MIXTURE DESIGN INFLUENCE TO CONCRETE MULTIAXIAL STRAIN-SOFTENING

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INTRODUCTION

It is very well known that concrete is a heterogeneous multiphase system which on the macrolevel consists of cement paste,fine and coarse aggregate grains and different kinds of defects present already from the start of hydration and hardening process.

As numerous failure criteria are not consistent for new analytical improvements,an extensive experimental enlargement of the data base is necessary.Specially rare are multiaxial and tensile experiments consisting of strain-softening behaviour of concrete.

Developments of experimental facilities such as deformation controlling technique made possible to follow the descending branch of σ-ε diagram after the peak stress was reached,under different stress conditions.

EXPERIMENTAL WORK

Tests obtained in the Netherlands(TH-Eindhoven)as a continuation of an extensive experimental programme,on middle strength concrete by van Mier (1),were done on six different concrete mixes,(2).

Equipment. Special triaxial apparatus,one direction deformation controlled with loading applied by means of brush-bearing platens,was used.Deformations were measured directly from the specimen surface (if free)and measuring the relative displacement between opposite platens

Loading. The experimental programme consisted of three different loading combinations : $(\sigma_1:\sigma_2:\sigma_3) \longrightarrow$ (-1 : 0 : 0) ; (-1 : 0 : -0.05) ; (-1 : -0.33 : -0.05) .Ratios σ_1/σ_2 and σ_1/σ_3 were kept constant until failure.The testing speed was varying depending on stress combination.

Specimens. Concrete mixtures were made with 320 kg/m^3 portland cement,W/C ratio : Mix 1,2 W/C=0.5 , Mix 3,4 W/C=0.56 and Mix 5,6 W/C=0.62 and aggregate according to Yugoslav standard graduation curves : Mix 1,3,5 D_{max}=16mm and Mix 2,4,6 D_{max}=8mm.From each mix five prisms were cast (120 x 120 x 360 mm) and after hardening sawn in cubes (100 x 100 x 100 mm).54 cubes were tested.

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Results

Comparison was made graphically according to the stress combination and the concrete mixture,for all three main directions. σ_1-$\varepsilon_1$curves for the main stress direction are shown on Figure (1) and Figure(2).

Discussion of results. It is obvious that regarding strain-softening the influence of the size of adopted aggregate is relevant,but of W/C ratio with the range of variation (0.5 - 0.62) it is not.

The explanation is in the change of the concrete inner structure,which determines the potential crack-path.Adopting bigger aggregate grains the crack is constrained to path longer distance avoiding stronger grains and developing in the material of lawer strength (cement matrix).The formed,very curved,path together with the widening of cracks increases the deformation on the same stress level in comparison to small-grain concretes,where the crack-path is much more smooth and direct so shorter.

The descending branch in the first case is more flat than in the second when it is steeper.It can be concluded,that the size of the maximum diameter of the adopted aggregate grain influences the ductility of concrete.

REFERENCES

(1) van Mier,J. "Strain-softening of concrete under multi-axial loading conditions",Ph.D.thesis,TH-Eindhoven,1984, pp.349.

(2) Angeli Radovani,B. "Prilog eksperimentalnoj podlozi za numeričku analizu betonskih konstrukcija"Ph.D.thesis,Zagreb University 1986,pp.380,(in Croatian).

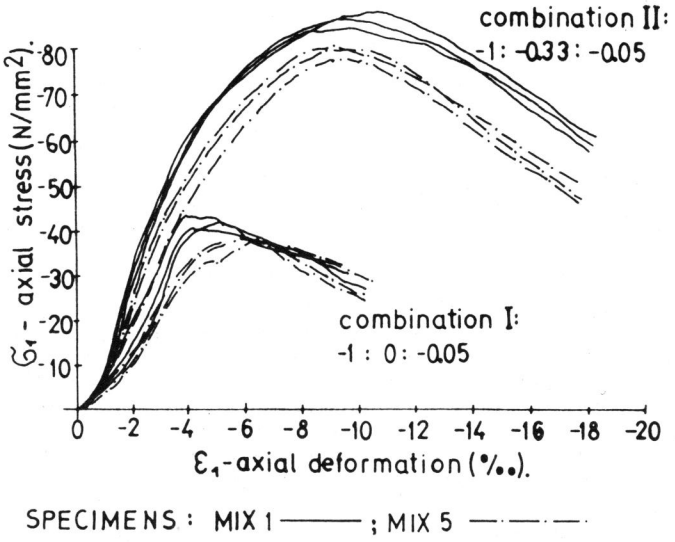

Figure 1 σ_1-ε_1 curves for concretes with different W/C ratio under bi- and three- axial stress combinations.

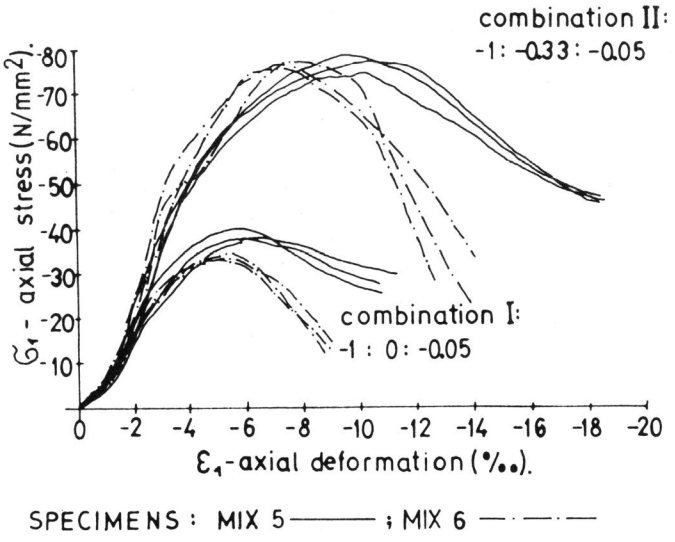

Figure 2 σ_1-ε_1 curves for different grains concretes under bi- and three- axial stress combinations.