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# The testing of the tensil strenght concrete at bending

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**ABSTRACT**
The theme of this paper is the behavior analysis of the concrete girders classically armored with the addition of mineral wool fibers.
The author made five sets of concrete girders of the same geometric characteristics: 12x20x250 cm and twelve concrete elements (cubes and prisms).
The following parameters were tested: the strength of the classically armored concrete with the addition of mineral wool fibers, the concrete ductility and the control of cracking.
The girders were loaded with the variable force: 2x5kN to 2x19 kN at the short time load after 28 days from the day of their making and at the long time load , during 365 days.
The influence of the concrete , armored by the fibers mineral wool , reflected to the concrete strength at bending 16,5% .
Key words: mineral wool fibers, shrinkage, creeping, cracks, ductility, tensile strength at bending.

## I. INTRODUCTION

The need for the concrete better mechanical characteristics follows the building operations from the moment from their application up to now.

There are some data that the Romans managed to make the concrete with better characteristics by adding some fibers to the concrete paste.

The theme of many researches was the idea to get the concrete with better characteristics by adding different material fibers (steel, polypropylene, optic, texstily, fibers). That concrete was better than the traditional type of concrete. It’s quality remained the inspiration and the need of many investigators and constructors.

## II. RESEARCH SIGNIFICANCE

The aim of this paper is to show the influence of material fibers on the behavior of the reinforced concrete elements (supports and samples) exposed to bending by the shearing force. Research aspects enclude the tensile strength, the ductility and the control cracking.

### III. EXPERIMENTAL PROGRAM

This paper describes the behavior of the concrete reinforced girders with or without were the additional of the fibers and 12 concret speciments (three cubes and nine prisms loadedand unloaded.

The concrete mix design is as follows there aggregate fractions (South Morava): 35% of 0-4 mm, 25% of 4-8 mm, 40% 8-16 mm, 300 kg/m$^3$ of Portland cement from (Greece) and w/c – 0,55%.

The author made the concrete girders according the program: a set test of girders 12x20x250 cm armored with 4ø8 of the ribbed armature; 2ø6 smooth armature in the upper girder area (the constructive armature) with three stirrups 3ø6: one in l/2 half of the girder span and other the rest above the support each: two sets of girders 12x20x250 cm classically armored with 4ø8 of the ribbed armature, 2ø6 of the smooth armature in the upper area of the girder with three stirrups 3ø6 one of them in l/2 of the girder span and one above the girders support each with 100 gr mineral wool fibers.

Another twelve concrete elements were done: three sets of concrete cubes (15x15x15 cm each) according to the concrete mix design of the armored girders; three of them were made without the addition of the mineral fibers to define the concrete make; nine concrete prisms 10x10x30 cm to fallow the concrete shrinkage of 365 day from the day of their making; three concrete prisms 10x10x30 cm to define the diagram $\sigma$-$\varepsilon$ .

All the concrete girders of the same geometrics were tested at short time load 28 days from the day of their making, and they were tested at long time load 365 days.

All the concrete elements (the girders and the specimen’s) were tested by the use of deformeters at the base 21 cm and accuracy of 1/100 mm.

## IV. EXPERIMENTAL PROCESS

The concrete girders armored according to the procedure were loaded with the fallowing process: from P=2x3,5 kN, 2x5 kN, 2x6,5 kN, 2x9,5 kN, 2x10,75 kN, 2x13,0 kN, 2x14,0 kN, 2x15,0 kN, 2x17,0 kN up to 2x19,0 kN (tab.1) .

| | P kN | $\sigma_{br}$ | $\sigma_{ar}$ | $\varepsilon_{br}$ | $\varepsilon_{ar}$ |
|---|---|---|---|---|---|
| 1 | 3,5 | 4,64 | 122,78 | 1,47315x10$^{-4}$ | 6,13900x10$^{-4}$ |
| 2 | 5,0 | 6,42 | 169,00 | 2,03895x10$^{-4}$ | 8,45000 x10$^{-4}$ |
| 3 | 6,25 | 7,86 | 206,82 | 2,48253x10$^{-4}$ | 1,03458x10$^{-3}$ |
| 4 | 9,25 | 11,44 | 302,47 | 3,63124x10$^{-4}$ | 1,51235x10$^{-3}$ |
| 5 | 10,75 | 13,21 | 349,34 | 4,21904x10$^{-4}$ | 1,74670x10$^{-3}$ |
| 6 | 13,0 | 15,82 | 419,65 | 5,03809x10$^{-4}$ | 2,09825x10$^{-3}$ |
| 7 | 14,0 | 17,05 | 451,04 | 5,41587x10$^{-4}$ | 2,25520x10$^{-3}$ |
| 8 | 15,5 | 18,75 | 559,27 | 5,81587x10$^{-4}$ | 2,69080x10$^{-3}$ |
| 9 | 17,5 | 21,18 | 560,28 | 6,72698x10$^{-4}$ | 2,80340x10$^{-3}$ |
| 10 | 19,0 | 22,96 | 607,15 | 7,28880x10$^{-4}$ | 3,03575x10$^{-3}$ |

| | P kN | $\sigma_{bm}$ | $\sigma_{am}$ | $\varepsilon_{bm}$ | $\varepsilon_{am}$ |
|---|---|---|---|---|---|
| 1 | 3,5 | 4,34 | 120,27 | 1,31428 x10$^{-4}$ | 6,01350x10$^{-4}$ |
| 2 | 5,0 | 5,92 | 164,81 | 1,81587x10$^{-4}$ | 8,24050x10$^{-4}$ |
| 3 | 6,25 | 7,02 | 195,25 | 2,21587x10$^{-4}$ | 9,76250x10$^{-3}$ |
| 4 | 9,25 | 10,89 | 256,38 | 2,82222x10$^{-4}$ | 1,28175x10$^{-3}$ |
| 5 | 10,75 | 12,2 | 288,55 | 3,23809x10$^{-4}$ | 1,44250x10$^{-3}$ |
| 6 | 13,0 | 14,79 | 332,80 | 3,74285x10$^{-4}$ | 1,66400x10$^{-3}$ |
| 7 | 14,0 | 15,21 | 435,92 | 4,83001x10$^{-4}$ | 2,17960x10$^{-3}$ |
| 8 | 15,5 | 16,16 | 460,56 | 5,13015x10$^{-4}$ | 2,30280010$^{-3}$ |
| 9 | 17,5 | 18,15 | 558,15 | 5,76190x10$^{-4}$ | 2,79070x10$^{-3}$ |
| 10 | 19,0 | 21,84 | 607,15 | 6,93650x10$^{-4}$ | 3,03575x10$^{-3}$ |

Tab.1 The calculated and measured values of the stress and the dilatations

The first hardly seen crack (fig.2) appeared in l/2 at the force of P= 2x8 kN , the second crack was a little bit langer and at the force of P=2x10 kN .

Fig.2 The first crack front and back opposit

By increasing the load there appeared a number of small cracks, up to the final crack in the cross section in l/2 with a blunt detonation. (fig3) .

Fig.3 The next crack on fornt and both sides

The dilatations , the stress and the flexions were simultaneously measured by loading the girders. The flexions increased from 2,2 cm in l/2 to 2,65, 3,02, 3,05 to 4,00 cm i.e. at the force of 2x19,0 kN which provoked the cracking (fig.4) .

Fig.4 The deflexion

## V. DILATATIONS MEASURING IN THE CONCRETE AND THE ARMATURE

The dilatations for the acceptance of the bending moment were measured in the tensed armature (of the biggest bending moment) and in the upper pressed girders armature. The chosen arrangement of the measured places enabled to get a more real image of the pressed and the tensed area at the girders and the real values of the stress and the dilatations in the girders under load.

The dilatations were measured with the deformeters ‘’Izmeron’’ of the bas 21 cm and the accuracy 1/100 mm.

## VI. CONCRETE SHRINKAGE

The dilatations of concrete shrinkage were measured with the deformeters of the base 21 cm and of the accuracy 1/1000 mm placed at every side of the unloaded prisms (tab.2) .

| | 28 | 54 | 73 | 150 |
|---|---|---|---|---|
| D61 | 118,129 | 200,492 | 295,998 | 359,186 |
| D62 | 88,456 | 142,329 | 322,488 | 302,576 |
| D63 | 96,412 | 178,893 | 254,378 | 321,926 |
| D71 | 129,835 | 218,121 | 311,728 | 397,818 |
| D72 | 120,056 | 195,232 | 290,896 | 324,396 |
| D73 | 111,298 | 192,350 | 254,198 | 329,193 |
| D82 | 161,632 | 187,903 | 288,281 | 339,183 |

| | 200 | 250 | 300 | 360 |
|---|---|---|---|---|
| D61 | 351,912 | 379,512 | 388,472 | 400,005 |
| D62 | 299,714 | 321,347 | 339,518 | 350,150 |
| D63 | 322,475 | 334,542 | 352,906 | 348,074 |
| D71 | 381,594 | 399,178 | 408,213 | 418,818 |
| D72 | 341,092 | 354,343 | 376,643 | 380,250 |
| D73 | 352,091 | 356,428 | 356,655 | 346,650 |
| D82 | 341,466 | 358,126 | 370,401 | 374,046 |

Tab.2 The measured values of the dilation’s at the time

The measuring process of the concrete shrinkage in the girders 12x20x250 cm and loaded at long time load started after 7 days of the girders making and it lasted up to 365th day. Were measured under the constant load at P=2x7,81 kN.

## VII. CONCRETE CREEPING

The concrete creeping was measured in the girders under the constant load which was applying through so called a single bar on the steel frame (it was purpose constructed for this experiment).

So the girders were under the constant loading throughout the testing. The concrete creeping was measured by the deformeters. The measured dilatations provoked by the concrete creeping in the girders included the dilatations provoked by the concrete shrinkage and they were 25,2%.

The value 11% of the concrete creeping of the concrete girders presents the difference between the sum 24% of the concrete shrinkage abtained in the unloaded prisms (fig.5).

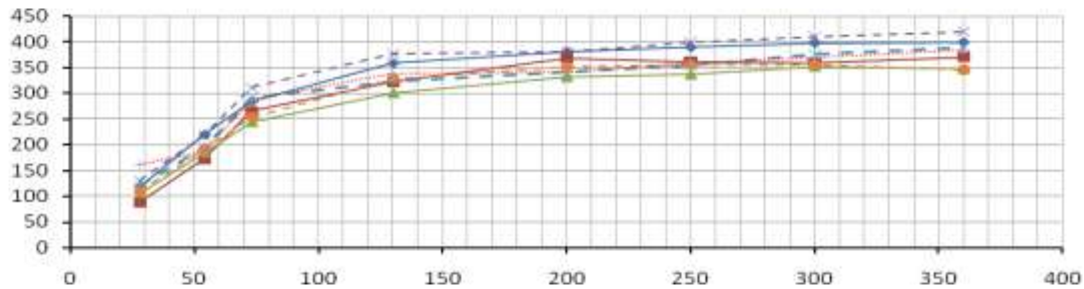


Fig.5 The diagram of the concret schrinkage

It the concrete creeping in the loaded prisms was measured under long time load at 365 days through the apparatus made for this experiment .

## VIII. EXPERIMENTAL RESULTS

- according to my experience concerting the reinforced girders with or without the mineral eool fibers , I can conclude that :

- the concrete shrinkage and creeping were fallowed at the same time on the concrete test girders (12x20x250 cm) and on the prisms (10x10x20 cm).

- the shrinkage of the concrete was measured on the unloaded prisms with the addition of the mineral wool fibers by the deformeters .

- the dilatations changes caused by the concrete shrinkage and creeping appeared at the same time.

- the stress, in the most stressed fibers decreased 25,2 to throughout 12 months while it increased in the tensed armature as follows: the concrete shrinkage was 11,2% and the concrete creeping was 14,2%.

- the difference between the calculation and the measured stress in the concrete was 5,66 and the calculated stress were bigger than the measured values.

- the difference between the calculation and the measured stress in the tensed armature was 1,65 and the measured stress values were bigger from the calculated values.

- the calculated stress and the dilatations were defined according to the regulation in the Regulation book BAB '87, $\varepsilon_b$=3,5‰ , $\varepsilon_a$=10‰ .

- The concrete compressive strength at bending was defined by the value got from the prism loaded by the cross force P=8 kN and it was 2,95 MPa.

- The $E_b$=31500MPa and $E_a$= 210000 MPa while analyzing the stress in the concrete and in armature.

- The concrete tensile compressive strength bending was obtained by testing prisms: 10x10x20 cm with fibers of mineral wool 2,95 MPa and without fibers of mineral wool 2,5 Mpa .

- The calculated strem the measured stress and stress coincided with this one.

## IX. CONCLUSION

The aim of this paper is to investigate the effect of fibers mineral wool on behavior of reinforced concrete elements tensil compressive strength bending by the transversal forces.

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