse aggregate (Kg/m^3)	1168.5	1168.5	1168.5	1168.5	1168.5
Water (Kg/m^3)	191.59	191.59	191.59	191.59	191.59

Table: 5 mix Proportion of M30 with Sap

Mix	CC	1	2	3	4
SAP % of cement	0%	0.5%	1.0 %	1.5%	2.0%
SAP (Kg/m^3)	0	0.197	3.94	5.91	7.88
Cement (Kg/m^3)	438	438	438	438	438
Fine aggregate(Kg/m^3)	610.47	610.47	610.47	610.47	610.47
Coarse aggregate(Kg/m^3)	1127.84	1127.84	1127.84	1127.84	1127.84
Water (Kg/m^3)	197.16	197.16	197.16	197.16	197.16

Table: 6. Mix Proportion of M40 with SAP

Mix	CC	1	2	3	4
SAP % of cement	0%	0.5%	1.0 %	1.5%	2.0%
SAP (Kg/m^3)	0	2.1	4.2	6.3	8.4
Cement (Kg/m^3)	421	421	421	421	421
Fine aggregate (Kg/m^3)	804.4	804.4	804.4	804.4	804.4
Coarse aggregate (Kg/m^3)	1064	1064	106	1064	1064

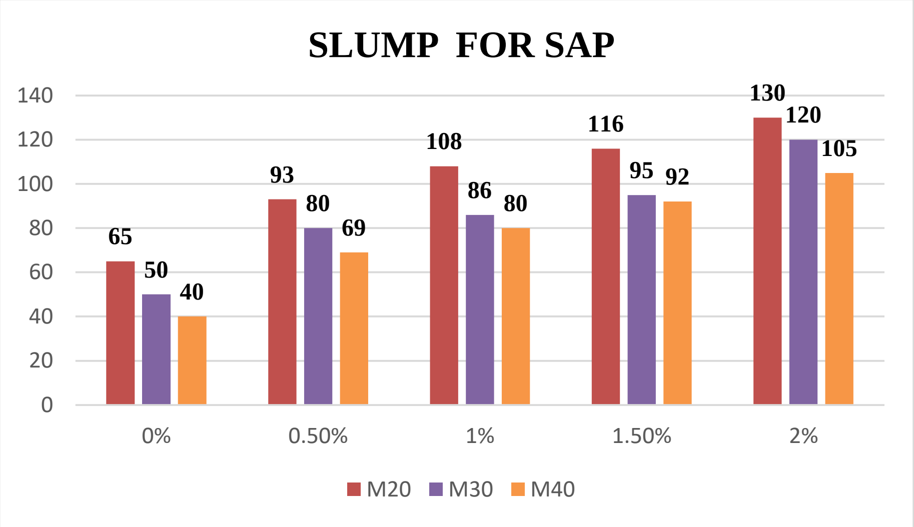
Water (Kg/m^3)	151.81	151.84	151.84	151.84	151.84

4 RESULTS AND DISCUSSIONS

4.1Slump Test

Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199 – 1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod

Graph: 4.1. Slump cone test results SAP

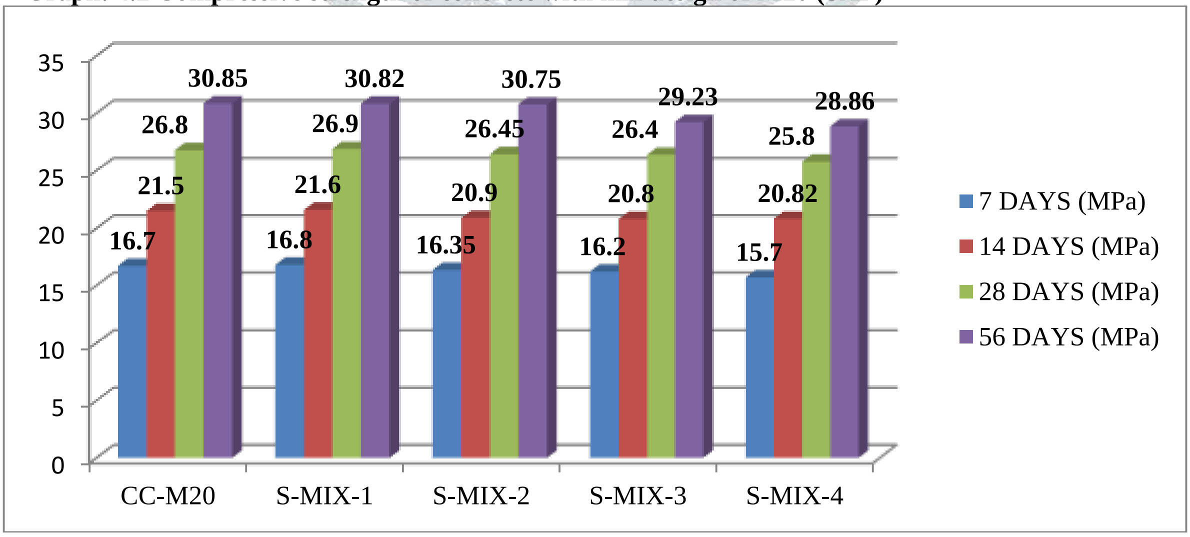


4.2 COMPRESSIVE STRENGTH

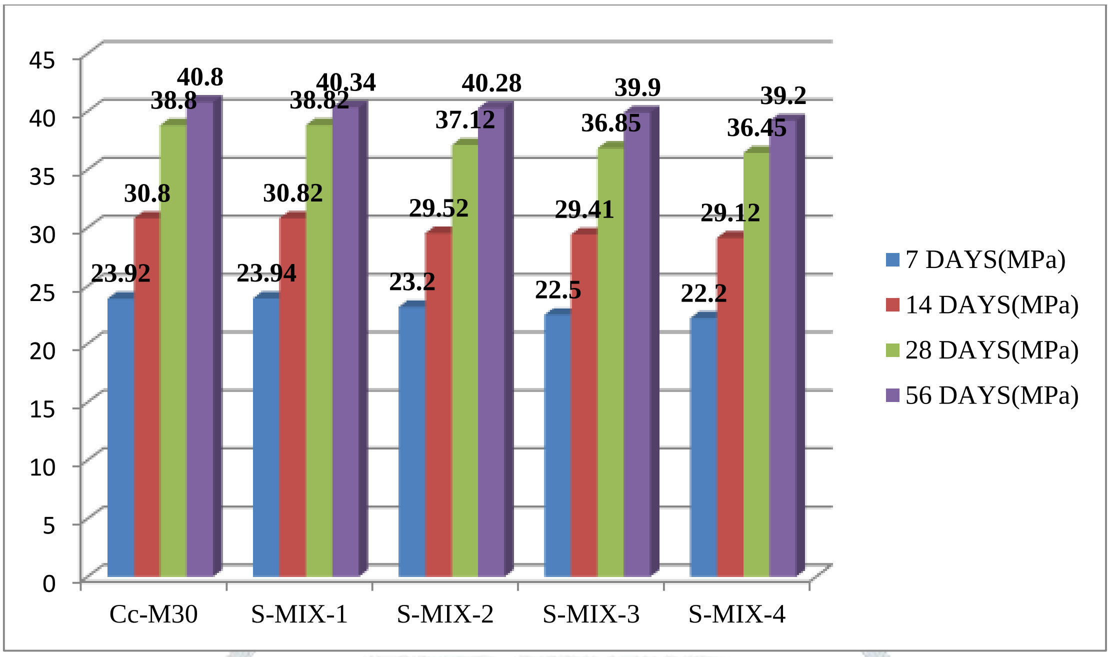
The test is carried out on 150 x 150 x 150 mm size cubes, as per IS: 516-1959. The test specimens are marked and removed from the moulds and unless required for test within 24 hrs, immediately submerged in clean fresh water and kept there until taken out just prior to test. A 2000 kN capacity Compression Testing Machine (CTM) is used to conduct the test. The specimen is placed between the steel plates of the CTM and load is applied at the rate of 140 kg/cm^2/min and the failure load in kN is observed from the load indicator of the CTM.

Compressive strength = Load / Area (MPa)

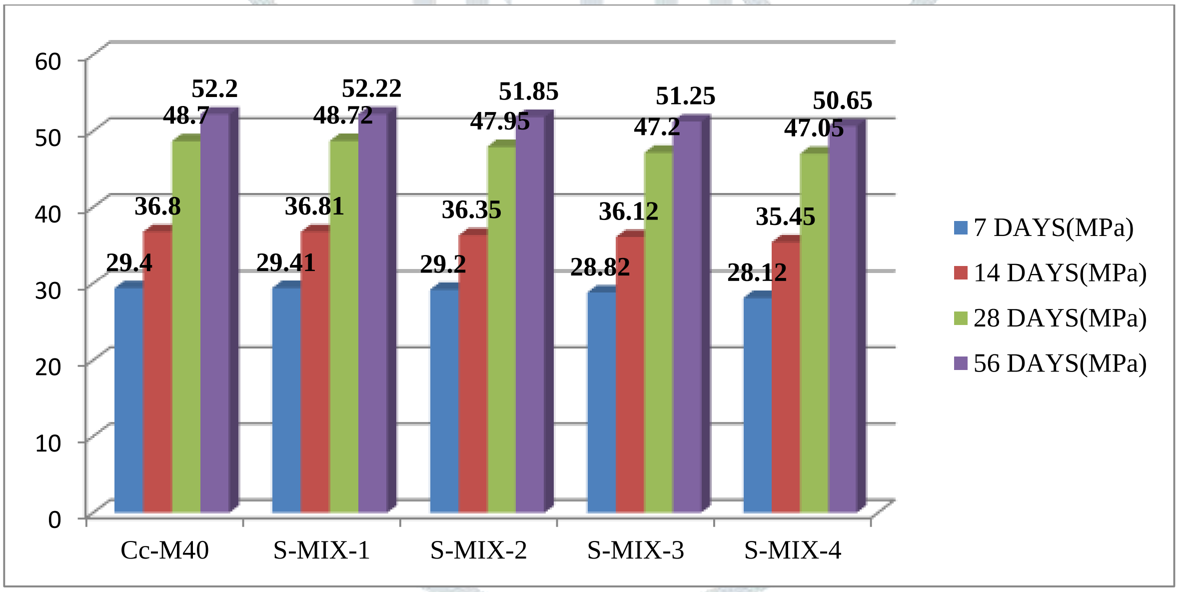
Graph: 4.2 Compressive strength of concrete with mix design of M20 (SAP)



Graph: 4.3 Compressive strength of concrete with mix design of M30 (SAP)



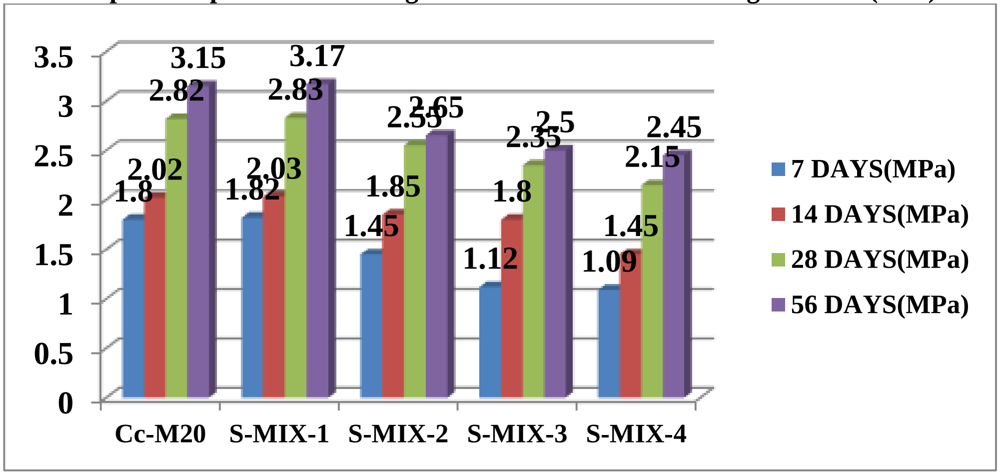
Graph: 4.4 Compressive Strength of Concrete with Mix Design of M40 (SAP)



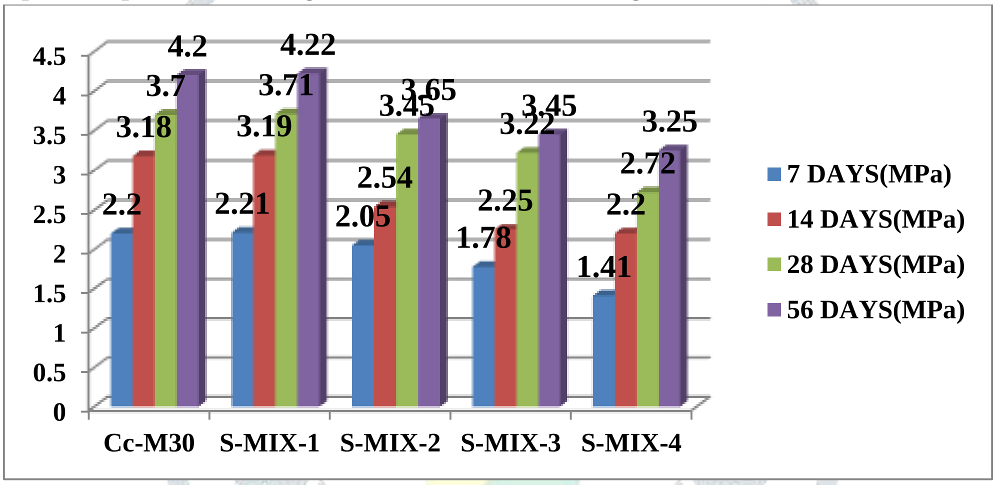
4.3 SPLITTING TENSILE STRENGTH TEST

The Splitting tensile strength of concrete cylinder was determined based on 5816-1970. The load shall be applied nominal rate within the range 1.2 N/(mm^2/min) to 2.4 N/(mm^2/min). The test was carried out on diameter of 150 mm and length of 300mm size cylinder

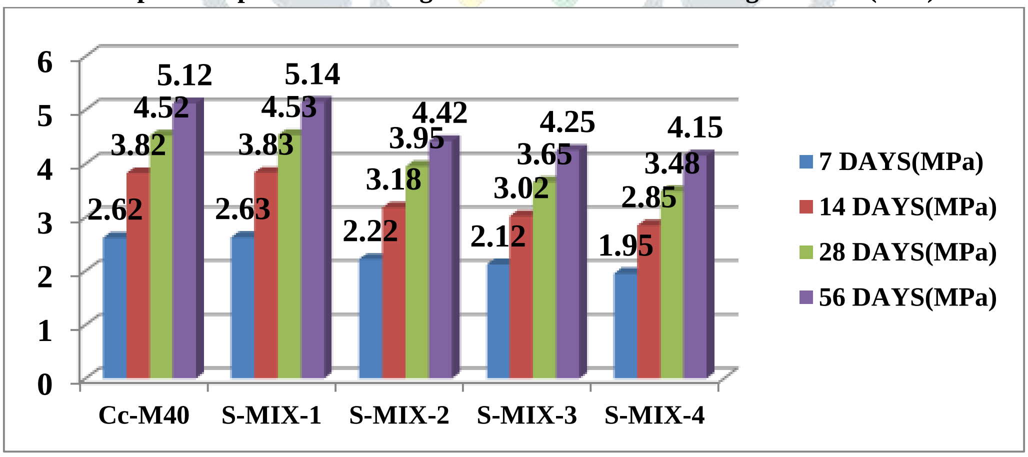
Graph: 4.5 Split Tensile Strength of Concrete with Mix Design of M20 (SAP)



Graph: 4.6 Split tensile strength of concrete with mix design of M30 (SAP)



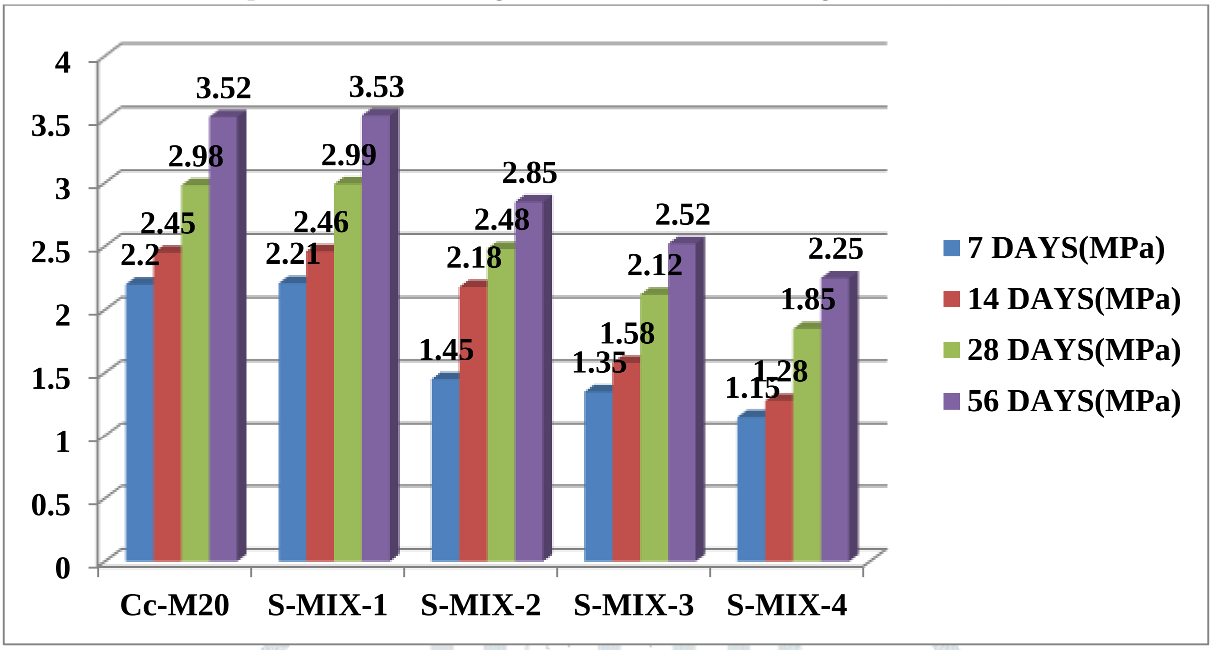
Graph: 4.7 Split tensile strength of concrete with mix design of M40 (SAP)



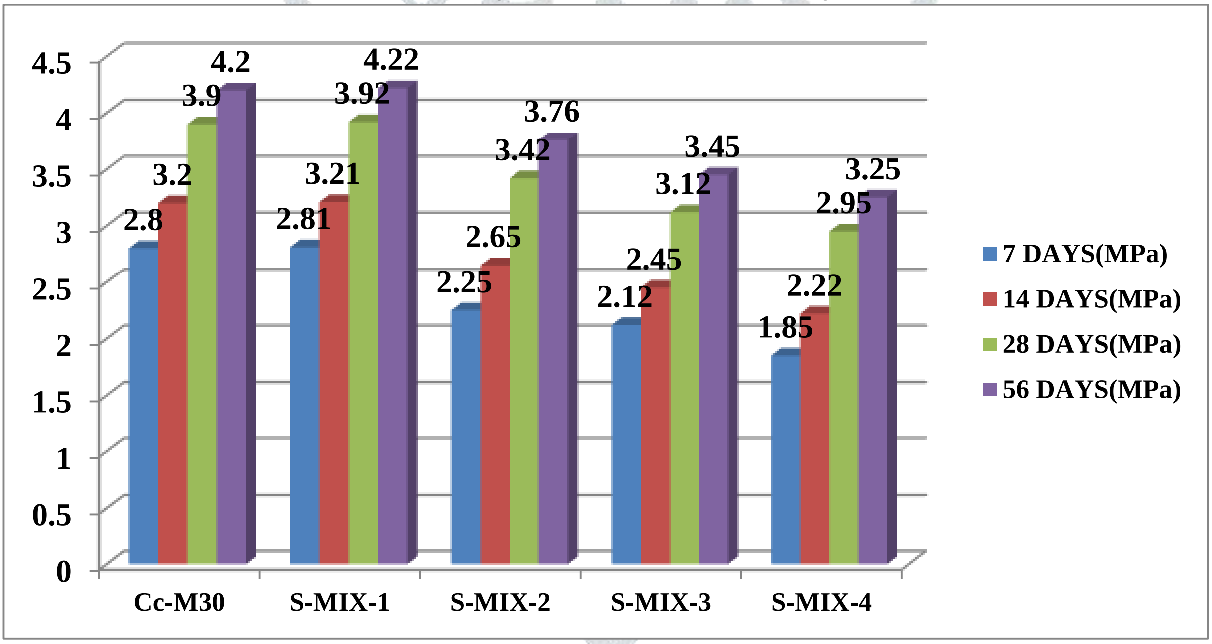
4.4 FLEXURAL STRENGTH TEST

The Flexural strength of concrete prism was determined based on IS: 516 – 1959. Place the specimen in the machine in such a manner that the load is applied to the upper most surface as cast in the mould along two lines spaced 13.3 cm a part. Apply load without shock and increase continuously at a rate of 180 kg/min and it is increased until the sample fails. Measure the distance between the line of fracture and nearest support.

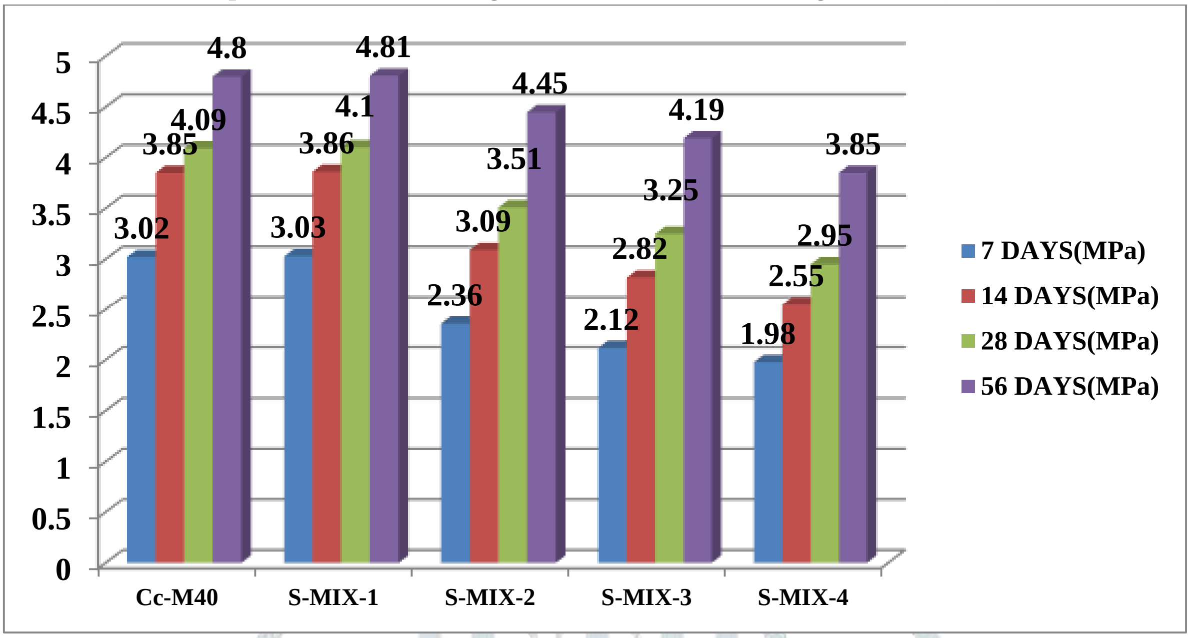
Graph: 4.8 Flexural strength of concrete with mix design of M20 (SAP)



Graph: 4.9 Flexural strength of concrete with mix design of M30 (SAP)



Graph: 4.10 Flexural strength of concrete with mix design of M40 (SAP)



5. CONCLUSIONS

Super Absorbent Polymer was used as self-curing agent.M20,M30 and M40 grades. Based on the experimental investigation carried out, the following conclusions were drawn:

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1. Compressive strength of self-cured concrete for dosage of 0.5% was higher than water cured concrete.

2Split tensile strength of self-cured concrete for dosage of 0.5% was higher than water cured concrete.

3. Flexural Strength of self-cured concrete for dosage of 0.5% was lower than water cured concrete

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