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Torsional Behavior of Recycled Aggregate Based Glass Fiber Reinforced Self-Compacting Concrete

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Abstract— *The quality and characteristics of concrete are profoundly impacted by factors such as compaction integrity and its inherently brittle nature. A promising solution to challenges related to compaction is Self-Compacting Concrete (SCC), which achieves consolidation without the need for vibrators. Despite its potential, there remains a need for comprehensive investigations, particularly concerning its behavior in torsion a fundamental structural action often overlooked but crucial for analyzing structures exposed to wind and seismic forces. The analysis of lateral loads on structures is where torsion really shines. The response of members to lateral forces is greatly affected by characteristics such as torsional rigidity, toughness, and twist at ultimate torque. Sustainable concrete development is aided by the incorporation of recycled aggregates, and glass fibres improve the material's energy absorption properties. Existing literature shows a lack of investigation into the torsional behaviour of Self-Compacting Concrete that is reinforced with glass fibres and recycled aggregates. To fill this void, we conducted a study comparing the performance of self-compacting concrete beams made with recycled coarse aggregate (at 20%, 30%, and 40% weight replacement) and glass fibre (at 0.5, 1, and 1.5 aspect ratios) to conventional Vibrated Concrete. We used both natural and recycled coarse material to cast 16 beams to 30 MPa. Our results show that self-compacting concrete with either natural or recycled coarse aggregates has significantly better torsional properties than vibrated concrete in terms of ultimate torque, angle of twist, torsional stiffness, and torsional toughness. The incorporation of fibres also contributes to this enhanced functionality. As an example, researchers found that members with fibre aspect ratios of 1.5 in self-compacting concrete and 0.5 in conventionally vibrated concrete had the best performance. Furthermore, it was discovered that a ratio of 40% recycled aggregate was ideal for both self-compacting concrete and conventional concrete. In summary, this study underscores the significant potential of self-compacting concrete, especially when enhanced with glass fibers and combined with recycled aggregates, to achieve superior torsional properties. These findings hold implications for enhancing the performance and sustainability of concrete structures*.

I. Introduction

Any system of forces can be broken down into the following five actions: axial tension, compression, flexure, shear force, and torsional moment. Torsion affects everything from space frames and curved beams in water tanks to inverted L-beams and flat slab edge beams. The study of torsional stresses in reinforced concrete beams is complex. The more complex issue of torsion in reinforced concrete can be better understood through the torsion test for plain concrete members. Therefore, it can be used as a primer on the topic of reinforced concrete. In reinforced concrete, the torsion strength is often determined from certain plain concrete elements. Concrete's torsional strength can, in theory, be calculated using Elastic and Plastic analysis.

Glass fibre reinforced materials are increasingly used in production because of their excellent strength-to-weight ratio, corrosion resistance, and low maintenance cost over their service life. Increases in fibre content led to enhancements in strain, tensile strength, and modulus of elasticity. The inclusion of glass fibre to concrete additive serves a critical purpose in situations where the admixture is subjected to extreme environmental conditions and severe loading circumstances that standard concrete cannot sustain. When the mechanical and physical properties of conventional concrete are insufficient, glass fibre reinforced concrete has been shown to be useful. When added to ordinary concrete members, the effect of glass fibres on improving torsion strength became clear. Indeed, the recycling of concrete aggregate (coarse and fine) may be a significant revolution toward sustainability, as it opens up new opportunities to utilise recycled materials for structural applications. Using recycled aggregate is critical in addressing the issue of surplus garbage while keeping the quality of concrete to a suitable level. To ensure products have desirable qualities, quality control procedures must be linked to construction waste reuse. A fine understanding of the characteristics of this new material is extremely important so that good applications can be applied. Recycled aggregate (RA) is a part of stone that is attached to old cement mortar, generated by crushing concrete waste. Mixing RA with natural ingredients, cement, water, coarse and fine aggregate, and other components yields recycled aggregate concrete (RAC). Since cement is the only non-water component in concrete, the fine powders leftover from making RA can be recycled into cement. Concrete is the adaptable material used in construction industry.

In an effort to create long-lasting concrete buildings, self-compacting concrete (SCC) was invented in 1988. Large Japanese construction firms have been using self-compacting concrete in real projects since the early 2000s, after years of research. Many studies and self-compact ability testing methods were developed to make it a standard concrete for the purpose of developing a rational mix design process. Numerous studies have been launched, not just in Japan but across the globe, and it has been implemented in real-world institutions primarily in Canada, Sweden, the Netherlands, Thailand, and Taiwan. Japan has also published guides and suggestions for using self-compacting concrete (SCC).

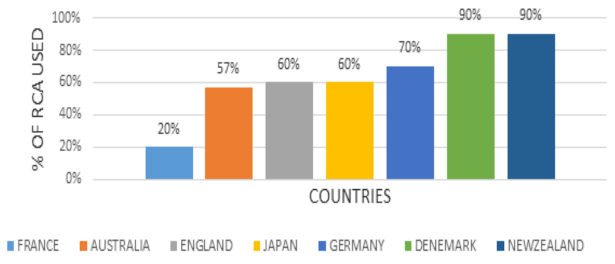

Figure 1-1: The amount of concrete waste that is being recycled in some countries of the world [1]

Consolidation can be attained with self-compacting concrete (SCC) without the need for vibrating equipment, resolving compaction-related issues. Without the need for any external source contribution, SCC is able to completely fill the formwork, retain homogeneity and integrity even at congested reinforcing areas, and achieve full compaction without any concrete segregation. The enhanced qualities, such strength and durability, suffer from insufficient compaction.

II. LITERATURE REVIEW

Mix design for SCC can be kept simple by following the advice given by Su et al. [6], who suggest utilising the "Packing Factor" to calculate how much aggregate will be required. This can be done by reading their work and following their instructions. In order to quantify the effect that the packing had on strength, flow, and self-compatibility, the overall Packing Factor (PF) was calculated. Recommendations and Standards from the SCC The EFNARC [7] ensures that the composition and application of SCC materials are consistent with one another. Characterizing the unique properties of SCC, such as its flowability, passing ability, viscosity, and resistance to segregation, can be done by a number of different tests that are proposed in the EFNARC standards. Researchers Nagaratnam and colleagues [9] investigated the resilience of vibrated concrete when subjected to torsional forces by using fibres with varying aspect ratios. Crushing concrete produces recycled coarse aggregate, which Zoran Jure Grdic et al. [15] investigated using in self-compacting concrete. [Crushing] generates recycled coarse aggregate. The fact that the results showed only a small amount of variation in the characteristics of these concretes suggests that recycled coarse aggregate could be successfully utilised in the creation of self-compacting concrete. This is suggested by the fact that the results showed only a small amount of variance. Concrete that contains steel fibres is an excellent addition since it makes the material more resistant to the harm that can be caused by bending and twisting. More specifically, Patil et al. [16]. The effects of various quantities of replacement on the strength characteristics of recycled coarse aggregate were explored by Saha [17], who came to the conclusion that a replacement amount of 25 percent did not significantly affect the strength parameters after conducting the study. Self-compacting concrete (SCC) created with 100 percent natural aggregate was compared to self-compacting concrete (SCC) made with 100 percent recycled coarse aggregate (RCA) from garbage to see which had superior qualities. Both types of aggregate were obtained from natural sources (NA). According to the findings, the target level of compressive strength was very close to being attained when SCC was used in place of thirty percent of the RA.

After doing some study on SCC, I came to the conclusion that this cutting-edge material has the ability to self-compact into every nook and cranny of the formwork. Research into SCC can be conducted using the plethora of resources that are now available. In recent years, notably in the production of SCC, it has become increasingly customary to use recycled resources in place of natural aggregates in concrete. We find through a review of the relevant literature that utilising recycled aggregates as a replacement for natural aggregates is an effective way to manage the disposal of waste concrete. In addition, we investigate the effect that steel fibres have on SCC and find that using recycled aggregates as a replacement for natural aggregates is an effective way to manage waste concrete. On the subject of the torsional behaviour of steel fibre reinforced SCC, there is not a lot of research available in the literature.

The low tensile strength of concrete is one of the primary reasons for the material's poor performance in torsion. Cracks can be found in the mortar matrix as well as in the interfacial transition zone, both of which contribute to the low strength of concrete. When steel fibres are added to the mixture of concrete, the tensile capabilities of the concrete are greatly improved, as is demonstrated by a survey of the relevant academic literature in this area. In this study, we utilised hookend steel fibres with aspect ratios of 50, 70, and 100 respectively. The purpose of this research was to establish whether or not there was a connection between the aspect ratio of hookend steel fibres and the degree to which concrete was subjected to torsional stress. The effectiveness of SCC is evaluated relative to that of vibrated concrete (VC). It is possible to employ recycled aggregates in natural aggregate concrete, but only up to a certain point. After that point, the fresh and hardened properties of the concrete begin to clearly change. The influence of recycled coarse aggregate, often known as RCA, on the torsional behaviour of concrete is explored by substituting recycled coarse aggregate for 75 percent of the natural coarse aggregate.

Research Significance

Few studies have focused on the torsional properties of SCC, and even fewer have examined the torsional behaviour of GFRSCC made from recycled coarse aggregate (RCA). Therefore, the purpose of this research is to examine the impact of glass fibre with various aspect ratios (0%, 0.5%, 1%, and 1.5%) on the plastic, elastic, and torsional properties of SCC and to compare these results to those obtained with conventional concrete (TVC). The utilisation of RCA as a replacement for natural coarse aggregates at varying percentages (0%, 20%, 30%, and 40%) and in combination with glass fibres for both SCC and TVC is studied. We cast 16 beams with different parameters (plain concrete, fibre reinforced concrete, glass fibre aspect ratio, 30 MPa concrete) to see how

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they perform under stress. Fibers at a dosage of 0.5% by volume of concrete.

III. Materials and Methods

Cement: The cement utilised in this study is regular 42.5-grade Portland cement with 90-micron cement particles. The substance had a standard consistency of 32% and a specific gravity of 3.12.

Fine Aggregate: The IS: 383-1999 [20] zone-II compliant desert sand that was readily available in the area was employed. The sand had a bulk density of 1.41g/cc, a specific gravity of 2.68, and a fineness modulus of 2.9.

Coarse Aggregate: Crushed granite aggregate with a maximum size of 16 mm has been used, as specified by IS: 3831999 [20]. Coarse aggregate has a bulk density of 1.46g/cc and a specific gravity modulus of 2.7.

Recycled Coarse Aggregate (RCA): The RCA for this experiment came from the crushing of concrete cubes that had already been tested in the concrete lab at the Benha Faculty of Engineering. The aggregates were washed in water to eliminate any contaminants, presoaked for 30 minutes, and then allowed to dry in the air before being used. The coarse aggregate had a bulk density of 1.30g/cc, a specific gravity of 2.52, and a fineness modulus of 7.10.

Chemical Admixture: We employed a superplasticizer based on modified polycarboxylates, which conforms to IS 91031999 [23]. Master Glenium SKY 8612 is the name of the product. The normal dosage is 1.5% of body weight.

Glass Fibers: chopped type E glass into monofilament fibres. To facilitate better initial dispersion and bonding, silane-based sizing is applied to the fibres. The fibres have a diameter of 13 microns and a length of 18 (for scientific purposes) millimetres. Potable water is utilised in the concrete mixing and curing processes.

Mix Proportions:

The Nan Su, et al. [6] method was utilised in the development of the SCC mix percentage, whereas the International Standard: 10262-2009 [26] serves as the foundation for the standard 20 MPa vibrated concrete mix proportions. The components of the material, together with their corresponding split tensile and cube compressive strengths, are broken down and presented in Tables 1, 4, and 5. In this study, samples of concrete were evaluated according to the standards described in IS: 516-1999 [27].

TABLE 1: Quantities of ingredients (kg/m^3).

No.	Specimen Code	% of RCA	% of Fiber	Compaction	Gravel	Sand	Cement	Water	RCA	Fiber	S.P.
1	CS	0	0	SCC	68.06	34.03	18.56	8.35	0	0	0.27
2	R0 – F1- S	0	1		67.13	33.57	18.56	8.35	0.00	1.36	0.27
3	R20 – F1- S	20	1		55.85	33.51	18.56	s	11.17	1.36	0.27
4	R30 – F1- S	30	1		51.51	33.48	18.56	8.35	15.45	1.36	0.27
5	R40 – F1- S	40	1		47.81	33.47	18.56	8.35	19.11	1.36	0.27
6	R30 – F0- S	30	0		52.23	33.95	18.56	8.35	15.67	0	0.27
7	R30 – F0.5- S	30	0.50		51.87	33.72	18.56	8.35	15.56	0.68	0.27
8	R30 – F1.5- S	30	1.50		51.15	33.25	18.56	8.35	15.35	2.03	0.27
9	CT	0	0	TVC	68.53	34.26	18.56	8.35	0	0	0
10	R0 – F1- T	0	1		67.60	33.80	18.56	8.35	0	1.36	0
11	R20 – F1- T	20	1		56.23	33.73	18.56	8.35	11.24	1.36	0
12	R30 – F1- T	30	1		51.88	33.72	18.56	8.35	15.57	1.36	0
13	R40 – F1- T	40	1		48.13	33.69	18.56	8.35	19.25	1.36	0
14	R30 – F0- T	30	0		52.59	34.19	18.56	8.35	15.78	0	0
15	R30 – F0.5- T	30	0.50		52.23	33.95	18.56	8.35	15.67	0.68	0
16	R30 – F1.5- T	30	1.50		51.51	33.48	18.56	8.35	15.45	2.03	0

Experiments were conducted on fiber-reinforced SCC and TC beams made with recycled concrete with zero, twenty, thirty, and forty percent aspect ratios by weight. Aspect ratios of zero, half a percent, one percent, and 1.5 percent of fibre by volume of concrete are all possible. In total, 16 beams measuring 1700 mm in length and 1500 mm in test span were cast, with each beam's cross section measuring 100 mm in breadth and 200 mm in depth. Compressive strength was determined by casting and testing three identical 150 mm cubes in accordance with IS: 516-1999 [27]. All the samples were cured for up to 28 days at room temperature and submerged in water.

Experimental setup

The previously stated beams were whitewashed and divided into two portions after curing for 28 days; these sections were placed L/3 and 2L/3 from the left side of the beam, with L being the unsupported length and equal to 1500 mm. Marks were made on all sides of the beams between the two segments so that the angle of the crack could be gauged. The ends of the beams were made to be simply supported by putting them on two solid supports. A roller was installed on the longitudinal supports to facilitate beam twisting. The bearing on the East face of the beam was somewhat constrained to spin about the

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longitudinal axis. The twist arms at each beam support were custom-made and installed to have an arm length of 1.8 m. To apply the force to the twist arm, a mechanical screw jack was used. Since the twisting arm and loading plane were perpendicular to the beam's longitudinal axis, the beam was only subjected to pure torsion and no bending occurred. In Fig.1 we see the entire setup for testing.

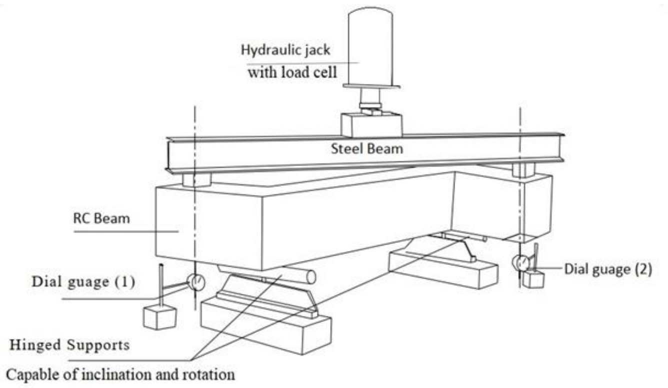

Fig. 1: Schematic Diagram of Loading for Beams under Torsion

The load was 1.51 metres off centre on the beam. Digital readings of the load were taken. Beam twist was measured using twist metres. The twist metres in Fig. 2 have a steel frame that is fastened to the beam using transverse screws. Rigid steel frames were employed, with arms extending 230 millimetres from the vertical faces of the frame, to make rotation measurements easier. Underneath the steel arms, as indicated in Fig. 2, four dial gauges were installed. The dial gauges had a 250 mm separation, allowing for the computation of twist per unit length.

Testing Procedure:

Fig. 2: Torsion test set up

The mechanical jack was utilised to gradually apply a transverse load to the beam's stiff supports that were aligned in an East-West direction. As a consequence of this, the beam will not bend in any direction. A fresh evaluation of the specimen's twist per unit length was carried out after each iteration of the load increase. Following the conclusion of the test, the angle of the potential crack was analysed. The crack pattern of beams in all four different orientations is depicted in Figure 3.

IV. Results and Discussions

The properties of newly formed SCC were tested in a number of ways to ensure their workability (see Section 3.1). Tests for TVC included slump flow, a slump test, and a compaction factor test. Tables 2 and 3 display the fresh qualities of TVC and SCC, respectively.

TABLE 2: Fresh Properties of SCC

Specimen Code	Slump Flow (mm)	T500 mm (sec)
EFNARC Limits	**550-850**	**2-5**
CS	780	2.31
R0 – F1- S	735	3.16
R20 – F1- S	720	3.69
R30 – F1- S	765	3.7
R40 – F1- S	680	4.42
R30 – F0 - S	720	3.28
R30 – F0.5- S	710	3.92
R30 – F1.5- S	690	4.14

TABLE 3: Fresh properties of Traditional Vibrated Concrete

Specimen Code	Slump (mm)	Compaction Factor
CT	125	0.96
R0 – F1- T	100	0.94
R20 – F1- T	97	0.93
R30 – F1- T	95	0.92
R40 – F1- T	89	0.84
R30 – F0- T	94	0.9
R30 – F0.5- T	92	0.88
R30 – F1.5- T	90	0.85

Compressive and Split Tensile Strength:

TABLE 4: Details of the mechanical properties of self-compacting concrete.

Specimen Code	Cube Compressive strength (MPa)
CS	293.48
R0 – F1- S	258.22
R20 – F1- S	236.30
R30 – F1- S	203.85
R40 – F1- S	266.37
R30 – F0- S	234.81
R30 – F0.5- S	239.41
R30 – F1.5- S	239.70

TABLE 5: Details of the mechanical properties of Traditional Vibrated Concrete.

Specimen Code	Cube Compressive strength (MPa)
CT	315.56
R0 – F1- T	304.59
R20 – F1- T	299.11
R30 – F1- T	303.85
R40 – F1- T	281.33
R30 – F0- T	281.19
R30 – F0.5- T	314.37
R30 – F1.5- T	270.07

Crack Pattern:

Beam failure under pure torsion is analysed by determining the orientation of cracks after they have formed. When a structural member is subjected to just torsion, the result is torsional shear. Because of the pure shear state, there is biaxial compression-tension in the diagonal directions. The imposed torsional shear stress is balanced by compressive and tensile stresses along these diagonals. Torsion causes compressive and tensile loads that cancel each other out, leading to cracking at an angle of 45 degrees. Measuring the crack's length from each

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of the beam's edges reveals its angular orientation. The angle of the fracture, measured in relation to the long axis, stays within a narrow range of 29° to 57° regardless of whether fibres are present, recycled aggregate is used, or the aspect ratio is increased. This finding indicates that the aforementioned parameters have little to no bearing on the fracture angle's inclination, which suggests that compressive and tensile stresses are the primary determinants of the crack angle.

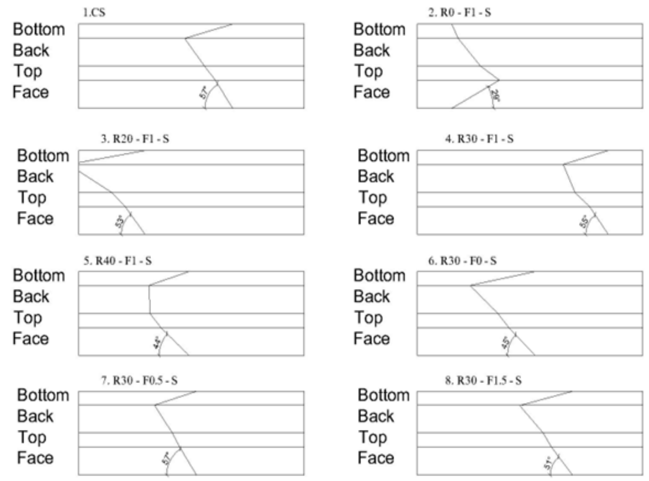

Fig. 3(a): Crack pattern on four sides of self-compacting concrete beams

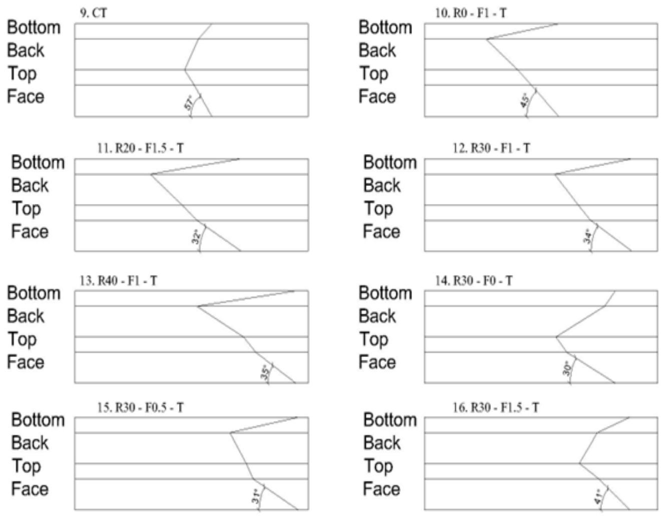

Fig. 3(b): Crack pattern on four sides of traditional vibrated concrete.

3.4 Torsional Properties:

TABLE 6: Torsion properties of SCC and TVC beams

Specimen code	Ultimate Torque (kNm)	Twist at ultimate torque (10-3 rad/m)
CS	**7.8**	0.0102
R0 – F1- S	**7.4**	0.0033
R20 – F1- S	**5.52**	0.0021
R30 – F1- S	**5.85**	0.0071
R40 – F1- S	**6**	0.0173
R30 – F0- S	**6.75**	0.0134
R30 – F0.5- S	**4.8**	0.0075
R30 – F1- S	**5.85**	0.0071
R30 – F1.5- S	**7.2**	0.0133
CT	6.15	0.0078
R0 – F1- T	5.85	0.0316
R20 – F1- T	**4.2**	0.0107
R40 – F1- T	4.2	0.0217
R30 – F1- T	4.5	0.0217
R30 – F0- T	**4.2**	**0.0084**
R30 – F1.5- T	**4.05**	**0.0103**
R30 – F1- T	**4.5**	**0.0217**
R30 – F0.5- T	**4.65**	**0.0145**

Discussion on Test Results:

High water absorption capacity of recycled aggregates and the incorporation of steel fibres in SCC both impair the workability of RAC mixtures because they prevent the aggregates from freely moving within the concrete. We do see a decrease in workability, although it falls within the parameters established by EFNARC (2005) [7].

The localised reinforcing capacity of fibres and their ability to halt the opening and widening of micro fractures are responsible for the improvement in the concrete's mechanical properties. Tensile characteristics were found to be greater in fibres with a 70 aspect ratio compared to those with a 50 or 100 aspect ratio for both SCC and VC. Both plain and steel fibre beams of SCC and VC failed with one possible crack, as shown in the testing. All of the plain beams failed suddenly, violently, and independently. In contrast, both SCC and VC steel fibre beams have demonstrated superior ductility without breaking into two parts, while failing with a single possible crack. This is because the steel fibres in the matrix are locked into place. Both plain and fibrous beams of both concretes broke in a skew bending failure mode. The failure was caused by a tension crack forming on the longer face, propagating to the top and bottom faces, and joining on the fourth face as a compression hinge (collapse).

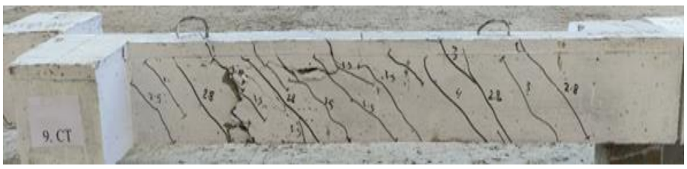

Fig. 4: Crack pattern

Table 6 displays the torsional characteristics of both concretes. Fibers added to either concrete have boosted its torsional strength. Torsional stiffness of beams was shown to increase with the addition of steel fibres, as indicated by the linear portion of the torque-twist curve (the slope of the initial tangent). The addition of steel fibres has increased the matrix's modulus, which accounts for much of the improvement. The use of steel fibre greatly increases the torsional toughness of concrete, as measured by the area under the torque-twist curve. This is because of the fibrous matrix's ability to prevent cracking and absorb energy. Table 7 displays the increases in torsional characteristics, both SCC and VC, of fibrous beams compared to plain beams.

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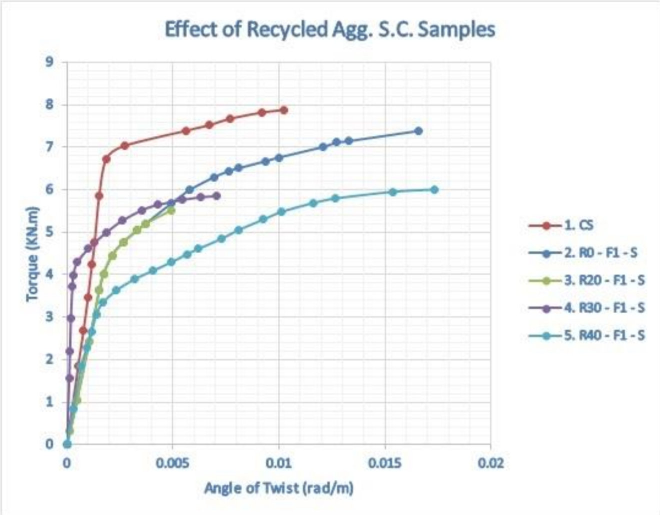

Fig. 5: Torque-Twist behavior of SCC – Effect of recycled Agg.

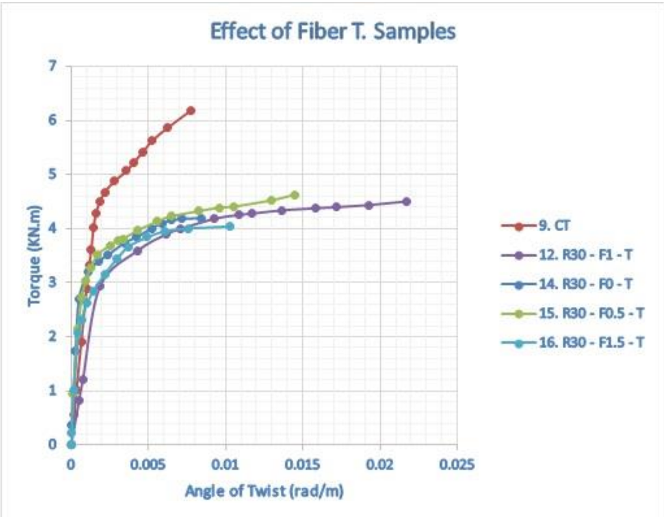

Fig. 6: Torque-Twist behavior of TVC - Effect of fiber

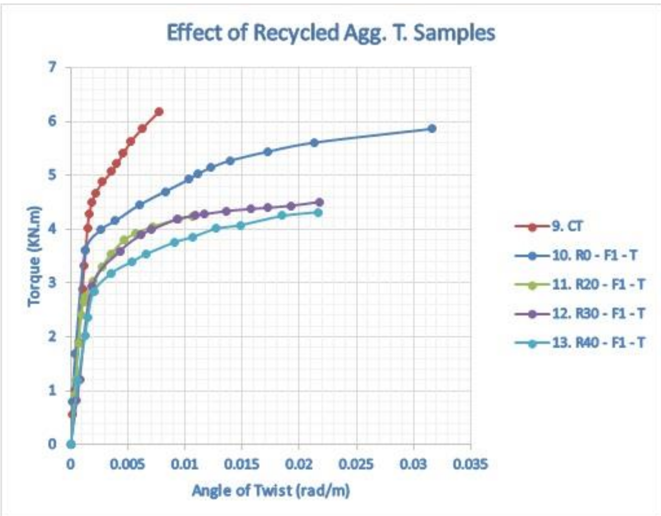

Fig. 7: Torque-Twist behavior of TVC - Effect of recycled Agg

Evaluation of Test Results Against Several Published Models:

In this paper, we compare the torsional strength models for vibrated concrete that can be found in the existing literature with the experimental results that were achieved for the ultimate torsional strength of TVC and SCC.

Elastic Theory [1]:

Saint Venant first proposed an equation for applying elastic analysis to determine the torsional strength (Te) of rectangular sections, and it is written as follows. $T_e = \alpha b^2 d f_t$

Where b is the beam's width (the smaller dimension), d is the beam's depth (the larger dimension), and ft is the concrete's tensile strength.

Using the membrane analogy, we can calculate the torsion of a completely plastic elastic rectangular section. For the sake of conservatism, this theory disregards the marginal increase in ultimate torque for plain concrete parts caused by plasticity. Therefore, it could appear acceptable to use Saint-elastic Venant's theory of torsion to accurately estimate the ultimate torque. The ultimate torque is greatly underestimated by the elastic theory, however, as shown by testing on plain concrete members.

Plastic Theory [1]:

The torsion analysis of a fully plastic rectangular section is achieved through the implementation of the sand heap analogy. Consequently, the expression representing the torsional strength is formulated as follows: $T_p = \alpha b^2 d f_t$

For plastic analysis, the value of 'α' is given as (0.5 - (b/6d)).

Hsu [29] ran extensive pure torsion experiments on flanged and rectangular sections of plain concrete. The most important discovery was that rectangular members made of plain concrete failed owing to skew bending when exposed to pure torsion. The following equation describes the maximum torque of the plain concrete rectangular section.

$T_{ue} = 1/3(b^2 d\ (0.85 f_r))$

Where 0.85 is the reduction factor used to adjust the modulus of rupture-based flexural tensile strength fr.

Souza and Wilhem [30] They conducted experiments on simple rectangular concrete beams in order to develop a formula that could be used to predict the torsional strength of the member. The following phrase characterised the torsional strength:

$T_{cr} = 0.412\ (1-0.233 b/d)\ b^2 d f_t'$

Wherein 5/6.7 times the split tensile strength is equal to the direct tensile strength of concrete per square foot (0.75(0.42 (compressive strength)).

T.D.G Rao et al. [11] rectangular plain steel fibrous concrete members were subjected to pure torsional testing. To predict the member's final torsional strength, they devised a semi-empirical formula.

$$T_g = (0.5-0.233(b/d))\ (b^2 d f_t)$$

TABLE 8 Torsional strength of SCC beams in kNm.

Specimen Code	Elastic Analysis (T_e)	Plastic Analysis (T_p)	Hsu (1968) (T_{ue})	Souza (1973) (T_{cr})	Rao (2004) (T_g)	Exp. Torque (T_{exp})
CS	2.9	4.92	3.35	4.3	4.53	7.8
R0 – F1- S	2.62	4.43	3.01	3.87	4.08	7.4
R20 – F1- S	2.62	4.44	3.02	3.88	4.09	5.52
R30 – F1- S	2.56	4.34	2.95	3.79	4	5.85

R40 – F1-S	2.6	4.4	2.99	3.84	4.05	6
R30 – F0-S	2.84	4.81	3.27	4.2	4.43	6.75

TABLE 9: Torsional strength of TVC in kNm.

Specimen Code	Elastic Analysis (T_e)	Plastic Analysis (T_p)	Hsu (1968) (T_{ue})	Souza (1973) (T_{cr})	Rao (2004) (T_g)	Exp. Torque (T_{exp})
CT	2.75	4.67	3.17	4.08	4.29	6.15
R0 – F1-T	2.56	4.33	2.95	3.78	3.99	5.85
R20 – F1-T	2.6	4.41	3	3.85	4.06	4.2
R30 – F1-T	2.62	4.44	3.02	3.88	4.09	4.5
R40 – F1-T	2.64	4.47	3.04	3.91	4.12	4.2
R30 – F0-T	2.76	4.67	3.18	4.08	4.3	4.2
R30 – F0.5- T	2.64	4.48	3.04	3.91	4.12	4.65
R30 – F1.5- T	2.52	4.28	2.91	3.74	3.94	4.05

V. CONCLUSIONS:

1. Glass fibres can be added to any form of concrete to boost its compressive strength while decreasing its fresh concrete properties. The split tensile strength of both concretes is greatly improved by the addition of glass fibres compared to unreinforced concrete.
2. The aspect ratio of the glass fibre, from 0.5 to 1.5, significantly affects the torsional toughness, ultimate torsional strength, and twist at ultimate torque. Both superplastisizer-containing and -free concrete mixtures can benefit from this improvement.
3. The maximum torsional strength and angle of twist were enhanced when glass fibres were added to both SCC and TVC.
4. It was discovered that SCC had superior torsional properties versus TVC. This is true whether or not the concrete contains a superplastisizer.
5. Glass fibre ratios of 1.5 in SCC and 0.5 in TVC were found to be optimal. The optimal percentage of RCA was also determined to be 30%.

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Highlights:

- The present investigation is focused on the torsional behaviour of Self compacting Concrete
- It highlights the effect of glass fiber and its aspect ratio on various grades of concrete.
- The present investigation produces the sustainable concrete with the use recycled concrete aggregates along the glass fibers
- The experimental torsional strength of Self compacting concrete is compared with standard approaches available in literature review
- The torsional behavior of self-compacting concrete is compared with the conventional vibrated concrete.