International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2584
Volume 3, Issue 06, June-2017

INFLUENCE OF GUAR GUM POWDER ON FRESH & HARDENED PROPERTY OF SELF-COMPACTING CONCRETE

Aniket Gavde[1], Tejas patil[2]

[1] *M.Tech. student, Civil department, Parul University, Vadodara,*
[2] *Assistant Professor, Civil department, Parul University, Vadodara,*

Abstract— Self compacting concrete is a latest trend in concrete technology because of ability to compact under its own weight and also due to its high resistance of segregation and bleeding; by using such kind of concrete in construction work economy can be achieved due to elimination in vibration and compaction. In this research the results show that for constant flow ability of the SCC, replacement of super plasticizer with guar gum requires an increase in water/powder ratio and a reduction in super plasticizer dosage. Both additions degraded the flow ability, consistence retention and hardened properties but not to a prohibitive extent. By limiting the content of guar gum powder not greater than 0.5% replacement of cement and by keeping super plasticizer content same as 0.8% of water gives better result than normal concrete in terms of strength. In this research Guar gum powder as viscosity modifying agent and super-plasticizer is used, by using particular amount of both admixtures higher compressive strength, flexural strength and split tensile strength can be achieved. Both admixtures are replaced with cement content which improves flowing ability and strengthening characteristics of concrete.

Keywords— Self compacting concrete (SCC), Viscosity modifying agent (VMA), super-plasticizer (SP), Guar gum powder (GGP)

I. INTRODUCTION

The traditional concrete is one kind of uneconomic concrete that with high water to cement ratio and low workability is difficult to place, and some problems are easy to occur, like honeycomb and bleeding. To solve these problems, concretes with high workability, such as self-compacting concrete have recently been developed and applied [1]. SCC is a special type of concrete with great self-compacting ability that can fill the formwork and vacancy among rebars without under its own weight. The use of VMA along with adequate concentration of super-plasticizer (SP) can ensure high deformability and adequate workability, leading to a good resistance to segregation [2, 3]. Guar gum powder is taken as Viscosity modifying agent, which is a cheap in price compared to commercially available VMA [4]. gum is always a favorite agro-based commodity, attracting wide interest of researchers all over the world. Guar gum powder is one of the most used agricultural by product with useful chemical properties. Guar gum powder has not been used in self-compacting concrete (SCC) so far as a cheap product. This paper intends to find the consequences of using Guar gum powder (GGP) as VMA in SCC. The most important property of guar gum is its ability to hydrate rapidly in cold water to attain uniform and very high viscosity at relatively low concentrations. VMA play an important role in controlling the rheology and consistency of concrete. VMA change the rheological properties of concrete. The dosages of VMA and SP is necessary to ensure suitable flow and passing ability and reduce the bleeding.

Objective of this study is, To investigate how the proportions of solids and liquids, the amount of super-plasticizer, and the guar gum need to be selected in order to produce SCC mixes with the right flow-ability. Also in this study, The fresh concrete properties (slump flow, flow time, V-Funnel, J- Ring) and hardened concrete properties (compressive strength, split tensile strength and flexural strength) of mixtures were evaluated and compared with normal concrete mix.

II. MATERIALS USED AND THEIR PROPERTIES

Cement, fly ash, Ground Granulated Blast Furnace Slag (GGBS), micro silica, fine aggregates, coarse aggregates, water, Super-plasticizer (Glenium SKY 8941) and Guar gum powder (GGP) are used in casting of concrete cubes. The specifications and properties of these materials are as under:

A. Cement: Ordinary portland cement of Ultra Tech make from a single lot is used for the study. The physical properties of cement as obtained from various tests. All the tests are carried out in accordance with procedure laid down in IS 1489 (Part 1):1991, valid for ordinary portland cements.

B. Fly Ash: Fly Ash is available in dry powder form and is procured from Dirk India Pvt. Ltd., Nasik. It is available in 30Kg bags, colour of which is light gray under the product name "Pozzocrete 60". The Fly ash produced by the company satisfies all the requirements of the IS 3812: 1981, BS 3892: Part I: 1997.

C. Ground Granulated Blast Furnace Slag (GGBS): Granulated Blast Furnace Slag is obtained by rapidly chilling (quenching) the molten ash from the furnace with the help of water. During this process, the slag gets fragmented and transformed into amorphous granules (glass), meeting the requirement of IS 12089:1987.

D. Micro silica: Micro silica is an artificial pozzolona having high pozzolonic activity. It is a By-product from an Electric Arc Furnace used in manufacture of Silicon metal.

E. Fine Aggregates: Locally available sand is used as fine aggregates in the preparation of the concrete mix. The specific gravity of fine aggregates is 2.644.

F. Coarse Aggregates: Crushed stone aggregates (locally available) of 16 mm is used through-out the experimental study. The specific gravity of coarse aggregates is 2.93.

G. Water: Fresh and clean water is used for casting and curing the specimens. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard.

H. Guar Gum Powder: Guar gum, also called guaran, is a galactomannan. It is primarily the ground endosperm of guar beans. The guar seeds are dehusked, milled and screened to obtain the guar gum. It is typically produced as a free-flowing, off-white powder. Properties of Guar gum powder shown in table 1.

Table 1: Properties of Guar gum powder

Chemical Composition	polysaccharide based
Particle size (μm)	300
Viscosity	5500 cPs
Ph	3 at 50 °C

I. Super plasticizer: Super-plasticizer is a chemical compound used to increase the workability without adding more water i.e. spreads the given water in the concrete throughout the concrete mix resulting to form a uniform mix. SP improves better surface expose of aggregates to the cement gel. Super plasticizer acts as a lubricant among the materials. BASF Master Glenium SKY 8941 is used in mix. Property of SP is shown in table 2.

Table 2: Property of Super-plasticizer

Aspect	Reddish brown liquid
Relative Density	1.10 ± 0.01 at 25°C
pH	>6 at 25°C
Chloride ion content	<0.2%

III. EXPERIMENTAL PROGRAMME

A. Mix proportion

Selection of mix design method, test, and target property as per IS Code and converting it in to Self-compacting concrete design based on the reference mixes available in the literature and various trail and errors had done at the laboratory. Production of SCC by varying percentages of guar gum(VMA) and by keeping super plasticizer constant and also measurement of flow properties of SCC.

The mixes thus prepared to follow the EFNARC guidelines [5]. Mix design forM30 grade concrete according to BIS method and EFNARC guidelines is shown in table 3& 4.

Mix design for SCC M30 without GGP in table 3.

Table 3: Mix design for SCC M30 without GGP

Mix	**Cement Kg/ m3**	**Fly ash Kg/m3 (30%)**	**GGBS Kg/m3 (9%)**	**Micro silica Kg/m3 (1%)**	**F.A. Kg/ m3**	**C.A. Kg/ m3**	**Water lit/ m3**	**S.P. 8941 lit/m3 (1.2%)**
TM 1	314.5	157.3	47.18	5.24	788.7 (62%)	773.1 (38%)	200.98 (0.38)	6.29
TM 2	275.7	137.8	41.36	4.60	874.5 (60%)	715.5 (40%)	199.92 (0.40)	5.51
TM 3	272.8	136.4	40.93	4.55	777.7 (58%)	866.9 (42%)	139.45 (0.42)	5.45
Final mix	280.5	139.7	41.93	4.66	915.6 (56%)	719.4 (44%)	191.88 (0.41)	5.59

Mix design for SCC M30 with GGP in table 4.
Taken Final mix and replace SP with GGP in varying persentages, SP is constant 0.8%.

Table 4: Mix design for SCC M30 GGP

Material	**GGP Mix 1**	**GGP Mix 2**	**GGP Mix 3**	**GGP Mix 4**	**GGP Mix 5**
Cement Kg/ m3	280.51	280.51	280.51	280.51	280.51
Fly ash Kg/m3(30%)	139.76	139.76	139.76	139.76	139.76
GGBS Kg/m3 (9%)	41.93	41.93	41.93	41.93	41.93
M. Silica Kg/m3(1%)	4.66	4.66	4.66	4.66	4.66
F.A. Kg/m3	915.69	915.69	915.69	915.69	915.69
C.A. Kg/m3	719.47	719.47	719.47	719.47	719.47
Water Lit/m3	191.88	191.88	191.88	191.88	191.88
S.P. 8941Lit/m3 (0.8%)	3.73	3.73	3.73	3.73	3.73
V.M.A GGP Kg/m3	For 0.30%=1.40	For 0.40%=1.86	For 0.50%=2.33	For 0.55%=2.56	For 0.60%=2.80

B. Test Programmes:

1.) Fresh Properties: SCC has three essential fresh properties filling ability, passing ability and Segregation resistance. Fresh property tests are performed as per guidelines of EFNARC february 2002 shown in below table 5 [5].

Table 5: Fresh property tests guidelines of EFNARC february 2002

Sr. No.	Method	Unit	Typical range of values	
			Minimum	Maximum
1.	Slump flow test	Mm	650	800
2.	T50cm Slump flow test	Sec	2	5
3.	V-funnel	Sec	6	12
4.	V-funnel at T5minutes	Sec	6	15
5.	J- Ring	Mm	0	10

i. Slump flow & T50 Test: The Slump Flow test can give an indication as to the consistency, filling ability and workability of SCC. The SCC is assumed of having a good filling ability and consistency if the diameter of the spread reaches values between 650mm to 800mm. The T50 test is determined during the slump flow test. It is simply the amount of time the concrete takes to flow to a diameter of 500 mm, acceptable T50 times range from 2 to 5sec.

Figure 1: Slump flow

ii. V-Funnel test & V–Funnel test at T5 minuets: Viscosity of the self-compacting concrete is obtained by using a V-funnel Apparatus, which has certain dimensions, in order for a given amount of concrete to pass through an orifice). The amount of concrete needed is 12 litres. The time for the amount of concrete to flow through the orifice is being measured. After this the funnel can be refilled concrete and left for 5 minutes to settle .If the concrete shows segregation then the flow time will increase significantly.

Figure 2: V funnel test

iii. Slump Flow/J-Ring combination test: This test involves the slump cone being placed inside a 300mm diameter steel ring attached to vertical reinforcing bars at appropriate spacing (the J-Ring itself). The Slump Flow/J-Ring combination test is an improvement upon the Slump Flow test on its own as it aims to assess also the passing ability of the fresh mix. In this respect, the SCC has to pass through the reinforcing bars without separation of paste and coarse aggregate.

Figure 3: J- Ring Test

2.) Mechanical property:

i. Compressive strength test of concrete: Compressive strength of concrete is defined as the load, which causes the failure of a standard specimen. The test of compressive strength should be made on 150mm size cubes. Place the cube in the compression-testing machine. The green button is pressed to start the electric motor. When the load is applied gradually, the piston is lifted up along with the lower plate and thus the specimen application of the load should be 300 KN per minute and can be controlled by load rate control knob. Ultimate load is noted for each specimen. The release valve is operated and the piston is allowed to go down. The values are tabulated and calculations are done.

ii. Splitting tensile test of concrete: The split tensile test is conducted by loading a cylindrical concrete specimen along its length. This results in the development of tensile stresses along the central diameter in the lateral direction (except for compression very close to the loading points). When these stresses exceed the tensile capacity of the concrete, the specimens simply splits into two halves. The resultant tensile strength is calculated as Split tensile strength = 2P/(piLD). Where P is the load at failure, L and D are the length and diameter of cylinder.

iii. Flexural strength test of concrete: Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam to resist failure in bending. It is measured by loading beam of size 150mm × 150 mm × 700mm size. The flexural strength can be found out by central loading as well as the load is applied through two similar rollers mounted at the third point of the supporting span. The flexural strength can be found out by formula $Fcr = P . L/ b.d^2$, Where, P = Fracture load for beam, L = Span b = Width of the beam, d = Depth of the beam.

IV. RESULTS AND DISCUSSION

A. Results of fresh property tests:

1.) Result of fresh property Without GGP as V.M.A shown in table 6.

Table 6: Result of fresh property Without GGP

Tests	Units	TM 1	TM 2	TM 3	Final Mix
Slump flow	mm	650	660	640	680
T50 cm slump flow	Sec	4.23	4.03	4.44	3
V- funnel	Sec	13.09	11.56	14	10.56
V- funnel at T5 min	Sec	16	14.04	16.52	13.56
J- Ring	Mm	9	8	11	7

2.) Result of fresh property With GGP as With GGP as V.M.A and S.P. = 0.8% (constant) shown in table 7.

Table 7: Result of fresh property With GGP as With GGP

Test	Units	GGP Mix 1	GGP Mix 2	GGP Mix 3	GGP Mix 4	GGP Mix 5
Slump flow	mm	710	670	660	656	651
T50 cm slump flow	Sec	3.39	4.13	4.58	3.43	4.52
V- funnel	Sec	10.54	11.24	11.56	11.58	16.24
V- funnel at T5 min	Sec	13.04	14.04	15	13.21	20.04
J- Ring	mm	7	7	8	7	8

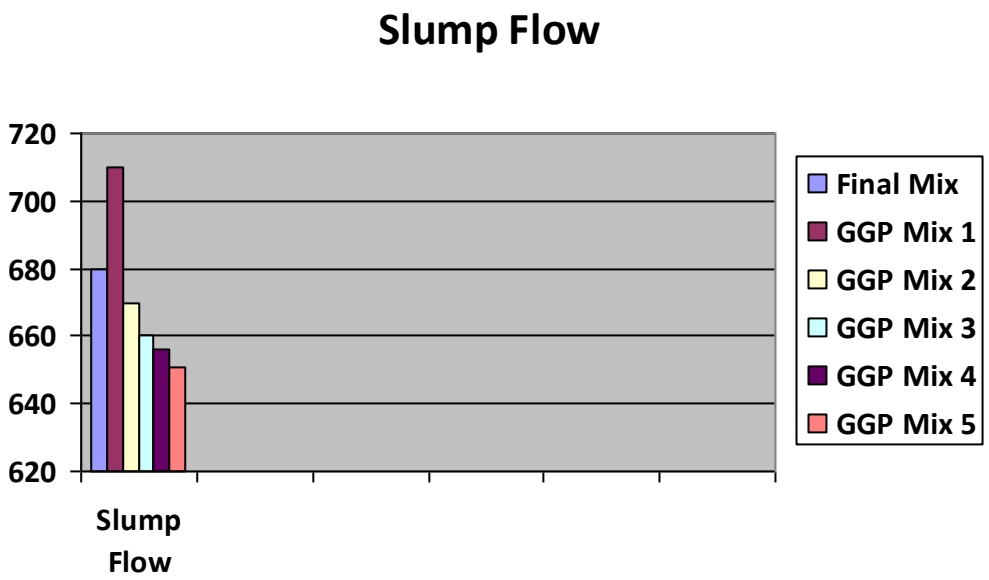

Figure 4: Slump flow

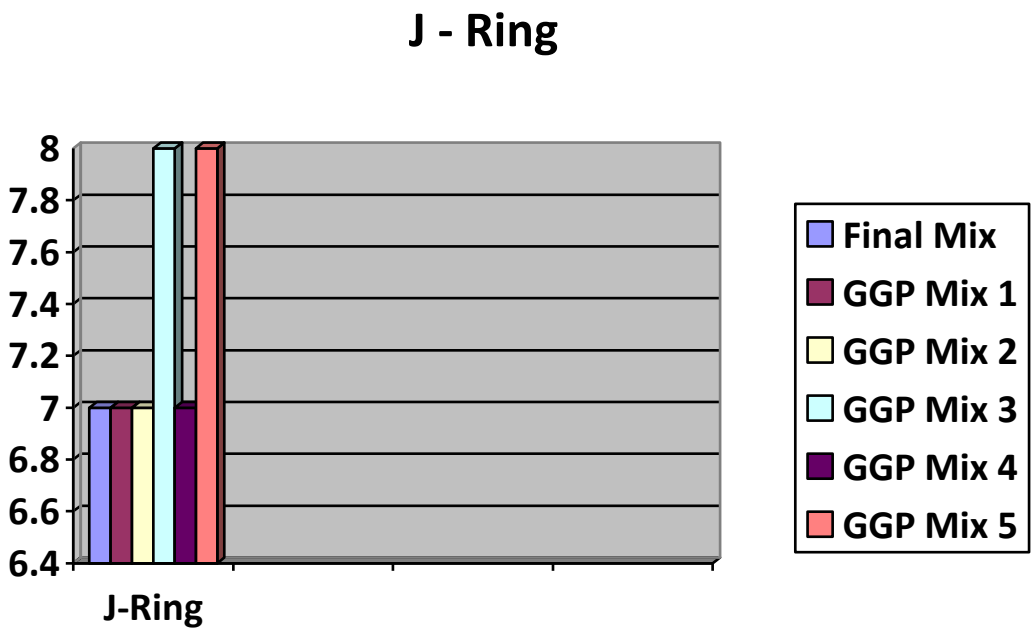

Figure 5: J - Ring

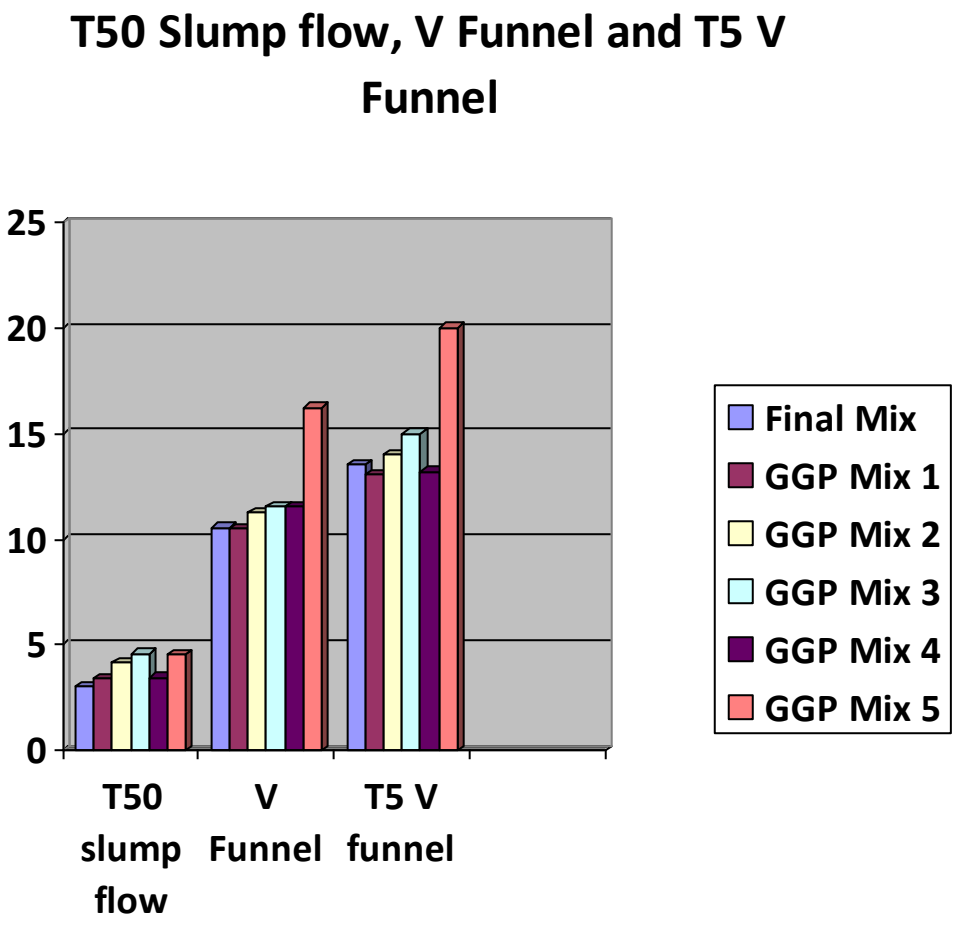

Figure 6: T50 slump flow, V funnel & T5 V funnel

B. Mechanical properties Results

1.) Results of compressive strength test :Results of 7 & 28 Days compressive strength test Without GGP as V.M.A.

Table 8: Results of 7 & 28 Days compressive strength test Without GGP

Mix Type	TM 1	TM 2	TM 3	Final Mix
7 Days	27.43	24.99	24.14	26.09
28 Days	35.62	34.74	37.75	40.33

i. Results of 7 & 28 Days compressive strength test with GGP as V.M.A & S.P. = 0.8% (constant).

Table 9: Results of 7 & 28 Days compressive strength test with GGP

Mix Type	Final mix	GGP mix 1	GGP mix 2	GGP mix 3	GGP mix 4	GGP mix 5
7 Days	26.09	27.33	26.71	24.26	20.27	18.89
28 Days	40.33	44.47	38.55	30.33	30.06	29.78

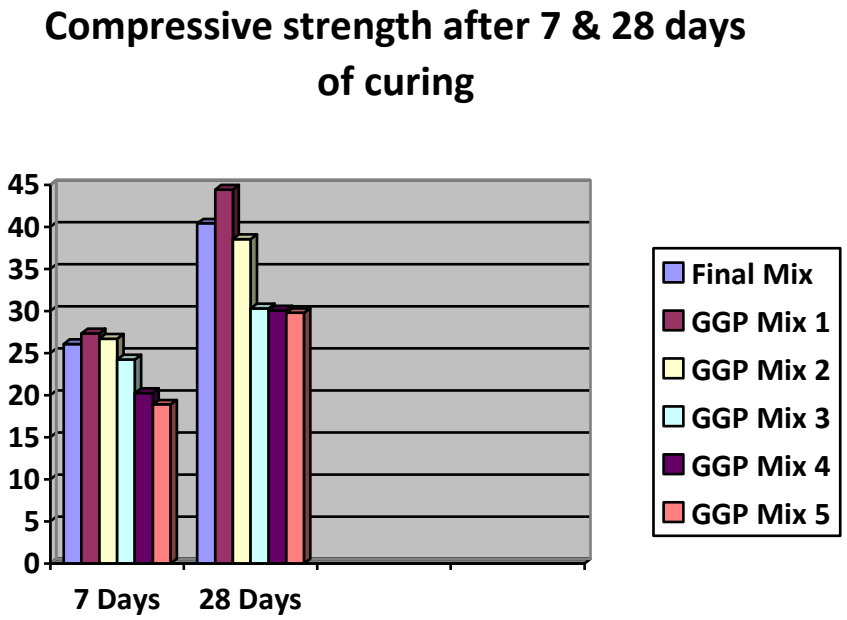

Figure 7: Compression strength

2.) Results of split tensile & Flexural strength test: Results of 7 & 28 Days split tensile & Flexural strength with GGP as V.M.A & S.P. = 0.8% (constant).

Table 10: Results of 7 & 28 Days split tensile & Flexural strength

Mix Type	split tensile		Flexural strength	
	7 days	28 days	7 days	28 days
Final Mix	2.30	2.91	2.98	3.50
GGP Mix 1	2.43	3.00	2.95	3.68
GGP Mix 2	2.29	2.98	2.78	3.44
GGP Mix 3	2.20	2.94	2.61	3.18

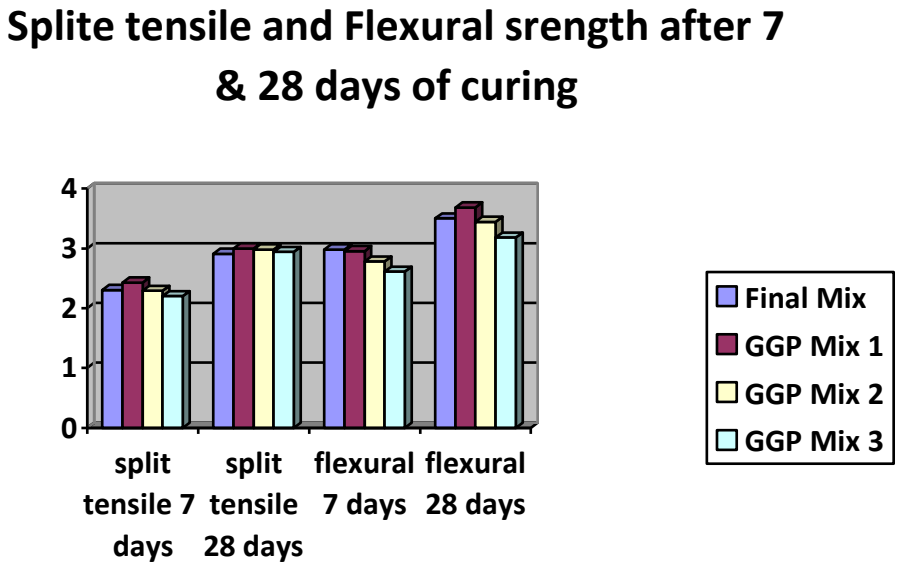

Figure 8: Split tensile & flexural strength

V. CONCLUSIONS

1) With addition of Guar Gum powder as V.M.A & Super-plasticizer Glenium SKY 8941 the 7& 28 days Compressive strength of concrete mix compared to final mix is increases.
2) GGP mix gives very good results of workability tests compared to the other mix of SCC, GGP mix 1 with 0.30% V.M.A. and 0.8% S.P. gives higher results compared to normal super-plasticizer type SCC mix.
3) In normal super-plasticizer type SCC mix S.P. 8941 is 1.2%, which replace by GGP from 0.30% to 0.60%. These makes combined type SCC mix and its also reduce the cost of admixture used in SCC.
4) To increase flowability Super plasticizers are required with Guar Gum powder. Workability results shows that Slump flow, V funnel is decreasing with increasing dosage of Guar Gum more than 0.50%. The workability and compression test results of 0.55% and 0.66% GGP with 0.8% constant dosage of SP shows lower strength and not satisfying the EFNARC guidelines 2002.
5) At 7 and 28 Days Compressive strength, split tensile strength and flexural strength are increasing up to 0.50% of Guar Gum along with super plasticizer 0.80%.
6) At 7 Days and 28 Days 0.30% Guar gum and 0.80% S.P. gives higher compressive strength, split tensile strength and flexural strength compared to all mix.

REFERENCES

[1] M. Ouchi, S. Nakamura, T. Osterberg, S. Hallberg, M. Lwin, Applications of Self-Compacting Concrete in Japan, Europe and the United States, Kochi University of Technology, Kochi, Japan, Swedish National Road Administration, Borlange, Sweden, 2003.
[2] K. H. Khayat, *The Viscosity-Enhancing Admixtures for cement-based materials-an overview*, Cement and Concrete Composites 20, pp. 171-188, (British 1998).
[3] Lechemi M, Hossain KMA, Lambros V, Nkinamubanzi P-C, Bouzoubaaˆ N., *performance of new viscosity modifying admixtures in enhancing the rheological properties of cement paste.* Cement concrete Res 2004;34 (2) 185-93.
[4] K. Ozawa, N. Sakata, H. Okamura, *Evaluation of self-compacting of fresh concrete in funnel test*, Proc. JSCE 90 (23) (1994) 59-75.
[5] N. Sakata, K. Maruyama, M. Minami, in: P.J.M. Bartos, D.L. Marrs, D.J Cleland (Eds), *Basic properties and effect of welan gum SCC ,Production method and workability of concrete*, E&FN Spon, London, UK, 1996, p.p 237-252.
[6] The European guidelines for Self Compacting Concrete Specification production and use, (2005).
[7] Ronak B Patel, M A Jamnu and B M Purohit, 'Application of Xanthan Gum as a Viscosity Modifying Admixture along with Super Plasticizer for Self-Compacting Concrete (SCC)', 1.12 (2015), 1402–6.
[8] V R Macam Jr and Universiti Teknologi Petronas, 'Performance of a Locally Produced Viscosity Modifying Admixtures in the Manufacture of Self-Compacting Concrete', 347–54.
[9] Kishor S Sable and Madhuri K Rathi, 'Comparison of Normal Compacted Concrete and Self Compacted Concrete in Shear & Torsion', *ISSN International Journal of Computer Technology and Electronics Engineering*, 2.4 (2012), 2249–6343.
[10] Andreas Leemann and Frank Winnefeld, 'The Effect of Viscosity Modifying Agents on Mortar and Concrete', *Cement and Concrete Composites*, 29.5 (2007), 341–49 <http://dx.doi.org/10.1016/j.cemconcomp.2007.01.004>.
[11] Wen-cheng Liao and others, 'Self-Consolidating High Performance Fiber Reinforced Concrete : Schpfrc', 0–10.
[12] International Journal and others, 'Effect of Addition of Combination of Admixtures on the Properties of Self Compacting Concrete Subjected to Cholride Attack', 102.2 (2013), 96–101.