Flexural strengthening of concrete structures using prestressed fibre reinforced polymers

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Fibre bolstered polymers (FRP) reinforcement has been used for flexural strengthening either as AN outwardly warranted (EB) system within the style of FRP laminate (sheets, plates or strips) applied to the side tension facet of the ferroconcrete (RC) members or as a near-surface mounted (NSM) system within the style of FRP strips or bars embedded within a pre-cut groove into the concrete cowl at the stress facet of the RC member full of epoxy adhesive. though flexural strengthening victimisation non-prestressed FRP reinforcement will remarkably increase the last word strength of a member, it doesn't considerably amendment the behaviour of the member underneath service hundreds or considerably increase the stiffness of the member. It ought to be noted that in non-prestressed FRP strengthening application solely some of the strength of the FRP reinforcement is effective and therefore the system could be a passive strengthening technique that is still inactive till extra hundreds square measure applied. to realize a rise within the stiffness of the member, the strengthening system should move instead of passive. Thus, to boost the potency of the system, the FRP reinforcement ought to be prestressed before being warranted to the concrete. Therefore, by prestressing the FRP, the fabric is employed a lot of with efficiency as a result of a larger portion of its tensile capability is used, and it contributes to the supporting capability underneath each service and supreme conditions. Prestressing the EB and NSM FRP reinforcement needs a special anchorage system that ought to be sensible in implementation. In general, prestressing is employed to reinforce the flexural behaviour of ferroconcrete members underneath service hundreds particularly in bridges and (or) beams that have massive spans and there's a limitation on the deflection and serviceableness conditions. due to their high lastingness properties, FRP materials have nice benefits to be used in prestressing and post-tensioning strengthening applications. The specialised application of prestressing the FRP reinforcement for flexural strengthening of structures combines the noncorrosive and light-weight advantages of the FRP reinforcement with the benefits related to external prestressing. However, the difficult a part of the active FRP strengthening system is that the application of the prestressing force to the FRP material victimisation acceptable sensible anchorage and prestressing system. A comprehensive review on the techniques and anchorage systems developed to prestress the EB and NSM FRP with the main target on the utility of the prestressing systems wherever the FRP is prestressed against the member itself, and therefore the performance of members reinforced victimisation prestressed FRP reinforcement square measure mentioned during this presentation.

Concrete structures are used for an extended time and there area unit currently several structures that area unit in want of repair (Täljsten, Carolin, and Nordin, 2003). Concrete performs well beneath compression however can simply crack once subjected to tension. Cracking of concrete affects its performance and have a negative impact on the aesthetics in addition. Concrete

structures area unit designed for an extended time period and, because of the apace improving technology of nowadays, the structures can be subjected to higher masses than what was meant in the style section. rather than reconstruction structures, techniques for strengthening are developed. Fiber strengthened chemical compound (FRP) has been used as reinforcement for flexural strengthening of existing Reinforced Concrete (RC) structures, each as outwardly warranted (EB) and Near-Surface Mounted (NSM) to the side tension facet. The FRP is sometimes warranted with structural epoxy adhesive and each EB and NSM acts passively and will increase the bearing capability of the RC member. In usableness Limit State (SLS) the FRP, freelance of that manner it's used, doesn't contribute that a lot of, considering stiffness and cracking load, crack breadth and crack pattern. there's additionally a high risk of debonding at low utilization quantitative relation of the FRP material. To be able to utilize actuality strength of the FRP composites and build it act during a additional active way, the FRP may be prestressed before put in onto the RC member. once the FRP is prestressed there is one main important issue regarding peak shear stress at the top of the FRP. This force cannot be transferred to the RC member while not a mechanical anchor because of the limitation of strength within the concrete. Mechanical anchors area unit unremarkably used nowadays, however they involve challenges with corrosion and inspection. To make the method of putting in and maintaining the strengthening with FRP additional easy, a new method has been developed Haghani and Al-Emrani, 2016. during this technique, the necessity for mechanical anchorage is formed redundant. this can be done by prestressing the FRP in tiny steps to avoid the height shear stress at the top of the FRP. so as to check this new technique and examination it with gift strategies, full-scale tests were conducted at Chalmers University of Technology before this Master Thesis. Fiber strengthened chemical compound could be a material consisting of various phases. There are often one or several discontinuous sections embedded during a continuous phase. The discontinuous section is that the reinforcement consisting of fibers, that area unit sturdy and/or stiff and will offer the composite its strength. they're warranted at the side of associate either sturdy or weak interface. Both the reinforcement and therefore the matrix area unit generally light-weight. FRP will comprises each organic and inorganic fibers and therefore the most typical FRP in structural engineering is glass (GFRP), carbon (CFRP) and aramid (AFRP) at the side of a bonding thermosetting organic compound epoxy, vinylester or unsaturated polyester. The fiber half is that the largest volume dispense with concerning 60-70% of the composite. this can be because of the fibers being the most stress bearing part whereas the thermosetting organic compound (matrix or binder) is transferring the stresses between the fibers and protective them. FRP´s strength lies in the bearing capability because of all tiny fibers operating along and that they area unit very defect free orientation and microstructure. Since the matrix (binder) is that the stress transferring a part of the composite, it'll permit a sleek load transfer between broken or broken fibers and adjacent intact fibers, and additionally between intact fibers. The matrix system additionally results in decreasing native stress concentration and a rise of the simplex composite strength. It additionally protects the fibers mechanical injury and effects from the atmosphere. Glass fibers area unit the foremost unremarkably used fiber to bolster polymers with

and includes a big selection of different material properties. The fibers area unit a composition of silica and extra oxides that area unit very surface active and deliquescent. to boost the fibers behavior, individual fibers area unit processed with sizing to make sure enough protection against degradation and decent embedment inside the matrix. There area unit differing types of glass fibers and that they are often divided into teams counting on their chemical compound. the foremost common fiber is that the E-glass, that could be a low-priced fiber with adequate strength and electrical ohmic resistance. The S-glass fiber is stronger than the E-glass, with higher stiffness and thermal stability. C-glass is employed for its resistance against acids and AR-glass is nice for its resistance against alkalies, particularly from cement. Even though glass fibers have sensible mechanical properties, like high strength, sensible electrical resistivity, and sensible thermal resistance, generally, they suffer from a scarcity of protection against water, acids and alkalies. The fibers don't perform well against creep and show a stress rupture behavior beneath constant stress. Cracks in concrete structures seem because of its restricted strength once subjected to fret. When examining cracks in concrete structures and evaluating whether or not or not these cracks area unit to be thought-about damage, it's vital to grasp the look technique of the structure (Engström, 2014). Cracking of the concrete is to be expected and is calculated for within the style, by limiting the crack breadth. The calculations are supported simplified models and don't take into account a lot of description which may occur within the finish of the design. so it'd be exhausting to differentiate "normal" cracks, that area unit calculated for, from cracks that might cause sudden injury to the structure. once planning a concrete structure, the vital factors to contemplate area unit the number of Reinforcement Bars (Rebars) and to rearrange them during a manner in order that the structure and therefore the applied masses can stay in equilibrium once cracking of the concrete. Cracking is predicted however once planning structures that area unit gently strengthened, cracking would possibly imply danger as there's a risk of brittle failure.

Biography

Raafat El-Hacha is a Professor of Structural Engineering at the University of Calgary in the Department of Civil Engineering. His pioneer research has been recognized as pushing the boundary of knowledge in using innovative and smart advanced materials for strengthening existing structures and for new construction, such as fibre reinforced polymers (FRP), shape memory alloy, and ultra-high performance concrete for hybrid structural systems in bridge applications and other structures. He published over 220 journal and conference papers, co-authored 3 refereed design guidelines. Supervised and graduated 42 PhD and MSc students. Served as guest editor for 3 journals and edited/co-edited 8 conference proceedings. He is a Fellow of the International Institute for FRP in Construction (IIFC) and the Canadian Society of Civil Engineers (CSCE). He is the recipient of several awards and fellowships including the CSCE Casimir Gzowski Gold Medal, CSCE Excellence in Innovation in Civil Engineering

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