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EXPERIMENTAL STUDY ON COLUMN MOULD STRENGTH WITH SELF COMPACTING AND SELF CURING CONCRETE

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ABSTRACT

Concrete is relatively easy material to mix, work and place in building constructions. However, you can run into huge problems if it is not worked properly. There are many problems that cause the concrete to deteriorate, among them improper compaction and curing of the concrete play a vital role in deteriorating the desired strength of the concrete. In the present study, the effects of self-compacting and self-curing concrete on the strength and deflection parameters of the reinforced concrete columns are investigated. The columns are of cross-section 150x150x1400mm cast with different percentages of steel in it. GELINIUM 8233 (GL) an admixture based on modified poly-carboxylic ether is used as a self-compacting agent, which is added 1% by weight of water. POLYETHYLENE GLYCOL (PEG) 1.5% by weight of water is mixed with concrete to obtain self-curing properties. SILICA FUME (SF) is added by 10% of cement weight. The specimens then cast are tested for their ultimate load carrying capacity under loading frame whose capacity is 200 tones. The load is applied axially. The ultimate load thus obtained for both the conventional and self curing-self compacting specimens are almost the same.

Keywords: Self Compacting, Self Curing, Gelinium 8233 & Polyethylene Glycol.

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1. INTRODUCTION

Concrete is the most often used construction material which adds beauty and durability to many buildings. Besides its function as a good material which can be plastic and amenable when freshly mixed and yet become tough and long-lasting when hardened, there are some drawbacks when the concrete is placed and treated improperly, indirectly causing the concrete not to attain its ultimate strength. There are many problems that cause the concrete to deteriorate, among them improper curing and compaction plays a major role in the concrete to deteriorate.

Compaction is an operation in which fresh concrete placed in the form is compacted by an external mechanism to oust the air voids present in it and packs aggregate particles together and also encompass the reinforcement present in the form. Improper compaction of concrete leads to the formation of honeycomb and rock pockets. Which make the concrete permeable ushering to steel corrosion and diminishing the ultimate strength of hardened concrete. In general, compaction operated by external mechanism is laborious and some complex form like columns higher than 2-3m, heavily reinforced sections cannot easily be compacted by an external mechanism. Self-compacting concrete is proposed to vanquish such type of problems. Self-compacting concrete is an innovative concrete that does not require vibration for placing and compacting as it flows through the form by its own weight. The fluidity and segregation resistance of SCC ensure a high level of homogeneity, minimal concrete voids, and uniform concrete strength.

The SCC admixture used here is MASTER GLENIUM SKY 8233 based on modified poly-carboxylic ether which is clear of chloride and low alkali. The admixture has a different chemical structure from the custom super plasticizers. It consists of a carboxylic ether polymer with extended adjacent chains. At the starting of the mixing process, it commences the same electrostatic diffusion mechanism as the custom super plasticizer, but the adjacent chains linked to the polymer backbone create a steric impediment which greatly stabilizes the cement particles ability to separate and scatter. Steric impediment provides a physical blockade between the cement grains. With this process, flow able concrete with greatly lessen water content is gained [7].

Concrete is a mixture of fine and coarse aggregates along with cement, although all these materials are brought together to form a bond it do not until water is added to the mix. The process of the reaction of water with different constituent complexes of cement is called hydration. When water is added to the mix to react with c3s, c2s, c3a & c4af minerals of cement to form a c-s-h gel which is the most important hydration product of cement, during this process being an exothermic reaction heat is generated leading to the evaporation of water in concrete. This process of hydration continues over a period of time. Curing of concrete is thus to provide continues water to the concrete until the end of hydration process. Curing of concrete in water surplus areas and for conventional small buildings can be carried out easily by general curing process, whereas curing in water arid regions and for some impractical constructions conventional curing is a big problem, Which leads to evaporation of water in concrete causing early age cracking and empty pores on the surface of concrete making it permeable to weathering actions.

Self-curing of concrete is a process that can be used to maintain moisture in concrete without any external watering on the member and thus more effective hydration of cement is obtained. Self-curing concrete in the present research is obtained by adding POLYETHYLENE GLYCOL which arrests the water to evaporate from concrete and also aids in water retention.

The previous studies on self curing and self compacting concrete has put efforts to develop this kind of concrete by adding the admixtures in reference to the weight of cement but in current study both the admixtures are added by weight of water and the results are then studied[1-4].

2. RESEARCH SIGNIFICANCE

Compaction and curing of high strength concrete generally used in vertical structural elements has less water content and high volumes of cement, cannot be carried out smoothly because of their longer heights. Which ushered in the improper compaction and curing of vertical members. Thus the principal aim of the current research is to evaluate the outcomes of reinforced concrete columns with percentage addition of self-compacting and self-curing agents along with silica fume. Two different types of columns cast with varying steel gross cross-sectional area i.e. 12# and 16# bars, with 1% GL, 1.5% PEG & 10% SF are evaluated for their structural properties of the column such as ultimate load, crushing strength, load vs deflection and are compared with conventional columns. The outcomes thus obtained are used to determine the use of chemical admixtures in enhancing the strength parameters of reinforced concrete vertical elements without any manual compaction and curing.

3. MATERIALS

3.1. Cement

Cement used in this study is ultra-tech OPC 53grade. The specific gravity of cement is evaluated as 3.89

3.2. Silica Fume

Silica fume is a by-product of producing silicon metal or Ferrosilicon alloys. It is a reactive pozzolan due to its chemical properties. It is 1/100th the size of an average cement particle. The main purpose to use silica fume in the present study is to avoid excessive bleeding, which happens when SCC compound is mixed with concrete

Table 1 Comparison of chemical and physical properties of Portland cement and silica fume

S. NO	Property	Portland cement	Silica Fume
1	Sio_2content(%)	21.9	85-97
2	Al_2o_3content(%)	6.9	
3	Fe_2o_3content(%)	3	
4	Caocontent(%)	63	< 1
5	Mgocontent(%)	2.5	
6	So_3content(%)	1.7	
7	Specific surface (m^2/kg)	370	15000-30000
8	Specific gravity	3.15	2.22

3.3. Master Glenium sky 8233

An admixture based on poly carboxylic ether. It is free of chloride and alkali. Addition of this admixture enables high workability with less water content.

Table 2 Performance test data

Aspect	Relative Density	PH	Chloride ion content
Reddish brown liquid	1.08±0.02 at 25°c	≥6	< 0.2 %

3.4. Polyethylene glycol 400

It is a self-curing agent. In the present study, the agent is brought from MERCK Company.

4. EXPERIMENTAL PROGRAMME

Concrete mix proportion for the M40 grade is computed by using IS 10262: 2009. After several trail mixes the mix proportion for the chosen grade is computed as (1:1.3: 2.9). The water-cement ratio is fixed to 0.40.The cement content is taken as 450 Kg/m3 based on the codal provisions. Fine and coarse aggregates used in the experiment are collected locally. The specific gravity values are 2.51 and 2.77 respectively. 12 cubes are then cast based on the obtained mix proportion using a horizontal concrete mixer, in which 6 are conventional cubes and the other six are added with silica fume, glenium and polyethylene glycol 400. Silica fume is added 10% by weight of cement by referring previous studies. Glenium 8233 admixture used for self- compacting is mixed with concrete 1% by weight of water. Polyethylene glycol is substituted into the mix by 1.5% by weight of water. The percentages of GL and PEG are finalized after several trail mixes. The cubes are then tested for their compressive strength using compressive testing machine capacity up to 200 tones.

Table 3 Composition of concrete in (Kg/m^3)

Mix no	Cement	Water	FA	CA	SF	GL	PEG
M1	450	180	585	1305			
M2	450	180	585	1305	4.5	2.7	1.8

Using both the mixes i.e. M1(control mix) & M2(scc & sc mix) 12 columns has been cast. With each mix containing 6 columns. Among those six columns, 3 are designed for 12# bars and the other three are designed for 16# bars. On whole 6 columns are designed for 12# bars and another 6 for 16# bars. The analysis & design of the columns is carried out using STADD PRO software. The cross-section of columns is 1400×150×150 mm. To cast the columns a wooden plywood mold is been made in reference to the cross-section of the columns. The concrete is then mixed by using a horizontal electric mixer is poured into the mould. The final form of the column after the casting is shown in figure 3.

4.1. Specimens Geometry

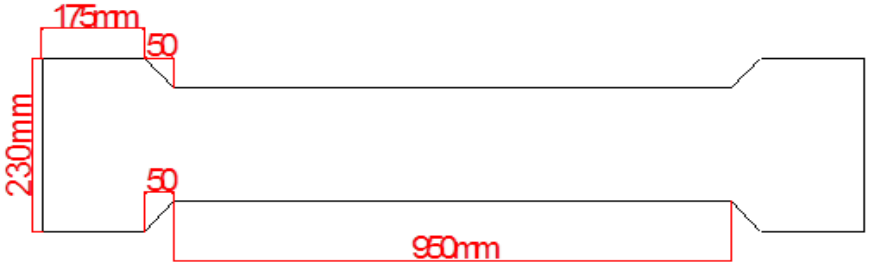

Figure 1 Schematic diagram of column cross-section with dimensions

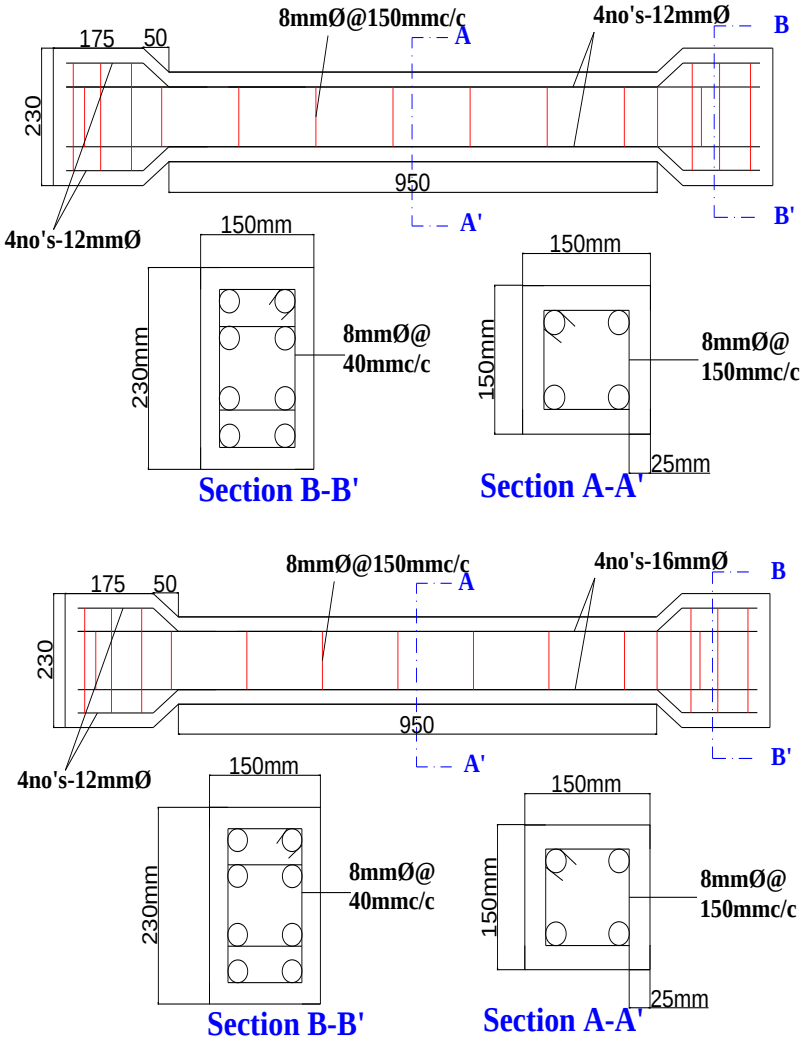

Figure 2 Reinforcement detailing of 12# and 16# bar columns

Figure 3 Final form of column cast

The support condition used to test the column is both sides fixed condition. To avoid local failure and to allow the load to pass through the section the column is provided with top and bottom heads of cross section 230×150mm. The columns were then tested under loading frame of capacity 2000KN. Fig 4 shows the test setup of the column which is then tested. The load is applied axially.

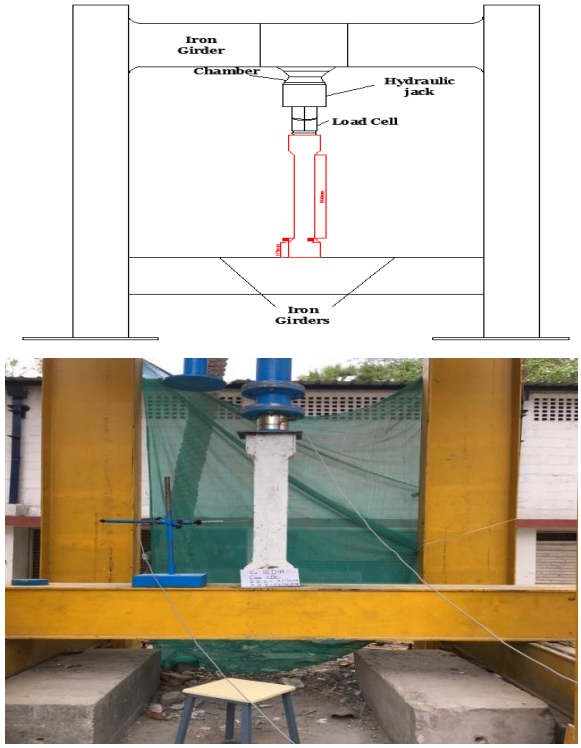

Figure 4 Column placed on loading frame to tests under axial loading.

In table 4 the columns are classified according to their concrete mix and reinforcement used.

Table 4 Classification of columns

Column name	Concrete mix no	Rebar dia	Designed ultimate load
C_1	M1	12#	508kN
C_2	M1	12#	508kN
C_3	M2	12#	508kN
C_4	M2	12#	508kN
C_5	M1	16#	640kN
C_6	M1	16#	640kN
C_7	M1	12#	508kN
C_8	M1	16#	640kN
C_9	M2	16#	640kN
C_{10}	M2	16#	640kN
C_{11}	M2	12#	508kN
C_{12}	M2	16#	640kN

5. RESULTS AND DISCUSSIONS

To specify that concrete has obtained the self compacting concrete properties. EFNARC guidelines proposed by European Federation for SCC have been used as a reference. The guidelines had proposed a suitable test to conduct on concrete so that the concrete obtained satisfies self-compacting concrete properties. The tests and their values are mentioned in table 5.

Table 5: Test values of EFNARC guidelines

Test name	Range	Obtained value
T_{50} slump flow	2-6(sec)	5.4 sec
U box	0-30 mm	25 mm
V funnel	6-12 sec	7 sec
L box	0.8-1.0	0.88

The cubes cast then are tested for their compressive strength under the compressive testing machine. The compressive strength values for 7days and 28days of curing are mentioned in the table no 6 & 7

Table 6 The compressive strength of cubes after 7 days in (N/mm^2)

Mix No	Cube 1	Cube 2	Cube 3
M 1	30.6	29.4	30.2
M 2	31.1	30.2	31.1

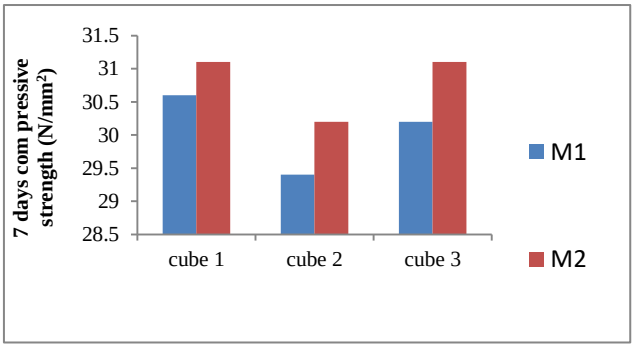

Figure 5 Comparison of 7days compressive strength between M1 & M2 mixes

Table 7 The compressive strength of cubes after 28 days in (N/mm^2)

Mix No	Cube 1	Cube 2	Cube 3
M 1	48.5	44.4	50.0
M 2	64.8	64.0	67.1

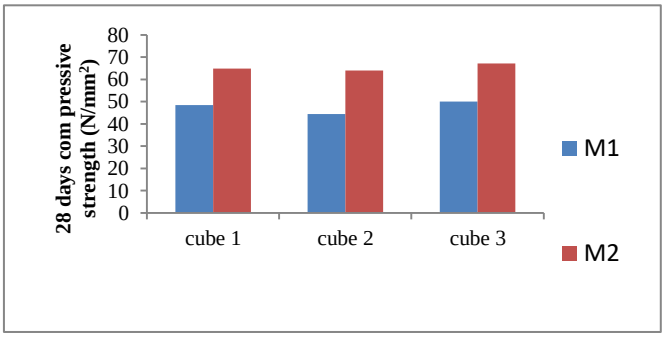

Figure 6 Comparison of 28days compressive strength between M1 & M2 mixes

From fig 5 & fig 6 it can be derived that the cubes that are cured conventionally have less compressive strength compared with cubes that having SCC & SC admixtures.

The columns cast then are tested for their ultimate load carrying capacity and the results are shown in table 8

Table 8 Ultimate load carrying capacity of columns in (kN)

Column name	Ultimate load (kN)	Design load(kN)
C_1	1012.0kN	508kN
C_2	1001.3kN	508kN
C_3	1040.0kN	508kN
C_4	1050.6kN	508kN
C_5	746.0kN	640kN
C_6	1041.6kN	640kN
C_7	999.5kN	508kN
C_8	1156.5kN	640kN
C_9	1197.5kN	640kN
C_{10}	832.0kN	640kN
C_{11}	999.9kN	508kN
C_{12}	1084.8kN	640kN

Table 8 shows the ultimate load carrying capacity of all the columns in relation to the designed ultimate load evaluated using STADD PRO. It is observed that both the mixes of concrete embedded with steel exceed the design ultimate load. All the columns which are tested had withstood the designed load which can be clearly understood by the above table.

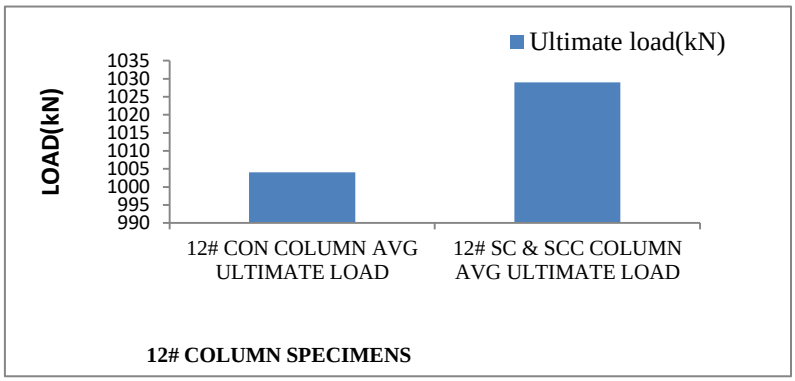

Figure 7 Comparison of ultimate between control & self compacting self curing 12# RCC columns

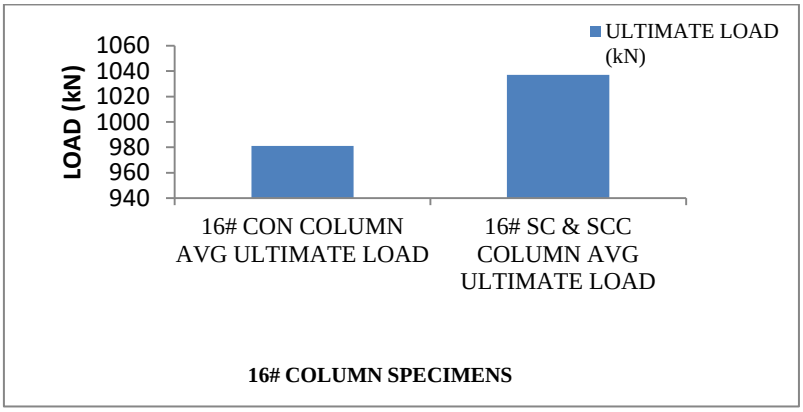

Figure 8 Comparison of ultimate load between control & self compacting self curing 16# RCC columns

Fig 7 & 8 Indicates that the self compacting and self curing columns have slightly more ultimate load when compared to conventional columns. The increase in load carrying capacity for both columns is around 2-3%.

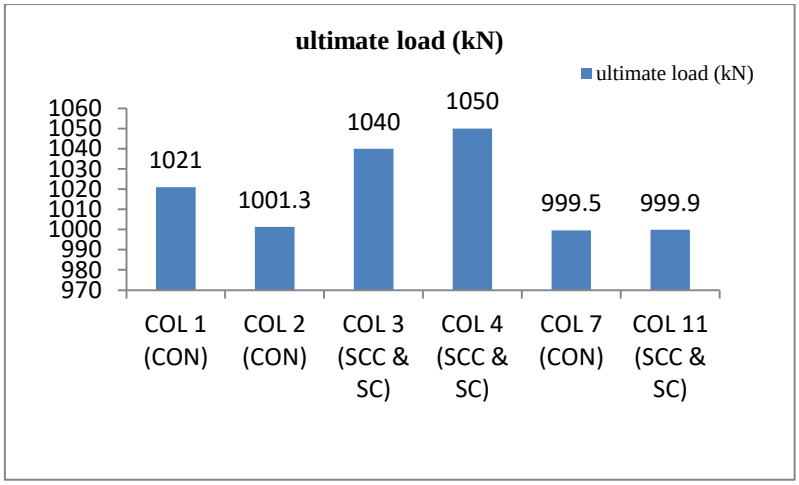

Figure 9 Ultimate load of 12# columns

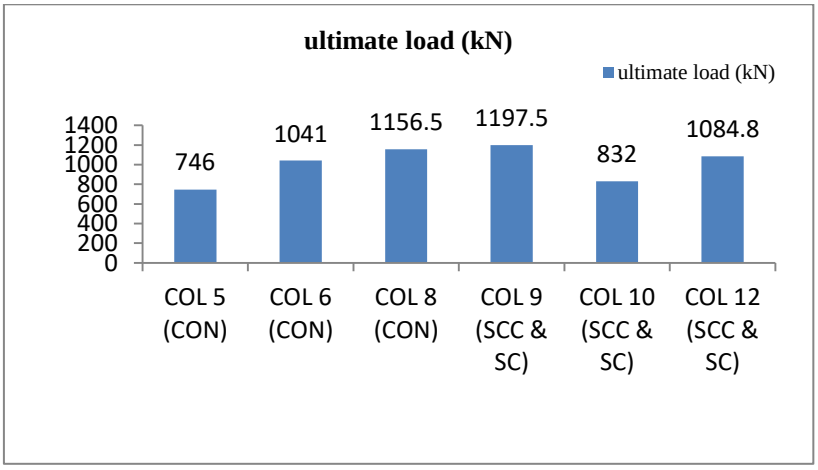

Figure 10 Ultimate load of 16# columns

5.1. Load vs. Deflection curves

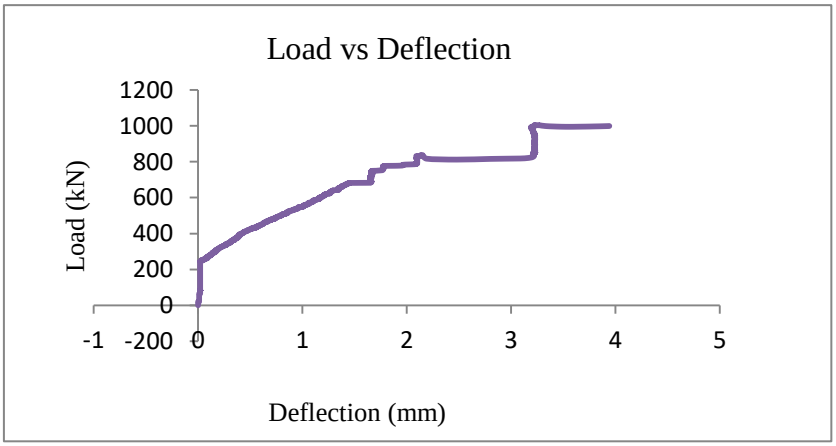

Figure 11 Load versus Deflection curve for 12# conventional column

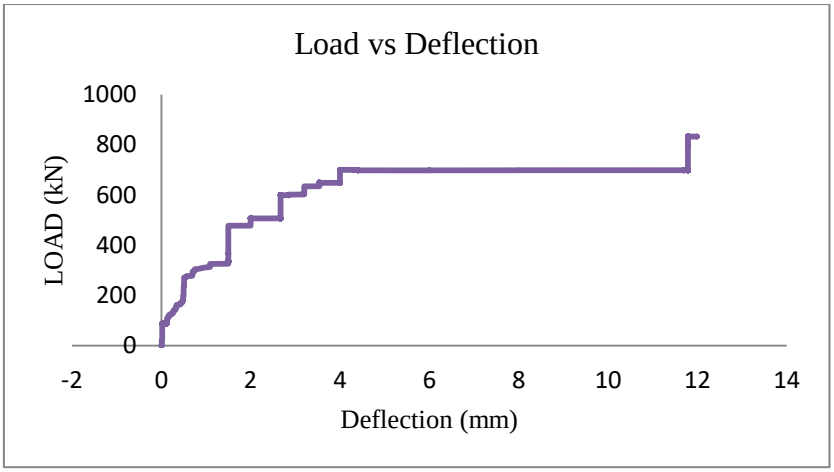

Figure 12 Load versus deflection curve for 12# sc & scc column

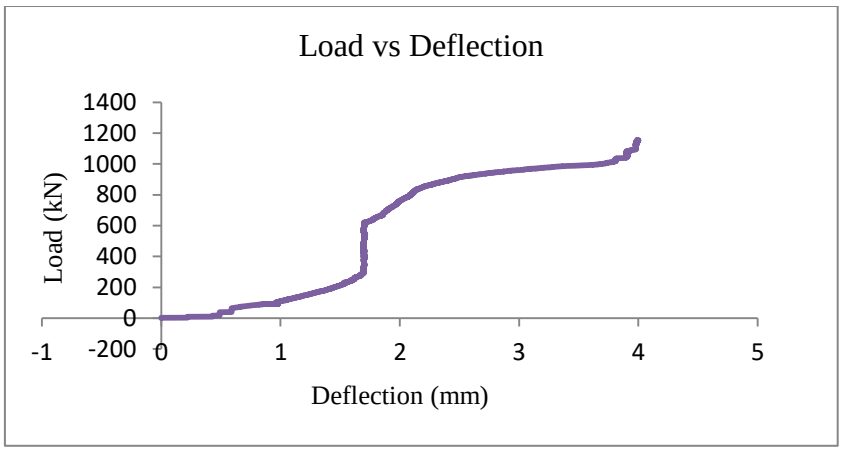

Figure 13 Load versus deflection curve for 16# conventional column

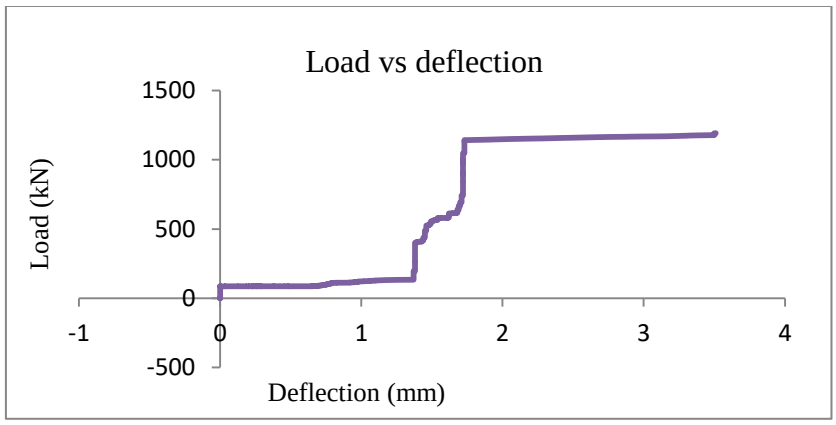

Figure 14 Load versus deflection curve for 16# sc & scc column

The load vs deflection for all the columns shows minimal deflection as the load increases

5.2. Economic and Environmental Importance

In general for curing a cubic meter of concrete 3 cubic meters of water is required for which water has to be collected by a nearby source by means of any power source which includes heavy costs. And also for curing a multi-storied building extra labor is required all these lead to increase in construction costs. Whereas PEG 400 a self-curing compound added by 1.5% of

water requires nothing mentioned above. And also save 3000 litres of water per cubic meter which can be used for other public purposes.

6. CONCLUSIONS

The following conclusion was drawn from this study.

- Columns cast with both the mixes of concrete exhibit almost equal mould strength
- All the specimens cast have exceeded the designed ultimate load which shows PEG used for self curing is better to use than manual curing in vertical structural members of construction.
- The admixtures added by weight of water to concrete also providing the desired compressive strength
- The compressive strength of cubes is increased by 35% when the concrete is added with GELINIUM & PEG(for 28 days).
- Among the entire 12 columns column, no 9 has achieved highest ultimate load which is cast with self-compacting and self-curing concrete.

REFERENCES

[1] Magda I. Mousaa,*, Mohamed G. Mahdya,AhmedH. Abdel-Reheema,Akram Z. Yehiab"Physical properties of self-curing concrete (SCUC)" Housing and Building National Research Center (HBRC) journal Volume 11, Issue 2, August 2015, pp. 167-175.

[2] Magda I. Mousaa,*, Mohamed G. Mahdya,Ahmed H. Abdel-Reheema,Akram Z. Yehiab "Mechanicalproperties of self-curing concrete (SCUC)" Housing and Building National Research Center (HBRC) Journal Volume 11, Issue 3, DECEMBER 2015, pp. 311-320.

[3] Amr s. El-Dieb, Tamer A. El-Maaddawy,AhmedA . M. Mohmoud, "Water-soluble polymers as self-curing agents in cement mixes" Institution of Civil Engineers (ICE), Advances in Cement Research, 2012, 24(5),pp. 291–299

[4] G. Thrinath*, P. Sundara Kumar, "Eco-friendly Self-curing Concrete Incorporated with Polyethylene Glycol as Self-curing Agent"International Journal of Engineering(IJE), Vol. 30, No. 4, (April 2017),pp. 473-478

[5] GidionTurualloa,*, MariosN.Soutsosb, "Supplementary cementitious materials: Strength development of self-compacting concrete under different curing temperature", Procedia Engineering 125 (2015), pp. 699 – 704

[6] CH RAJESH, C.RAJAMALLU, S.S.ASADI, "Experimental investigation of SCC with confinement by partial replacement with cement with GGBS, Lime stone powder & fine aggregate with Pondash" IJCIET, Volume 9, Issue-3, March 2018

[7] MasterGlenium® SKY 8233 by BASF Master Builder Solutions.

[8] R. Udhayan, Dr. N.P. Rajamane, "Experimental Study Of Selfcompacting Self Curing Concrete", Volume 8, Issue 4, April 2017, pp. 638–643

[9] IS10262:2009, "Concrete Mix Proportioning - Guidelines" Bureau of Indian standards, New Delhi.

[10] IS456:2000, "Plain and Reinforced Concrete-Code of Practice" Bureau of Indian standards, New Delhi.