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A STUDY ON BUILDING INFORMATION MODELLING RELATED TO COASTAL AND OFFSHORE ENGINEERING

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Abstract

The excellent mechanical properties of UHPC are mainly achieved by the use of a high amount of energy-intensive raw materials like Portland cement or micro steel fibers. Ultra-high performance concrete has a discontinuous pore structure that reduces liquid ingress, significantly enhancing durability compared to conventional and high-performance concretes. UHPC is being considered for use in a wide variety of highway infrastructure applications. The present paper discusses on off shore and coastal building material used by engineers.

Keywords: Building Information Modelling, Ultra High Performance Concrete, Engineering.

Introduction

One of the most often utilised building materials worldwide is concrete. In fact, this material is used twice as often than all other building materials combined, including wood, steel, plastic, & aluminium. As a result, a complete understanding of the real tangible behaviour is required given the material's widespread use. Since the stress-strain behaviour of concrete under uniaxial compression as well as tension loading was indeed nonlinear, using linear models to simulate the behaviour of concrete in numerical modelling methods results in inaccurate results, making the use of non-linear models a necessary solution to reduce the error margin. The accepted constitutive model has a significant impact on the results of non-linear models, hence it is crucial to pick the right one to forecast the accurate load-displacement and/or stress-strain lines.

In situations like geothermal energy recovery and fire incidents, ordinary concrete buildings may be heated to dangerous levels. Barite-based radiation shielding structures for deep disposal of nuclear waste may also frequently be subjected to high temperatures up to 400°C. High temperature exposure has a specific impact on the mechanical and microstructural characteristics of materials that resemble concrete, which may be a factor in the failure of these structural concrete. Moreover, these structures can be exposed to impact loads from terrorist attacks, earthquakes, operational blasting, petrol explosions, and operational blasting. Understanding the dynamic failure process of concretes after exposure to high temperatures is so desirable. The precise assessment of the dynamical strength properties of concrete-like composites after being subjected to high fatigue stress is the primary form of failure for these materials.

Much attention has been paid to the use of fibre reinforced polymers (FRP) for strengthening materials for structural components in civil engineering. When compared to outer strengthening with steel, carbon FRP reinforcement has proven to be advantageous in preventing or minimising known potential issues resulting from (i) local strain concentrations (ii) digging in earliest steel material (iii) significantly increased weight (iv) corrosion problem. Applications and studies have shown that CFRP laminates external reinforcement by bonding enhances the fatigue qualities of steel components by increasing strength capacity and stiffness [2-3].

However, the usage of CFRP laminates with large moduli has the greatest potential to raise the stiffness for steel beams, whereas the vertical strength and stiffness of the CFRP primarily influence the strength properties of steel beams. The coat used to attach the CFRP to the steel beam may reduce the pace at which cracks form when subjected to fatigue loading. Also, when subjected to fatigue loads, its CFRP locally debonds near a notch that, in the instance of the work done, was intentionally formed on steel beams. In this instance, it was discovered that the debonded length of something like the notched steel beam was significantly impacted by the lengthening of the crack. However, the usage of CFRP laminates with large moduli has the greatest potential to raise the stiffness for steel beams, whereas the vertical strength and stiffness of the CFRP primarily influence the strength properties of steel beams. The coat used to attach the CFRP to the steel beam may reduce the pace at which cracks form when subjected to fatigue loading. Also, when subjected to fatigue loads, its CFRP locally debonds

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near a notch that, in the instance of the work done, was intentionally formed on steel beams. In this instance, it was discovered that the debonded length of something like the notched steel beam was significantly impacted by the lengthening of the crack.

Due to uncertainties regarding the reinforced system's life cycle when exposed to prolonged severe environmental situations at the debonding issue of said CFRP bonded steel system, it is advised also that bond sturdiness of freeze-thaw environments be studied. Nevertheless, the long-term achievement of reinforced systems remains a significant concern. The weakest points of CFRP-reinforced steel systems include (i) adhesive loss (ii) adhesion breakdown at either the CFRP/adhesive as well as steel/adhesive interfaces (iv) CFRP delamination (v) CFRP rupture, or (vi) combined failure modes. It has frequently been discovered that the deterioration of the contact is substantially more essential compared to the adhesive [5].

Review of Literature

Wei (2018) [1] In order to assess the material's load carrying capacity and to restore thermos damaged buildings, it is crucial to understand the dynamic tensile failure process of concretes after exposure to high temperatures. We look into how two mortars' dynamic tensile strengths are affected by thermal damage. The temperatures used to heat-treat the Brazilian disc (BD) mortar specimens are 150°C, 250°C, 350°C, 450°C, 600°C, and 850°C. The CT measurements made using the X-ray Computer Tomography (CT) technology, the P-wave velocity, and the density are then used to calculate the thermal damage to two mortars.

Xuefeng (2019) The dynamic uniaxial and triaxial compression tests of sandstone were carried out with a traditional and modified triaxial SHPB system, respectively, to examine the dynamic Mohr-Coulomb and Hoek-Brown strength criteria at the low confining pressures at high strain rates. The strain rates ranged from roughly 40 s1 to 160 s1, and the confining pressures were 5.0 MPa, 7.5 MPa, 10.0 MPa, 12.5 MPa, and 15.0 MPa. The findings indicate that the internal friction angle has a linear negative correlation with the logarithm of strain rate while cohesiveness has a linear positive association.

Nasser (2020) Fiber-reinforced polymer (FRP) composite materials are effectively used to strengthen and renovate reinforced concrete (RC) structural elements. The repairing business is still concerned about their long-term endurance, though. Researchers and engineers have recently begun to pay attention to the usage of steel wire mesh-epoxy systems for strengthening, and their long-term endurance calls for research. In-depth experimental research on 60 RC beams strengthened in flexure by medium and high cord density galvanised steel mesh is presented in this work (MSM, HSM).

Engineering Approach for Material

A concrete compound with great durability, enhanced strength, and workability is ultra-high performance concrete (UHPC). The ability of steel fibres to improve the mechanical properties of concrete, including primary cracking resistance, impact resistance capacity, energy absorption capacity, toughness, and ductility, is generally known. UHPC has been effectively used in a variety of concrete built infrastructure due to its exceptional qualities, including large-span bridges, high-rise buildings, structural strengthening, retrofitting, and precast parts. Many experimental findings have proven that the failure of concrete material controls the failure of concrete buildings. The constitutive behaviour, or inherent mechanical response of concrete material under external loads, is one of the fundamental elements in the nonlinear analysis, design, and application of concrete structures. Various earlier investigations have established that the accumulation of plastic deformation and damage evolution is the primary source of the nonlinearity of concrete material and structure. To properly analyse and design UHPC structures for performance, a suitable and accurate elastoplastic damage constitutive model must be created.

Many efforts have been done to date to investigate the stress-strain behaviour of UHPC under compression, and several promising findings have been made. A UHPC mixture reinforced with 1.5% long and 0.5% short steel fibre had the highest compressive performance in terms of strength and toughness, according to research on the impact of hybrid steel fibres on the compressive behaviour of UHPC. models that have been developed to illustrate stress-strain curves and the stress-strain behaviour of UHPC during uniaxial compression. Moreover, a modified toughness index was suggested to reflect the steel fibres' reinforcing impact. Using aggregate gradation and optimum binder proportions, the compressive response of UHPCs was proportioned. The compressive behaviour of UHPC and the development of an equation for the stress-strain response's ascending branch. However, the majority of the currently available research on UHPC is focused on the mechanical properties under monotonic compression, and the equations that have been established are typically for the stress-strain relationship under monotonic loading.

It is well known that local material failure, which is primarily influenced by the degree of damage buildup throughout the loading process, is the primary cause of failure of concrete members and buildings. The most important factors for a precise prediction of the mechanical behaviour of UHPC structures are the damage evolution law and damage process at the material level. Yet, because UHPC is a type of heterogeneous composite material, damage to it is a multi-event phenomena, which complicates the UHPC material's damage disclosure. The acoustic emission (AE) technique, a type of nondestructive testing (NDT) technology, makes it possible to characterise material damage. Internal energy will quickly release and transform into elastic waves as a strained concrete crack begins to form and spread, and these waves will be picked up by sensors positioned on the material's surface. The failure pattern and fibre reinforcing mechanism can be identified by examining the AE signals produced during the loading procedure. From a microscopic perspective, the internal failure mechanisms of UHPC include fibre pullout, matrix cracking, and fiber-matrix debonding. From a macroscopic perspective, the tensile crack mode and the shear crack mode are the two crack patterns that determine the failure of UHPC. Higher average frequency (AF) and a smaller rising angle define the tensile crack mode (RA). The shear fracture mode, on the other hand, has a lower average frequency and a higher rising angle. The identification of the failure mechanism advances knowledge of the mechanical properties of UHPC materials and structures.

Conclusion

In conjunction with curved steel reinforcing bar (rebar) & prestressing strand, concrete has been widely employed as a building material. Steel rebar or strands, also known as reinforced concrete (RC) / prestressed concrete (PSC) elements, are only used in areas where tensile or shear stress occur because of their high compressive strength. Under quasi-static loading conditions, RC and PSC are successfully used as structural elements due of their improved tensile or shear resistance. However over the past few years, civil constructions or buildings have regularly been subjected to extreme loading circumstances, including such impacts, blasts, and flames from a wide range of events, including terrorist attacks. Ordinary RC and PSC constructions work well under static conditions, but because of concrete's weak capacity to absorb energy and brittleness, which cause it to fracture, they are inadequate under high pressures. Researchers have looked into concrete reinforced with continual textiles, discontinuous short fibres, outside fiber-reinforced polymer, etc. to solve the shortcomings with plain concrete during impacts and explosions. Researchers have most frequently used discontinuous fibres made of materials like steel, polymer, carbon, & basalt because they have several benefits, including being simple to incorporate into concrete mixtures, useful for improving concrete's toughness under effect or blast, and more affordable than alternative methods.

Fiber-reinforced concrete is a type of concrete that comprises discontinuous fibres oriented randomly (FRC). The cement matrix may effectively be protected by the randomly oriented fibres, which increases the post-cracking concrete's elasticity under static & impact loads. The fibres' ability to improve post-cracking ductility is dependent on how well their bonds operate, which is influenced by a variety of variables including the density of the fibres per unit area, their orientation, their shape, and their aspect ratio, among others. Thus, it is essential to thoroughly investigate the parameters impacting post-cracking ductility in order to correctly design FRC with practical application on civil structures and buildings. In static settings, the whole mechanical characteristics and advancements of FRCs with different fibre kinds (namely the, steel, glass, synthetic, & carbon fibres) were studied. If using FRCs for constructions under extremely high loads, the characteristics of FRCs are irrespective of the loading rate. Unfortunately, ordinary concrete and FRCs display completely different behaviours under impact as opposed to static settings and are both particularly sensitive at loading rates (namely, strain / stress rates), necessitating a new study of the current knowledge on the strength properties of FRC.

Conflict of Interest

There is no conflict of interest between the authors in this manuscript.

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