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Design Approach to Incorporate Unique Performance Characteristics of Special Concrete

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Abstract : The advancement in various concrete ingredients like plasticizers, additives and fibers, etc. has enabled concrete technologists to develop many viable varieties of special concretes in recent decades. Such various varieties of concrete have significant enhancement in green as well as hardened properties of concrete. A prudent selection of appropriate type of concrete can resolve many design and application issues in construction projects. This paper focuses on usage of self-compacting concrete, high early strength concrete, structural lightweight concrete, fiber reinforced concrete, high performance concrete and ultra-high strength concrete in the structures. The modified properties of strength at various ages, flowability, porosity, equilibrium density, flexural strength, elasticity, permeability etc. need to be carefully studied and incorporated into the design of the structures. The paper demonstrates various mixture combinations and the concrete properties that can be leveraged. The selection of such products based on the end use of structures has been proposed in order to efficiently utilize the modified characteristics of these concrete varieties. The study involves mapping the characteristics with benefits and savings for the structure from design perspective. Self-compacting concrete in the structure is characterized by high shuttering loads, better finish, and feasibility of closer reinforcement spacing. The structural design procedures can be modified to specify higher formwork strength, height of vertical members, cover reduction and increased ductility. The transverse reinforcement can be spaced at closer intervals compared to regular structural concrete. It allows structural lightweight concrete structures to be designed for reduced dead load, increased insulation properties. Member dimensions and steel requirement can be reduced proportionate to about 25 to 35 percent reduction in the dead load due to self-weight of concrete. Steel fiber reinforced concrete can be used to design grade slabs without primary reinforcement because of 70 to 100 percent higher tensile strength. The design procedures incorporate reduction in thickness and joint spacing. High performance concrete employs increase in the life of the structures by improvement in paste characteristics and durability by incorporating supplementary cementitious materials. Often, these are also designed for slower heat generation in the initial phase of hydration. The structural designer can incorporate the slow development of strength in the design and specify 56 or 90 days strength requirement. For designing high rise building structures, creep and elasticity properties of such concrete also need to be considered. Lastly, certain structures require a performance under loading conditions much earlier than final maturity of concrete. High early strength concrete has been designed to cater to a variety of usages at various ages as early as 8 to 12 hours. Therefore, an understanding of concrete performance specifications for special concrete is a definite door towards a superior structural design approach.

Keywords : high performance concrete, special concrete, structural design, structural lightweight concrete
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