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AN EXPERIMENTAL EVALUATION OF MECHANICAL PROPERTIES FOR UHSC MIXES

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ABSTRACT

Ultra High Strength Concrete (UHSC) originally proposed by Richard & Cheyrezy (1995) composed of cement, SF, quartz sand, quartz powder, steel fibres, superplasticizer etc. Later, other ingredients such as fly ash (FA), ground granulated blast furnace slag (GGBS), metakaoline, copper slag, fine aggregate of different sizes have been added to original UHSC. The main aim of the study is to examine an experimental evaluation of mechanical properties for UHSC mixes. Several mixes were made to finalize the mix which exhibits the required mechanical properties. Mechanical properties were evaluated for all the mixes. Mechanical properties include compressive strength, split tensile strength, flexural strength and modulus of elasticity. Ten UHSC mixes with various ingredients have been tested for evaluation of the above mechanical properties. The compressive strength, split tensile strength, flexural strength and modulus of elasticity of mix TM-10 corresponding to 28 days are 109MPa, 11.5 MPa, 27.35MPa and 35.43 GPa respectively.

Keywords: compressive strength, split tensile strength, flexural strength and modulus of elasticity, UHSC mix etc.

INTRODUCTION

Concrete evolution is defined in concrete technology as development of numerous forms of concrete. NSC progressed to High Strength Concrete (HSC) around 1970, a form of concrete with high compressive forces (55 MPa ormore) (McCormack & Brown, 2014).

The use of outstanding performance construction materials to build larger and safer structures is a contemporary trend in architectural engineering. Skyscrapers of various sorts have been built across the world as city landmarks, including Burj Khalifa, Shanghai Tower, Lotte World Tower, and One World Trade Center. One of fundamental design and construction techniques of such skyscrapers is the ability to successfully pump fresh concrete from ground to top of tower while maintaining structural integrity under extremely high longitudinal and lateral pressures produced by self-weight, wind, & disasters. These key skyscraper building needs may be addressed by creating self-consolidating UHSC. With a seamless flow of fresh concrete in pumping pipe, some of segregation that occurs during pumping may be minimized if a correct viscosity of the self consolidating concrete is created by employing large volumes of binder and superplasticizer. Based on use of UHSC with a compressive strength greater than 180 MPa for manufacturing, particularly for columns, very high lateral force owing to structures' self-weight may also be resisted with sufficient stability.

The introduction of Supplementary Cementitious Materials (SCMs) has significantly changed how UHPC is designed, produced, and built. The process's detrimental effects on carbon consumption, energy and resource use, and greenhouse gas (GHG) emissions are its main drawbacks. Global GHG emissions arelinked to global climate change, which is receiving much-needed attention, according to academics worldwide. Although there hasn't been much research onsustainability of SCMs, both scholars and engineers have mostly ignored the significance of the subject.

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Several prior research were undertaken to assess various material and structural capabilities of UHSC components (Kimura et al. 2007; Maruyama et al. 2012; Bindiganavile et al. 2002; Cwirzen et al. 2008; Lee 2012). Kimura et al. (2007) investigated seismic behavior of UHSCcolumns with compressive strengths of 200 MPa or higher. For the UHSC mixture, they (Kimura et al. 2007) employed a cement premixed with SF, sand, small-sized CA with a maximum particle size of 13mm, & a very low water-binder (W/B) ratio of 0.13. According to preliminary test findings, hooked-end steel fibers utilized as supplementary reinforcement increase flexural strength & axial load bearing capability up to a drift angle of 3 percent, & result in minimum column damage with superior crac dispersion. The research team of Mar et al. (2012) examined full-scaleUHSC columns in both the summer & winter seasons to examine how stress is distributed & fracture patterns, discovering many fractures induced by retention heat and autogenous shrinks around the steel reinforcing parts and within the columns.

OBJECTIVES OF THE STUDY

The main objective of the study is to examine an evaluation of mechanical properties for UHSC mixes.

LITERATURE REVIEW

Pyo et al. (2017) studied mechanical characteristics and shrinkage of UHPC with coarser fineaggregates up to 5 mm in particle size. Particle packing theory was used to properly develop UHPC blends with varying sizes of solid ingredients. UHPC mixes incorporating dolomite or basalt, as well as four fibre volume fractions up to 2 volume percent, were studied. The initial cracking tensile strength, ultimate tensile strength, tensile strain capacity, & cracking pattern were all evaluated using an axial tension test. At the age of 56 days, the UHPC mixes containing more than one volume percent dolomite and steel fibers obtained more than 150 MPa of compressive strength, as well as strain hardening behavior & a small drop in tensile strength compared to conventional UHPC without finer fine particles. The experimental findings demonstrate use of dolomite as a coarser crushed stone in UHPC.

In UHSC, Hossain et al. (2017) presented a research on bond properties of glass fiber reinforced polymer (GFRP) bars. As per RILEM standards, 144 beam specimens with varying characteristics such as bar diameter, GFRP bar types (standard low modulus 'LM' & high modulus 'HM'), three UHSC strength/classes, & embedding length (3, 5, & 7 times bar diameter) were evaluated. Based on testing data, the performance of different Codes and other known formulae in calculating the bonding capacity of both low/high modulus GFRP bars implanted in UHSC is presented. Bond strength dropped as embedment length increased, with maximum bond strength reductions of 31% and 37% observed for HSC and UHSC, respectively. Bond strength decreased with increasing bar size for both HSC/UHSCs, with maximum bond strength reductions of 12% and 42% for LM and HM bars, respectively. Bond strength was calculated with caution using code-based and other known algorithms.

Xiong et al. (2017) investigated flexural behavior of concrete filledtubes made of high tensile steel and UHSC. The use of high strength components in steel-concrete composite members is expected to boost resistance while also achieving sustainability norms. This study presented brand-new test results on structural performance of CFST components under flexural stresses. UHSCwith compressive cylinder strength upto 180 MPa & high tensile steel withyield strength up to 780 MPa were used. The findings of the tests will be used to establish whether employing high tensile steel and UHSC in CFST members will allow for crosssection plastic moment resistance. The analytical results predicted by the Eurocode 4 approach were compared to the maximum moment resistance determined through testing. The Eurocode 4 technique was then securely enlarged by design ideas to assess flexural resistance of CFST members manufactured of high-temperature steel & UHSC.

Shin et al. (2019) optimized the proportions and ingredients of the mixture utilized to make 180 MPa UHSC with CA. Several elements, including the type and quantity of supplementary cementitious material (SCM), the water-binder(W/B) ratio, the fine & CA type and amount, chemical admixture, and mixing technique, were addressed & their influence on compressive strength was investigated.

Rios et al. (2019) evaluated tensile properties of anultra-highstrength fibre-reinforced concrete manufactured with short and long steel fibres. The study demonstrates how pore size and distribution of concrete matrix are affected by type of fiber employed as reinforcement, which has an impact on tensile properties of concrete. The first-cracking tensile strength (ft) & ultimate tensile strength (ftu), which are connected to inner structure of concrete matrix, are calculated using an inverse analytical method described in literature. Our findings demonstrate that tensile characteristics, particularly first-cracking strength, rely on fibers utilized. These results allow for the quantification of fiber's impact and assist mix designers in choosing the right fibers to utilize when a high first-cracking tensile strength is required.

Amini Pishro and others (2020) The Local BondStress (LBS) b/w Ultra High-Performing Concrete (UHPC) & reinforcement steel bars was tested experimentally. As a result, a complete LBS equation for estimating local bond stress b/w reinforcing steel bars & UHPC was developed. An in-depth analysis of the data revealed that the values derived from the suggested LBS equation logically corresponded to the analytical and mathematical findings.

Sureshbabu, N., and Mathew, G. (2020) explore the bond-slip qualities of fly ash-containing concrete following high-temperature exposure. The decline in bond strength of concrete with increasing temperature exposure is less in fly ash concrete than in OPC concrete, owing to additional production of C-S-H with presence of silica in fly ash at raised temperatures, & varies with fly ash concentration. It has also been observed that when extreme conditions are applied to concrete, ductile behavior of bond-slip after peak strength of bond of ribbed bars reduces.

Shahri and Mousavi (2021) use 3 soft computingmodels, including multivariate adaptive regression spline (MARS), Kriging, & M5 model tree, to properly predict binding strength of spliced GFRP bars in concrete beams. The results reveal that suggested models greatly outperformed earlier models in terms of prediction accuracy. As compared to the best prior model, the suggested MARS, Kriging, & M5 models improved convergence coefficient by around 65, 63, & 49%, respectively.

H. Akbarzadeh Bengar and F. Ahmadi Zarrinkolaei (2021) investigate the effects of temperature (five temperatures), steel fibre ratio of volume (three the volume ratios), and building materials covering thickness over the rebar (three covers) on tensile strength, compressive strength, and concrete-steel rebar bond behavior. The results showed that increasing the temperature decreased compressive strength, with the strength of plain specimens after 800 °C exposure reducing by 71.6% when compared to equivalent non-heated exhibits.

Liang, R.; Huang, Y.; Xu, Z. (2022) investigated the bond behaviour of deformed steel bars and UHPC in an experimental study. Loading technique, UHPC strength, steel fibre type & composition, rebar diameter, & cover thickness were all investigated. The samples failed in three ways, according to the testing results: pull-out, splitting + pull-out, & cone failure. UHPC strength during compression, cover thickness, and fiber properties are the key elements influencing bond strength. Peak slip of rebar-UHPC rises as cover thickness & rebar diameter increase. Finally, an

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analytical model of bond stress-slip connection b/w UHPC & bent steel bar is constructed that closely matches the test results.

Lingqi Meng et al. (2023) developed an extremely light ultra-high strength concrete (L UHSC) with an apparent density range of 1995 kg/m3-2114 kg/m3 and a compressive load of 102.4-114.5 MPa over the whole design process. The proposed L-UHSC has a specific strength of more than 50 MPa/(t/m^3), making it tougher than standard structural lightweight aggregate cement (LAC). The functions of excellently good paste, lightweight stone aggregate (LWA), and steel fiber in L-UHSC were also revealed using SEM, mercury intrusion porosimetry (MIP), and strength testing. The data show that SF content has a bigger impact on density and toughness than the binder-sand ratio and aggregate ratio, with the aggregate ratio having the least impact. The compression strength, flexural strength, and splitting tensile strength of LAC improve by 44.3%, 120%, and 151%, respectively, from 0.5% to 2.0% steel fiber concentration, exceeding ultra-high performance (UHPC).

The study by Piotr Smarzewski et al. (2023) intended to assess the suitability of polypropylene fibres (PP) for reducing the brittleness of outstanding durability self-compacting concrete (HPSCC). The effect of PP fiber content on physical and fresh properties of PP-fiber-reinforced HPSCC was studied. At concentrations of 0.025, 0.05, 0.075, 0.125, and 0.25%, PP fibers were added to HPC blends with a high cement replaced by a combination of ground crumbled blast furnace slag. The exceptional performance of fresh and cured ecological HPSCCs containing 46% GGBS instead of cement and 0.025-0.25% PP fiber content demonstrates the enormous potential of employing these composites in a variety of building applications. Prospective GGBS recycling provides various advantages, including decreased cement usage in a long-lasting material, fewer rubbish in landfills, and lower emission levels of greenhouse gases.

Ahmed M. Maglad et al.'s (2023) investigation produced excellent results. That instance, when 24 percent of the cement mass is replaced by AWA (SBA 20% + CSA 4%), UHSC with tensile and flexural forces of more than 205 and 27 MPa are created at test age of 28 days. With 38 percent cement mass replacement by AWA (SBA 30% + CSA 8%), the lowest permeability of 140 joules and 0.95 (cm/sec) for chloride & water is achieved.

MATERIAL

The mechanical characteristics of concrete, which have a significant impact on its practical use on construction sites, are highly reliant on a variety of parameters, including the type of cement that is used, curing conditions, aggregate size, rate of loading, sample shape & size, and so on. Because of its extremely high easily compressed strength (in excess of 150 MPa) and flowable attributes with high volume parts of steel fibres (more than 2% by volume), RPC/UHSC/ultra-high-performance fiber-reinforced concrete (UHPFRC), which was developed in the mid-1990s, UHPFRC is particularly responsive to these factors. The following ingredients are used to prepare various UHSC mixes and final UHSC mixes

- Cement
- Micro-silica
- Flyash
- GGBS
- QuartzPowder
- QuartzSand
- M-Sand
- Coarse aggregate

- Fibres
- Water
- Superplasticizer

ANALYSIS AND RESULTS

The primary aim of the investigation is to arrive at a mix which exhibits more than 100 MPa compressive strength and 10 MPa tensile strength consisting of cement, industrial waste products, bi-products, Msand and CA. Keeping in view of this, mechanical properties such as compressive strength, split tensile strength, flexural strength, modulus of elasticity were evaluated for various UHSC mixes. Table 1 (A) presents various UHSC mixes planned for evaluation of mechanical and durability properties.

TABLE 1 (A) UHSC MIXES AND RELATED INGREDIENTS

INGREDIENT	MIX ID									
	TM-1	**TM-2**	**TM-3**	**TM-4**	**TM-5**	**TM-6**	**TM-7**	**TM-8**	**TM-9**	**TM-10**
Cement (kg/m^3)	500	600	700	800	600	600	600	600	600	600
Microsilica (kg/m^3)	100	100	100	100	100	100	100	85	150	100
Flyash (kg/m^3)	100	100	100	100	100	100	100	85	85	100
GGBS (kg/m^3)	150	150	150	150	150	150	150	85	85	150
Quartz powder(kg/m^3)	440	340	240	140	410	0	220	200	210	220
Quartz sand (kg/m^3)	915	930	950	965	845	0	370	460	450	460
Coarse aggregate,6mm (kg/m^3)	0	0	0	0	0	0	0	275	215	200
Coarse aggregate,10mm (kg/m^3)	0	0	0	0	0	0	0	275	215	200
Coarse aggregate,12mm (kg/m^3)	0	0	0	0	0	890	490	0	0	0
Msand (kg/m^3)	0	0	0	0	0	420	230	165	175	235
Water (litres)	170	170	170	170	176	190	175	190	200	170
w/b	0.13	0.13	0.13	0.13	0.13	0.21	0.15	0.18	0.17	0.14
Steel fibres (length = 60mm;dia. = 0.75mm)	0	0	0	0	0	1.5%	1.5%	1.5%	1.5%	1.5%
(length = 30mm;dia. = 0.6mm)	1.5%	1.5%	1.5%	1.5%	1.5%	0	0	0	0	0

PREPARATION

- A pan mixer machine of about 100 kg is used to mix concrete mixtures.
- In any planned mix, if CA is there, first CA is to be mixed thoroughly.
- The well-mixed dry binder powder and fine aggregate are then carefully put into the drum while the mixer rotates slowly.
- The mixer's speed is raised, & mixing procedure is repeated for 2 to three minutes.
- Water is then added.
- This speed is used for additional mixing until a homogeneous mixture is obtained.

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- Required quantity of superplasticizer is to be added by mixing with water
- After achieving the required slump, fibres are added.

Specimens with the following sizes were cast and tested as per relevant Bureau of Indian Standards to evaluate the mechanical properties.

Compressive strength: 100 mm Cube
Split tensile strength: 100 (Dia) x 200 mm (Height)
Flexural strength: 100mm (Breadth) x 100 mm (Depth) x 500 mm (length)
Modulus of elasticity: 100 (Dia) x 200 mm (Height)

The slump test were performed on all 10 mixes and the slump values were tabulated in Table 1 (B)

TABLE 1 (B) SLUMP VALUE FOR VARIOUS UHSC MIXES

	Mix ID									
	TM-1	**TM-2**	**TM-3**	**TM-4**	**TM-5**	**TM-6**	**TM-7**	**TM-8**	**TM-9**	**TM-10**
Slump (mm)	70	65	70	75	80	80	90	85	85	90

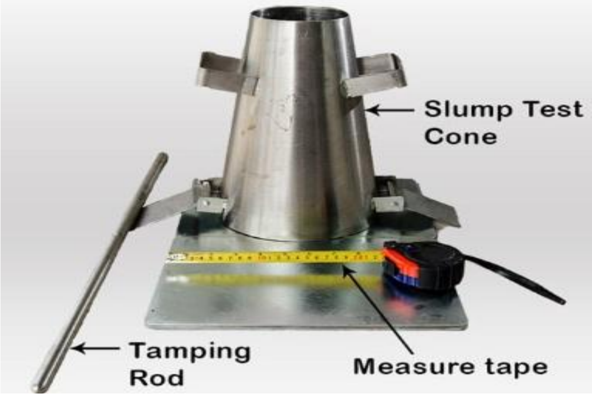
The test specimens were cast in respective cast iron steel moulds. The mould specimens were applied with oil in all inner surfaces for easy removal of specimens during demoulding. Three equal layers of fresh concrete were poured into molds, and molds were vibrated on a vibrating table to release any trapped air. To achieve complete compaction, the time of vibration was determined by how each mix looked when it was inspected. After 24 hours had passed after casting, specimens were demolded & put in a curing tank until testing. Typical casting & testing of UHSC specimens are shown in Figure 1. Five specimens were cast for each mix. Every specimen was cast in a controlled environment. The modulus of elasticity was estimated after 28 days, and the mechanical parameters such as compressive strength, split tensile strength, and flexural strength were assessed after 7 days & 28 days.

Compressive strength is very important mechanical property as it has relationship with all other mechanical properties and is primarily required for analysis and design of concrete structural components. All the specimens were tested under 300t capacity UTM as per IS: 516-1959. Splitting tensile strength is a measure of concrete tensile strength calculated by splitting the cylinder across its diameter. This is an indirect test method for determining tensile strength of concrete of cylinder test specimens. The compression testing equipment with a capacity of 2000 kN was used to apply load. The tests were carried out in accordance with IS 516-1959. Flexural strength tests were performed on 100mm x 100mm x 500mm prism specimens using a 500kN capacity flexural strength testing equipment and subjecting the specimen to 2 point loading to evaluate flexural strength in accordance with IS 516-1959.Modulus of elasticity is very important property of concrete, will be useful to develop constitutive relationship and also useful for analysis and design of structures/components.

TABLE 2 MECHANICAL PROPERTIES FOR VARIOUS UHSC MIXES

	Mix ID									
	TM-1	**TM-2**	**TM-3**	**TM-4**	**TM-5**	**TM-6**	**TM-7**	**TM-8**	**TM-9**	**TM-10**
Compressive strength 7 days, MPa	43.18	59.25	50.68	50.02	69.02	85.22	84.50	70.02	56.42	86.24
Compressive strength 28 days, MPa	46.84	78.80	55.91	58.81	93.67	96.58	93.12	92.85	81.64	109.20
Split tensile strength 7 days, MPa	4.57	6.22	5.42	5.32	7.45	8.99	90.09	7.37	6.07	8.7
Split tensile strength 28 days, MPa	4.96	8.56	5.90	6.36	9.86	10.17	9.71	8.52	8.46	11.5
Flexural strength 7 days, MPa	17.21	20.01	18.58	18.52	21.79	22.81	22.31	20.31	19.53	23.86
Flexural strength 28 days, MPa	17.45	22.45	18.96	20.11	24.38	25.35	23.64	24.18	22.13	27.35
Modulus of elasticity 28 days, GPa	20.12	28.23	23.23	24.36	31.23	33.49	31.04	30.94	28.94	35.43

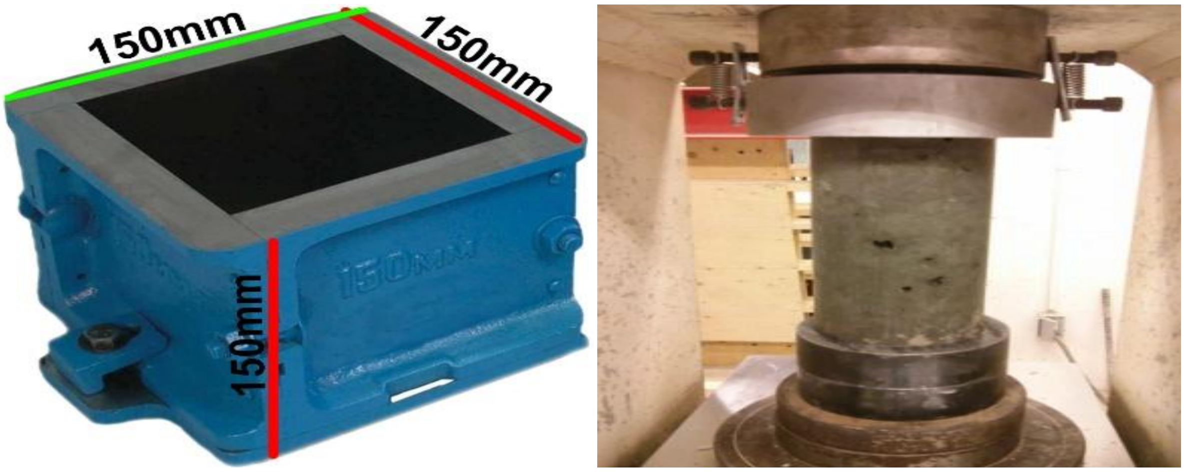
The test was performed as per guidelines of IS: 516 - 1959 by using an extensometer. The test is often performed on cylinders that contain extensometers. In the compression testing machine, the configuration is upright. Load is applied in increments, & length change is measured with an extensometer. This procedure is repeated until the prescribed load value, not necessarily failure load, is reached, at which point test is terminated. The measured length change can be converted to strain, and load may be converted to stress. As a result, a stresss train map may be generated, with slope indicating Young's modulus value. Table 2 displays the average outcomes achieved for various UHSC combinations.



SLUMP TEST

CASTING OF CUBES

CASTING OF CYLINDERS CURING OF SPECIMENS



TESTING OF A CUBE TESTING OF CYLINDER

TESTING OF PRISM MODULUS OF ELASTICITY TEST

FIGURE 1 TYPICAL CASTING AND TESTING OF SPECIMENS

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Table 3 presents the finalized UHPC mix details and the corresponding mechanical properties.

TABLE 3 FINALIZED UHSC MIXES WITH MECHANICAL PROPERTIES

INGREDIENT	MIX ID		
	UHSC0.5	UHSC1.0	UHSC1.5
Cement (kg/m^3)	600	600	600
Microsilica (kg/m^3)	100	100	100
Flyash (kg/m^3)	100	100	100
GGBS (kg/m^3)	150	150	150
Quartz powder (kg/m^3)	220	220	220
Quartz sand (kg/m^3)	460	460	460
Coarse aggregate, 6mm (kg/m^3)	200	200	200
Coarse aggregate, 10mm (kg/m^3)	200	200	200
Msand (kg/m^3)	235	235	235
Water (litres)	170	170	170
Steel fibres (length=30mm; dia.=0.6mm)	0.5%	1.0%	1.5%
Compressive strength @ 7 days, MPa	66	75	83
Compressive strength @ 28 days, MPa	87	98	109
Split tensile strength @ 7 days, MPa	6.9	7.8	9.7
Split tensile strength @ 28 days, MPa	9.1	10.3	11.5
Flexural strength @ 7 days, MPa	21.28	22.68	23.86
Flexural strength @ 28 days, MPa	24.43	25.93	27.35
Modulus of elasticity @ 28 days, GPa	31.67	33.4	35.43

From Table 2 and 3, it can be noted that the mixes (UHSC0.5, UHSC1.0 and UHSC1.5) containing CA (6mm and 10mm), Msand, binders and steel fibres exhibited improved mechanical properties. With increase of % fibre content, all mechanical properties enhanced significantly. The possible reasons for enhanced strength could be

- More pozzolanic reactions.
- Formation of additional calcium silicate hydrates (C–S–H).
- Denser microstructure.

The compressive strength of UHSC mixtures grows slowly with age, as shown in Tables 2 and 3. This is due to the rather thick structure of UHSC combined with a very low W/B ratio, which did not demonstrate enough free water for additional binder hydration at later ages. Enhanced compressive strength of UHSC is connected with increasing fibre content because more steel fibres can bridge more cracks and slow their development. Other researchers have validated the aforementioned elements (Cwirzen 2007; Wu et al. 2016). The investigations revealed that adding steel fibers to UHSC specimens changes failure mode from full damage to a near ductile behavior in which specimens can stay intact without chipping and spalling. El-Dieb 2009 also noted this observation. Other studies (Schmidt et al. 2003) showed that addition of high doses of steel fibers had no effect on UHSC compressive strength. UHSC combinations with higher aspect ratio fibers, for example, outperformed those with lower aspect ratio fibers in terms of flexural capacity. This was due to the fact that mixes with tiny diameter fibers (higher aspect ratio) included more fibers per unit volume of concrete, resulting in more fibers spanning fractures and hence increased flexural capacity. According to other investigations, UHSC can have flexural strength values of up to 48 MPa depending on the mixture design and healing regime. When flexural strength was compared to control beams that did not have fibers, the addition of 2.5% by mixture volume of steel fibers increased it by 144%. Liu et al. (2016) investigated the influence of CA and fiber on the strength properties of UHPC. It was determined that using CA to replace up to 25% of the mortar ingredients had a significant impact on mechanical properties. The experiments also revealed that as the percentage of fibers grew, so did the slump. Slump reduction might be ascribed to an increase in internal surface area, which resulted in greater cohesive forces between the fibers and the concrete matrix, as well as an increase in additional fiber content. Similarly, (Yu et al. 2014) obtained comparable results.

CONCLUSIONS

Several mixes were made to finalize the mix which exhibits the required mechanical properties. Mechanical properties were evaluated for all the mixes. Mechanical properties include compressive strength, split tensile strength, flexural strength and modulus of elasticity. Ten UHSC mixes with various ingredients have been tested for evaluation of the above mechanical properties. The mix TM-10 whose ingredients are cement, microsilica, flyash, GGBS, quartz powder, quartz sand, CA (6mm and 10mm), Msand, water, superplasticizer and steel fibres (length = 30mm, dia. = 0.6mm) exhibited the targeted mechanical properties. The compressive strength, split tensile strength, flexural strength and modulus of elasticity of mix TM-10 corresponding to 28 days are 109MPa, 11.5 MPa, 27.35MPa and 35.43 GPa respectively. The mix TM-10 has been considered as reference mix for further investigations. It is renamed as UHSC1.5 mix. Later, mechanical properties were evaluated for two more mixes (UHSC0.5 and UHSC1.0). The ingredients of the mixes UHSC0.5 and UHSC1.0 are same as UHSC1.5 except the % of steel fibres. UHSC0.5 contains 0.5% of steel fibres and UHSC1.0 contains 1.0% of steel fibres. From the experiments, it was observed that the slump reduced with the increase of percentage fibres. The reduction of slump could be due to the increase in internal surface area that produced higher cohesive forces between fibres and concrete matrix, with the increase of additional fibre content. It was further found that the % of fibres has significant effect on tensile strength. Mechanical properties were evaluated for UHSC mixes containing CA, Msand, various binders and steel fibres.

REFERENCES

1. McCormack, JC & Brown, RH 2014, ‘Design of Reinforced Concrete’, John Wiley & sons, Inc.: USA.
2. Kimura, H, Ishikawa,Y, Kamabayashi, A & Takatsu, H 2007, ‘ Seismic behavior of 200 MPa ultra high-strength steel fibre reinforced concrete columns under varying axial load’, Journal of Advanced Concrete Technologh, vol. 5, no. 2, pp. 193–200.
3. εaruyama, I, Suzuki, ε & Sato,R 2012, ‘Stress distribution and crack formation in full-scaled ultra-high strength concrete columns’, Materials and Structures, vol.45, no.12, pp.1829–1847.
4. Bindiganavile, V, Banthia, N & Aarup, B 2002, ‘Impact response of ultra-high strength fibre reinforced cement composite’, ACI εaterial Journal, vol. 99, no. 6, pp. 543–548.
5. Cwirzen, A, Penttala, V & Cwirzen, K 2008, ‘The effect of heat treatment on the salt freeze-thaw durability of UHSC’, Proceedings of the 2nd International Symposium on Ultra High Performance Concrete, pp. 221–30.
6. Lee, JH, Sohn, YS & δee, SH 2012, ‘Fire resistance of hybrid fibrereinforced, ultra high-strength concrete columns with compressive strength from 120 to 200 εPa’, εagazine of Concrete Research, vol.64, no.6, pp.539–50.

7. Sukhoon Pyo, Hyeong-Ki Kim & Bang Yeon δee, 2017, ‘Effects of coarser fine aggregate on tensile properties of ultra high performance concrete’, Cement and Concrete Composites, vol. 84, pp. 28-35.
8. Hossaina, KεA, Ametranob, D & δachemia, ε 2017, ‘Bond strength of GFRP bars in ultra-high strength concrete using RIδEε beam tests’, Journal of Building Engineering, vol. 10, pp. 69-79.
9. Ming-Xiang Xiong, De-Xin Xiong & Richard δiew, JY 2017, ‘Flexural performance of concrete filled tubes with high tensile steel and ultrahigh strength concrete’, Journal of Constructional Steel Research, vol. 132, pp. 191–202.
10. Jose D Rios, Carlos Leiva, MP, Ariza, Stanislav Seitl & Hector Cifuentes 2019, ‘Analysis of the tensile fracture properties of ultrahigh- strength fibre-reinforced concrete with different types of steel fibres by X-ray tomography’, εaterials and Design, vol. 1θη, pp. 1-14.
11. Amini Pishro, et al. (2020) Comprehensive equation of local bond stress between UHPC and reinforcing steel bars. Constr. Build. Mater. 2020, 262, 119942.
12. Sureshbabu, N.; Mathew, G. (2020) "Influence of Temperature on Bond–Slip Characteristics of Concrete Containing Fly Ash. Asian J. Civ. Eng. 2020, 21, 1013–1023.
13. Shahri and Mousavi (2021) "Bond strength prediction of spliced GFRP bars in concrete beams using soft computing methods", Computers and Concrete, Vol. 27, No. 4 (2021) 305-317.
14. Akbarzadeh Bengar, H.; Ahmadi Zarrinkolaei, F. (2021) Effect of Steel Fibers and Concrete Cover on Bond Behavior between Steel Deformed Bar and Concrete under High Temperature. Structures 2021, 32, 1507–1521.
15. Liang, R.; Huang, Y.; Xu, Z. (2022) Experimental and Analytical Investigation of Bond Behavior of Deformed Steel Bar and Ultra-High Performance Concrete. Buildings 2022, 12, 460.
16. Lingqi Meng et al. (2023) "Mechanical properties and microstructure of ultra-high strength concrete with lightweight aggregate" Volume 18, July 2023, e01745 https://doi.org/10.1016/j.cscm.2022.e01745.
17. Piotr Smarzewski et al. (2023) "Fresh and Mechanical Properties of High-Performance Self-Compacting Concrete Containing Ground Granulated Blast Furnace Slag and Polypropylene Fibres" Appl. Sci. 2023, 13, 1975. https://doi.org/10.3390/app13031975https://www.mdpi.com/journal/applsci
18. Ahmed M. Maglad et al. (2023) "Engineering properties of ultra-high strength concrete containing sugarcane bagasse and corn stalk ashes" Volume 23, March–April 2023, Pages 3196-3218 https://doi.org/10.1016/j.jmrt.2023.01.197.