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HIGH QUALITY CONCRETE BEAMS BENDING UNDER THE LONG AND SHORT TERM LOADS

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Vladimir Radojičić

University of Kosovska Mitrovica, Faculty of Technical Sciences, Serbia

Abstract. *The paper deals with the analysis of different compounds for the production of high-quality concrete and an experimental research of the selected high quality concrete beams. The beams have been bent by both the short term and long term transverse loads.*
By a detailed analysis of experimentally determined stress-strain quantities and by their comparison with the results of computation according to BAB-87, a good agreement of the results could be established.

Key words: *the high quality concrete, beams, bending, flowing.*

1. INTRODUCTION

Working upon the idea of Professor Dr M. Ivkovic, of how to produce concrete of domestic materials especially for the production of in-tension bending elements, I started experimental researches in the early 1990' defining the program so as:

- to make mixtures from domestic materials in order to get the high quality concrete of more than 70 Mpa
- to make reinforced concrete beams from that type of concrete
- to test the reinforced beams up to failure concerning the short term and long term loads
- to analyze the effects of the plastic flow of concrete in the tension redistribution over the cross section.

2. DESIGN OF CONCRETE MIXTURES AND STRENGTH OF CONCRETE

I followed the "step by step" procedure in order to obtain the necessary mixtures. The concrete mixtures were made using various types and quantities of cement, concrete addi-

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tives, w/c ratio, the sorts of aggregates and their mutual relation of the aggregate fraction; water from water supply mains; *w/c* ratio from 0,38-0,39; the granulometric curve of maximal quantity of the coarse fractions.

3. COMPRESSIVE STRENGTH

The compressive strength of concrete was tested on 15x15 cm cubes and calculated at standard 20x20 cm with the age limit of 7,14 and 28 days.

The following results were obtained:

– that the fracture of most cubes occurred in the cement mortar and that
– the fracture of the mixture number 13 was in the aggregate and thus it represented the limiting factor in getting better strength

I continued my investigation with concrete made of aggregate "Moravac" 0-4 and 4-8 mm and aggregate from grandiorite of the river Vrla (Surdulica) 16-18 mm whose compressive strength was 270 Mpa. The average strength after 45 days was 85,6 Mpa.

The conclusion: The best results were obtained by using "Moravac" 0-4 mm and the aggregate grandiorite 4-8 mm, 8-16 mm.

The experimental researches to obtain the high quality concrete were conducted from 1990-1992 in the Civil engineering concrete laboratory of "Gradjevinar" in Nis. At first it was the "Virolit" cement from Ljibuski (Bosnia and Hercegovina), later replaced with the cement from Beocin , Novi Popovac and Usje because of the market availability.

The production of beams (girders) was done in the concrete factory "Gradjevinar" in Nish from 1991-1992 . The beams were firstly tested on the short term load in the laboratory for construction testing at the Faculty of civil engineering of Nish from 1992-1993. They were also tested for the long term load from 1998-1999. During those experiments Dr Vlajic, professor at the Faculty of Civil Engineering of Belgrade and Mr.Milan Boskovic, a technician in the research construction laboratory of the Faculty of Civil Engineering of Belgrade greatly assisted with reading the instrumental results.

4. THE EXPERIMENT EQUIPMENT

The equipment for application of long term load was constructed especially for that purpose. The single lever machinery was produced in the factory "Zavarivac" in Vranje

The long-time load in reinforced concrete beams was performed by the 63 kg slabs. The slabs were fit in the steel frames as arranged by the program. Unloading of the beams from long term load was performed when strains in concrete and reinforcement were stabilized. After testing the beams on the long term load, and after unloading, the beams were shortly loaded with hydraulic presses until failure. The intensity of forces was controlled with dynamometer.

5. THE TESTING OF BEAMS OF HIGH QUALITY CONCRETE TO LONG TERM LOAD

The experimental research comprised loading the beams on short term and long term load; measuring the strain in concrete and reinforcement to their stabilization; measuring deflections and to monitor the further development of first cracks occurring on them.

The strain in concrete were measured with Russian-made deformeters "Isomer" from St. Petersburg, with the accuracy 1/100 with the basis of 210 mm, while in the compressed reinforcement they here measured with deformeters of Swiss production Hugerberger with the basis 210 mm , accuracy 1/1000 mm.

The detection of the first occurrence of cracks and their identification was carried out by the magnifying glass 0,025 mm.

Strain due to the flow of concrete were monitored in the next 5 monts from the moment of application of normal force of the intensity of 30, 72 Kn, to the moment of their stabilization on the prisms 12x12x36 arranged one on top of other. For application and maintaining of force, the S. Otovic device from IMS was used, according to national standards. Four deformeters with the basis of 210 mm were installed on each prism. The air humidity in the special chamber where the experiments were conducted., was 80%, while the temperature ranged between 1-12^{o}C.

Reinforced concrete beams H3, H4, H5, H6 as well as the cubes were loaded 45 days later. The observation of cubes under constant load lasted for six months.

Reinforced concrete beams H3 and H4 were loaded with the working load of 2,35 Kn and H5 and H6 with 2,43,75 Kn.

6. CALCULATION AND MEASURED STRESS IN CONCRETE AND REINFORCEMENT

- Due to the elasticity module decrease, strain increases while stress reduces in the straining zone under constant load . The calculated stress decrease according to AAEM method was 32,46% while the reinforcement stress increase was 5,62%.
- In the case of long-term load the reinforcement stress reduction in under working load was 19,95 while in the tensioned reinforcement in the course of time, it was higher for 6,24%.
- The stress reduction was 25,10% in concrete reinforced beams H5 and H6 loaded with forces 2 43,75 Kn , while it was increased to 8,17% with strained reinforcement.
- In the reinforced concrete beam N5 and N6 were loaded with forces 2, 43, 75 Kn. The decrease of stress 25, 10%, while in the tensioned reinforcement it was increased for 8,17%.
- At bending pre-stressed concrete reinforced beams there was the separation of the neutral line onto stress and strain. This phenomenon was first noted by Glan Will and Thomas.
- Strain in pre-stressed reinforcement was increased but significantly less so than in concrete. It was as a result of the absence of cracks at such stress, so the strained concrete zone accepted very low tensile stress.
- Finally, every cross-section of the concrete reinforced beams at every moment has a different strain deformation diagram which was a result of the absence of cracks.

7. CONCLUSION

– I managed to obtain a high quality concrete, higher than 70 Mpa, using local material.
– I managed to prove the behavior of the reinforced concrete beams up to the failure at short term load.
– I managed to analyze the effects of the plastic flow of concrete on the redistribution of stress on the cross section.

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SAVIJANJE GREDNIH NOSAČA OD VISOKOKVALITETNOG BETONA NA DUGOTRAJNO OPTEREĆENJE

Vladimir Radojičić

U radu su analizirane različite mešavine radi dobijanja visokokvalitetnog betona i sprovedena eksperimentalna istaržívanja grednih nosača spravljenih od visokvalitetnog betona . Nosači su savijani poprečnim silama do loma na kratkotrajno i dugotrajno opterećenje . Upoređivanjem vrednsoti dobijenih eksperimentalnim istaržívanjem sa rezultatima proračuna po BAB-u 87 može se konstantovati da postoji slaganje rezultata.