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HIGH PERFORMANCE CONCRETE

BY

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Abstract. The paper presents the last studies and researches accomplished in Cluj-Napoca related to high performance concrete, high strength concrete and self compacting concrete. The purpose of this paper is to raid upon the advantages and inconveniences when a particular concrete type is used. Two concrete recipes are presented, namely for the concrete used in rigid pavement for roads and another one for self-compacting concrete.

Key Words: high strength concrete; high performance concrete; self-compacting concrete; rigid pavement of roads.

1. Introduction

Keeping concrete competitive with construction materials encouraged the achievement of new high performance, and implicitly, high strength and ultra-high strength concrete. The need for tall buildings and the construction of high-way program from Romania made high performance concrete with remarkable physical, chemical and mechanical characteristics to be used.

The convenient utilization of this concrete consists in

a) the reduction of structural elements' dimensions, which reduces the self-weight of structural members, material consumption and seismic loads;

b) the possibility to increase the bays and net areas;

c) the cost reduction of the structure.

There are some inconveniences in using the high performance concrete, namely the brittle failure, higher endogenous shrinkage and low fire resistance. All these disadvantages can be corrected by using fiber admixture or by replacing parts of heavyweight aggregates with lightweight ones.

From all high performance concrete types, a special place is taken by the self–compacting concrete. A short exposure of the recent studies and researches related to high performance concrete achieved in Cluj-Napoca, in PhD studies activity, is presented in the next sections.

2. High Performance Concrete for Rigid Pavement

The usage of high performance rigid pavement of roads compel in:

a) careful material selection;
b) compelling design of the composition;
c) the definition of the technology of casting the concrete;
d) characteristics quantification of fresh and hardened concrete;
e) composition reconfiguration due to preliminary test results.

Rigid pavements are mostly used on heavy traffic roads, highway networks and for airport tracks. This kind of pavement is used in extremely advantageous technical and economical conditions due to their great capacities, like: increased compressive strength after using high performance plasticizers combined with silica fume, the increased ageing resistance, a higher level of impermeability and a better frost resistance.

The process of preparation and casting concrete *in situ* enforces a cautious verification of the quality of the components, cement–superplasticizers compatibility, a very specific order of setting up the materials in blender and the need to obtain an optimum blending time.

The next composition of concrete has been obtained after the studies and researches accomplished [4] namely

a) cement CEM I 52,5R (LaFarge) – 520,4 kg/m^3,
b) gravel 8...16 (Morlaca) – 706 kg/m^3,
c) gravel 4...8 (Morlaca) – 530 kg/m^3,
d) water – 152 l/m^3,
e) silica fume (Tulcea) – 52 kg/m^3,
f) superplasticizer – 13.5 l/m^3.

providing a 63 MPa average compressive strength at 7 days, 71 MPa at 28 days and 84 MPa at 56 days.

The usage of this type of concrete, with competitive characteristics, for rigid pavement for road offers the possibility to reduce the thickness of the concrete slab up to 28% (from 25 to 18 cm).

3. The Beneficent Effect of Utilization High Performance Concrete (HPC) in Multi–Storey Reinforced Concrete Structures Design

The favourable characteristics of high strength/performance concrete (HSC/HPC) and its frequent utilization in construction practices confer itself a high interest and a large field of research. Pursuant to Task Group 8.2 of *Federation Internationale du Beton* meeting, who gathered all the existent information regarded this type of concrete, jelled a new set of constitutive relations implemented in the extended version of Model Code CEB-FIB 1990 for concrete up to C120. The new set of constitutive relations, published in FIB 42/2008

bulletin, extended the HSC/HPC domain establishing a new constitutive modeling which ensures a new frame for research and design activities.

Implication analysis of utilizing HSC/HPC in structural design for multistory buildings for Cluj-Napoca town, showed the limits in which this design approach is beneficent.

For this purpose, four alternatives – eleven storey frame building have been designed. Concrete C16/20, C50/50, C90/105 and C100/115 have been used for these four cases. The comparative analysis concluded that for a reasonable reinforcement consumption there is the possibility to seriously reduce the concrete quantity used.

4. Self-Compacting Concrete (SCC)

Self-compacting concrete appeared and established in Japan, in 1988, in order to by-pass the vibrating process and to reduce the erection times of the monolith/in situ concrete structures. After a short period of time it has been observed that SCC has few other advantages in comparison to classical concrete like: technical, technological, economical, social and ecological benefits.

The ability of filling, passing and segregation resistance are the characteristics that make this type of concrete self-compacting. Along these properties, other specific requirements of hardened concrete must be fulfilled: compacting and durability.

Even if the component materials are similar with ordinary concrete, there are some essential differences related to SCC preparation process. The differences consist in the content of powder, water cement ratio, usage of superplasticizers, the number of cast operations and the preliminary composition test [9].

Recomended relative principal component rapports of SCC are

a) total powder – $380 \ldots 600$ kg/m^3,
b) paste volume – $300 \ldots 380$ l/m^3,
c) rough agregates – $750 \ldots 1000$ kg/m^3, referred to $270 \ldots 360$ l/m^3 volume ,
d) water/physical parts (volume) $0.85 \ldots 1.10$,
e) sand content: $48 \ldots 55\%$ from the entire aggregate weight.

The proof of performant SSC in laboratory, in various configurations (using as a powder: cement, ultrafine silica fume+cement, limestone filler+cement), is fullfilled with selecting the final compostion of SCC for precast industry and accomplished with experimental and numerical tests [5].

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BETONUL DE ÎNALTĂ PERFORMANŢĂ

(Rezumat)

Se prezintă o parte din rezultatele studiilor şi cercetărilor realizate legate de betonul de înaltă performanţă, betonul de înaltă rezistenţă şi betonul autocompactant în cadrul studiilor doctorale la Cluj-Napoca. Rolul acestei lucrări este de a prezenta avantajele şi inconvenientele folosirii acestor tipuri de betoane. Două reţete de beton sunt prezentate în capitolele lucării: una pentru îmbrăcăminţi rutiere rigide, iar cealaltă pentru beton autocompactant.