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DEFORMATIONS IN THE SHORT-TERM PROCESS ON SELF-COMPACTING CONCRETE FOR REPAIRED BEAMS

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ABSTRACT

Based on the very good properties for putting on the work of self-compacting concrete, today in the world has increased its use in the construction of high-rise buildings. Self-compacting concrete has very good viscosity which makes it suitable for pumping and at the same time compacting.

Based on the fact that self-compacting concrete does not have the same content of its constituent components as normal concrete, then we can say that both mechanical characteristics and deformations in concrete as in the short time process as well as deformations in the long process can not be same.

To verify the difference in the results of the information from the action of loads in the short time process as well as from the action of loads in the long process we conducted an experiment on beams from normal concrete, beams from self-compacting concrete and beams repaired with self-compacting concrete.

To determine the mechanical characteristics in the laboratory, laboratory samples were prepared in cubic, cylindrical and prismatic forms for the determination of compressive strength, tensile spliting strength, flexural strength and modulus of elasticity.

In this paper will be given the results of deformations in concrete as well as the results of deformations in reinforcement in beams from normal concrete, self-compacting concrete, and in repaired beams with self-compacting concrete.

The test was performed by the action of the loads on the loading and unloading process by loading the beams up to the load (g + p), the unloading up to the level of the load g and then the loading up to the fracture (the load action is applied incrementally). Some of the results for certain mechanical characteristics in the laboratory will also be given in samples from normal concrete and from self-compacting concrete.

Keywords: Strain gauge, Self-compacted concrete, Mechanical characteristics, Deformations, load action

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1. INTRODUCTION

The most commonly used method for repairing concrete beams is to reinforce with additional reinforcement and increase dimensions.

Based on the fact that the facilities built according to the standards that are no longer used, it is necessary that the elements of some of these facilities should be reinforced with additional reinforcement and increase the dimensions of the cross section.[4]

In this paper will be presented the experimental results for deformations in concrete and deformations in reinforcement in concrete beams with cross-sectional dimensions 15x28cm which are divided into three series where: Series I are beams from normal concrete, series II are beams made of self-compacting concrete and series III are beams which have a core of normal concrete while being repaired with self-compacting concrete. [10][2]

The measurement of deformations in concrete and reinforcement was performed with a mechanical straingauge for the long and short process, while the measurement of deformations in concrete and reinforcement in the short time process (test from load action to fracture) was performed with electronic straingauges.[10][2].

Compliance between repair and existing material is important for cracking prevention. However, optimal compliance is not necessarily achieved by equalizing the properties of repair and existing materials. [5].

When considering creep strain, its design effects should be evaluated under the quasipermanent combination of actions, regardless of the design situation considered.[6]

The consequences of deformation due to temperature, creep and shrinkage will be considered in the design. The impact of these effects is normally regulated by adhering to the rules of implementation of EC-2. Consideration should also be given to: minimizing deformation and cracking due to precipitation at an early age, creep and shrinking through the composition of the concrete mix.[6].

2. EXPERIMENTAL RESEARCH

Normal concrete and self-compacting concrete are made of aggregate with three fractions. For self-compacting concrete a super fluid-21 hyperplasticizer admixture is used. The compressive strength class for both types of concrete has been C 30/37.[1][2]

The experiment was performed on the concrete beams of the static simple beam system loaded with two concentrated forces figure 1. In the beam are assigned 20 points for measuring deformations with mechanical strain gauge.

The force is carried out with a hydraulic press in 2 kN increments in the loading process up to the load level g + p, unloading up to the load level g and loading up to the breaking force level.

Figure 2 shows the cross-sections of the beams from ordinary concrete, self-compacting concrete, self-compacting repaired concrete beams and their reinforcement.

The installation of electronic strain gauges for measuring deformations in concrete and reinforcement, the measurement of deformations with mechanical strain gauge, data logger and

Watson bridge for measuring deformations with electronic strain gauge are presented in figure 3.

During the testing process, the results for the deformations in the concrete, the deformations in the reinforcement, deflections ontee midle of the beams and on the supports, the appearance of the cracks and the size of the maximum crack have been recorded.

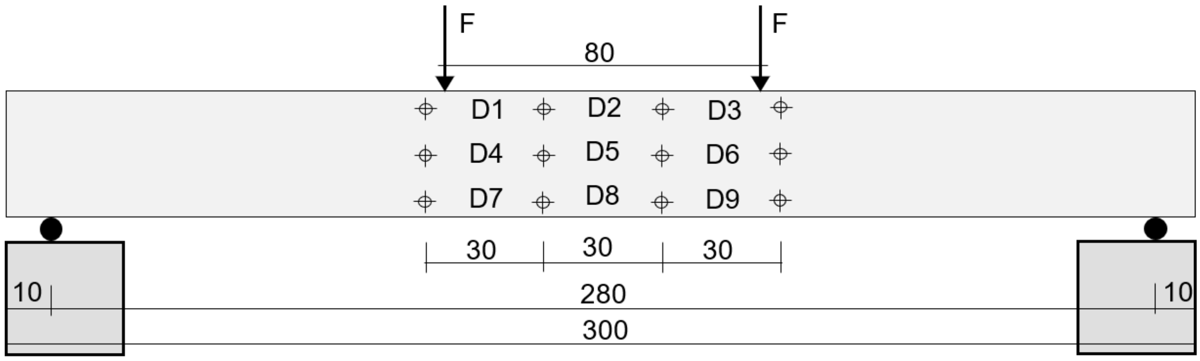

Figure 1 Static beam scheme and load action position

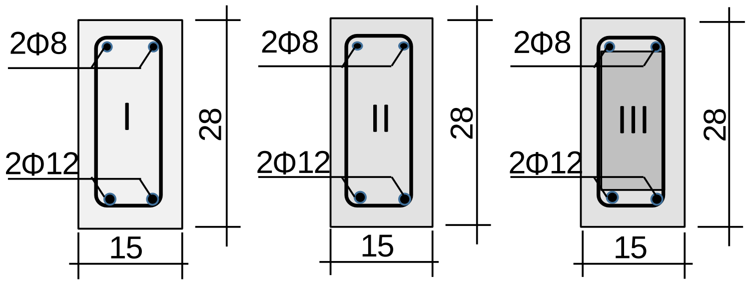

Figure 2 Cross-section of beams from ordinary concrete, self-compacting concrete as well as Cross-section of repaired beams with self-compacting concrete

Figure 3 The installation of electronic strain gauges for measuring deformations in concrete and reinforcement, the measurement of deformations with mechanical strain gauge, data logger and Watson bridge for measuring deformations with electronic strain gauge

3. MECHANICAL CHARACTERISTICS OF CONCRETE

The compressive strength of concrete for normal concrete and for self-compacting concrete is realized according to the standard EN 12390-3 in cubic samples with dimensions 150x150x150mm. Testing was performed on concrete age t = 28 days and t = 380 days. The cubic and cylindrical samples up to the testing phase have been stored in laboratory conditions, they have remained in the water at relative humidity RH = 100% at a temperature of 20 ± 20C. The values of the results in tabular form are presented in Table 1. Laboratory testing in hydraulic press is shown in figure 4. [8] [10].

Figure 4 Testing the compressive strength of concrete in the laboratory

Table 1 The results for compressive strength of concrete

Nr.	***Sign***	***Age* (*day*)**	***Area* (cm2)**	***Force* (kN)**	***C.Stren. f_{ck}* (N/mm2)**	**Med (N/mm2)**
NC t= 28 days						
1	M-1NC	28	225.00	1062.4	**47.22**	46.44
2	M-2NC	28	225.00	1041.2	**46.28**	
3	M-3NC	28	225.00	1030.9	**45.82**	
NC t= 380 days						
1	M-4NC	380	225.00	1205.0	**53.56**	53.35
2	M-5NC	380	225.00	1210.3	**53.79**	
3	M-6NC	380	225.00	1186.0	**52.71**	
SCC t= 28 days						
1	M-1SCC	380	225.00	994.1	**44.18**	45.88
2	M-2SCC	380	225.00	1052.5	**46.78**	
3	M-3SCC	380	225.00	1050.1	**46.67**	
SCC t= 380 days						
1	M-4SCC	380	225.00	1272.2	**56.54**	55.18
2	M-5SCC	380	225.00	1196.0	**53.16**	
3	M-6SCC	380	225.00	1256.7	**55.86**	

The modulus of elasticity of concrete is determined according to the American standard ASTM 469, the testing was carried out in standard cylindrical samples 150x300mm. Testing was performed on concrete age t = 28 days and t = 380 days. The values of the results in tabular form are presented in Table 2. Laboratory testing in hydraulic press is shown in the figure 5. [8][10]

Figure 5 Determination of the modulus of elasticity in the laboratory

Table 2 Test results for modulus of elasticity

E **(N/mm²)**	***E*** **(N/mm²)**
NC t= 28 days	SCC t= 28 days
33564	33285
32945	32374
32775	33296
NC t= 380 days	SCC t= 380 days
37076	33945
35869	34936
34054	35062

The tensile spliting strength of the concrete is realized according to the Sist standard. EN 12390-6 (Brazilian method) in cubic samples 150x150x150mm in concrete age t = 380 days. The test results are presented in tabular form in Table 3. Testing of tensile spliting strength in the laboratory is presented in Figure 6.[9][10][2].

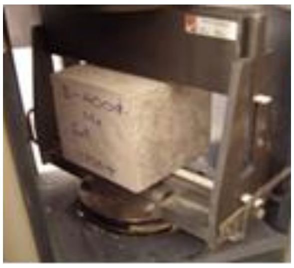

Figure 6 Testing of tensile spliting strength in the laboratory

Table 3 Results of tensile spliting strength in the laboratory

NC					
Sign	*Age* (*day*.)	Dimens. b x t (mm)	*Area* (mm2)	*Force* (kN)	***T.S.S. Streng. fct (N/mm2)***
M1-NC	380	150.00	22500.0	157.20	***4.44***
M2-NC	380	150.00	22500.0	159.00	***4.49***
M3-NC	380	150.00	22500.0	148.00	***4.18***
SCC					
M1-SCC	380	150.00	22500.0	156.60	***4.42***
M2-SCC	380	150.00	22500.0	129.20	***3.65***
M3-SCC	380	150.00	22500.0	146.80	***4.14***

4. EXPERIMENTAL RESULTS

The results of deformations in reinforcement and concrete for beams from normal concrete, for beams from self-compacting concrete and for reipared beams and comparison of these results for the tested beams in concrete age t = 28 days are presented in table 4. While the results of the deformations in the reinforcement and concrete for the tested beams in the concrete age t = 380 days are presented in table 5.

The results of the deformations in reinforcement and concrete through diagrams, for the beams tested in concrete age t = 28 days are shown in figure 7. While for the beams tested in concrete age t = 380 days are presented in figure 9.

Position measurement of deformations in cross-section of beams and results of deformations in reinforcement and concrete from force action F = 9kN (g), F = 17kN (g + p) and f = 29kN for beams tested in concrete age t = 28 days and t = 380 days are shown in Figs.8. And Figure10.[1][10]

Table 4 The results of deformations in reinforcement and concrete for beams from normal concrete, for beams from self-compacting concrete and for reipared beams and comparison of these results for the tested beams in concrete age t = 28 days

F		**F=9kN g**	**F=17kN g+p**	**F=29kN max**	**I-II**		**I-III**		**II-III**	
Series	h	**ε** [‰]			R	C	R	C	R	C
I	3	0.461	1.654	3.277	F=9kN					
	28	-0.144	-0.464	-0.925	33.75 %	38.53 %	15.59 %	33.72 %	-27.42%	-7.83%
II	3	0.697	1.653	3.090	F=17kN					
	28	-0.234	-0.514	-0.914	-0.06%	9.68%	-6.18%	9.88%	-6.11%	0.22%
III	3	0.547	1.558	3.206	F=29kN					
	28	-0.217	-0.511	-0.893	-6.07%	-1.26%	-2.22%	-3.60%	3.63%	-2.31%

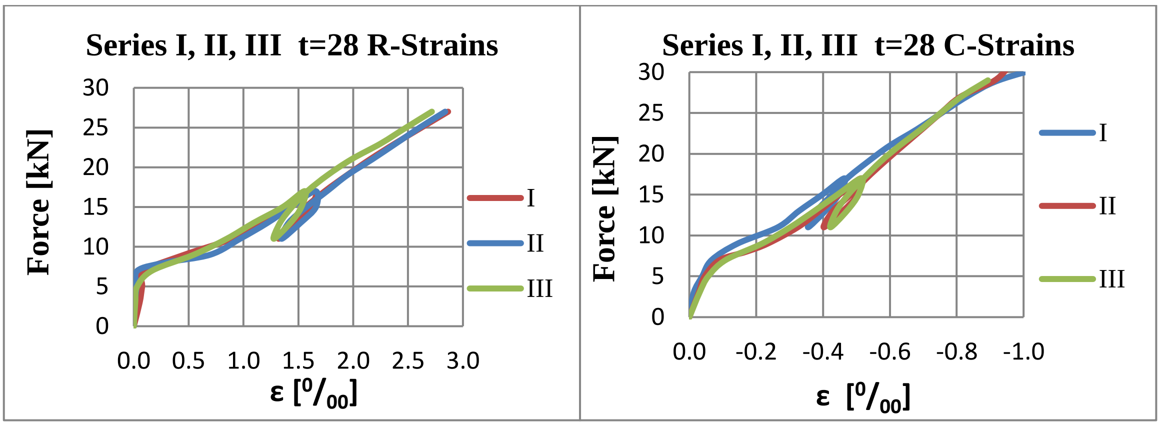

Figure 7 Results of reinforcement deformations and deformations in concrete for beams tested in concrete age t = 28 days

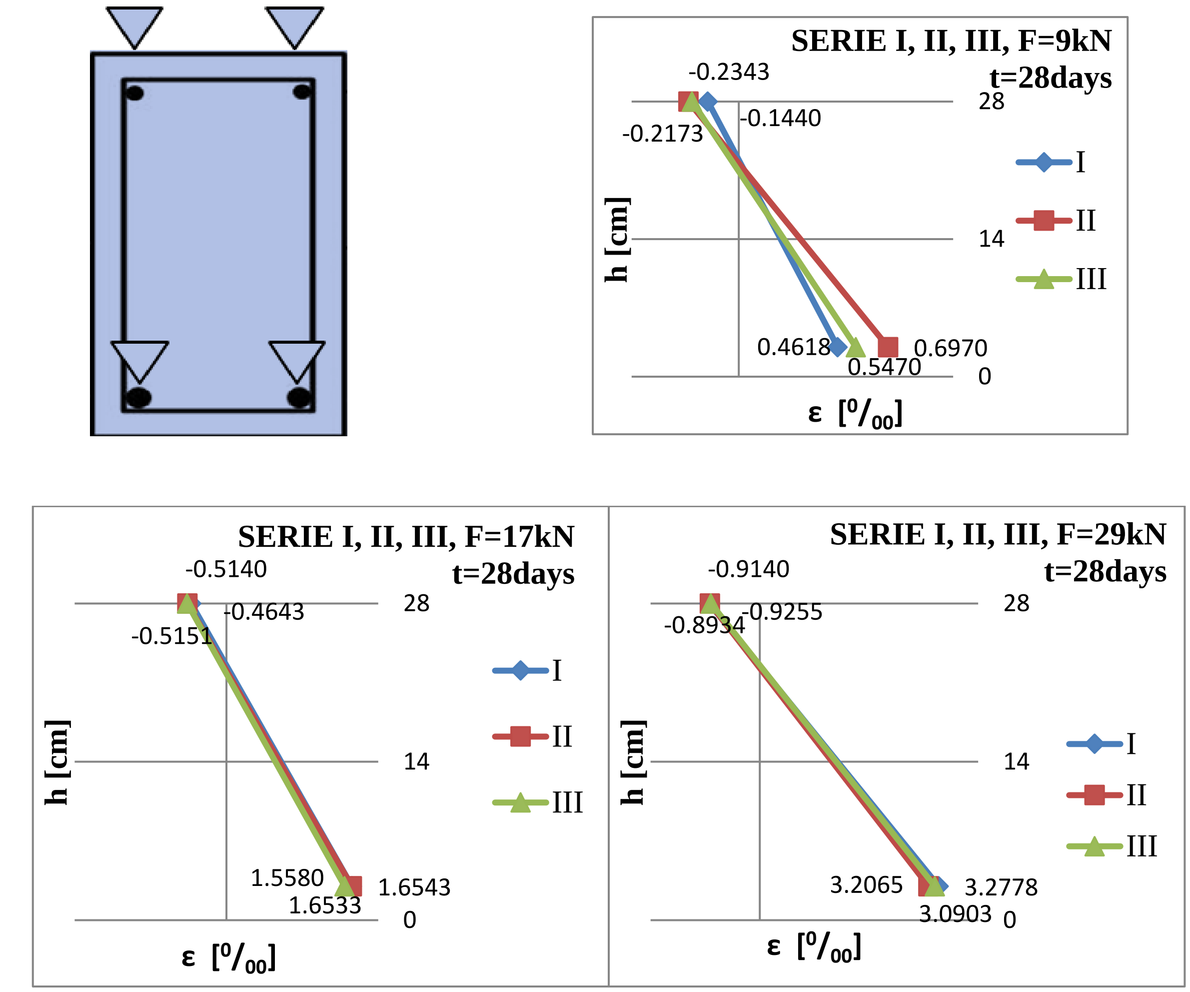

Figure 8 Position of measuring deformations in cross-section of beams and results of deformations in reinforcement and deformations in concrete by force action F = 9kN (g), F = 17kN (g + p) and f = 29kN for beams tested in concrete age t = 28 days

Table 5 The results of deformations in reinforcement and concrete for beams from normal concrete, for beams from self-compacting concrete and for reipared beams and comparison of these results for the tested beams in concrete age t = 380 days

F		**F=9kN**	**F=17kN**	**F=29kN**	**I-II**		**I-III**		**II-III**	
		g	g+p	max						
Series	h	*ε* [‰]			R	C	R	C	R	C
I	3	0.411	1.227	2.475	F=9kN					
	28	-0.333	-0.619	-0.938	9.77%	14.46 %	18.86 %	21.71 %	10.08 %	8.47 %
II	3	0.455	1.216	2.536	F=17kN					
	28	-0.389	-0.599	-0.904	- 0.93%	-3.21%	3.85%	6.29%	4.74%	9.20 %
III	3	0.506	1.277	2.491	F=29kN					
	28	-0.425	-0.660	-0.994	2.38%	-3.73%	0.63%	5.61%	-1.80%	9.01 %

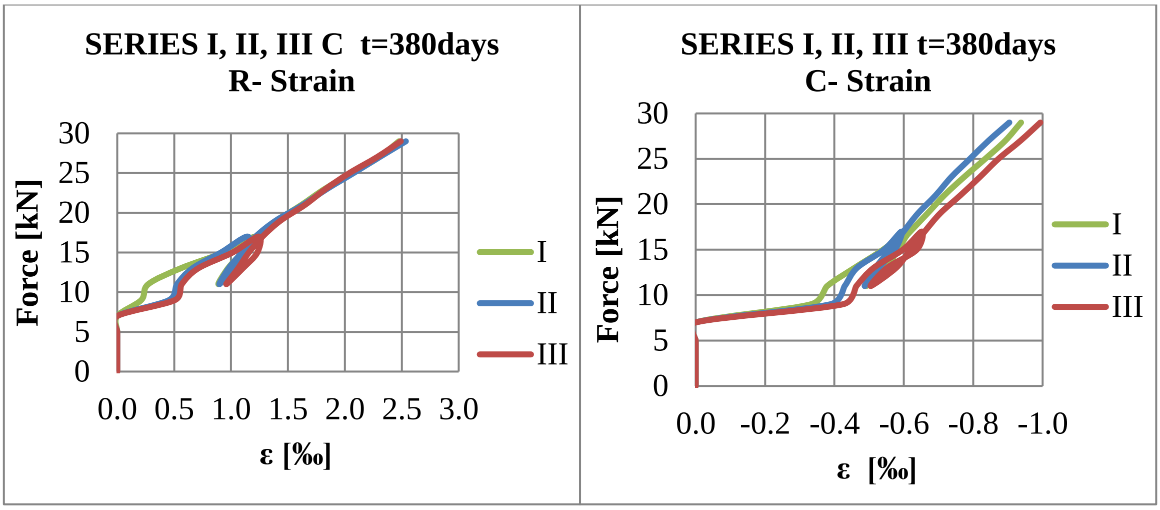

Figure 9 Results of deformations in reinforcement and deformations in concrete for beams tested in concrete age t = 380 days

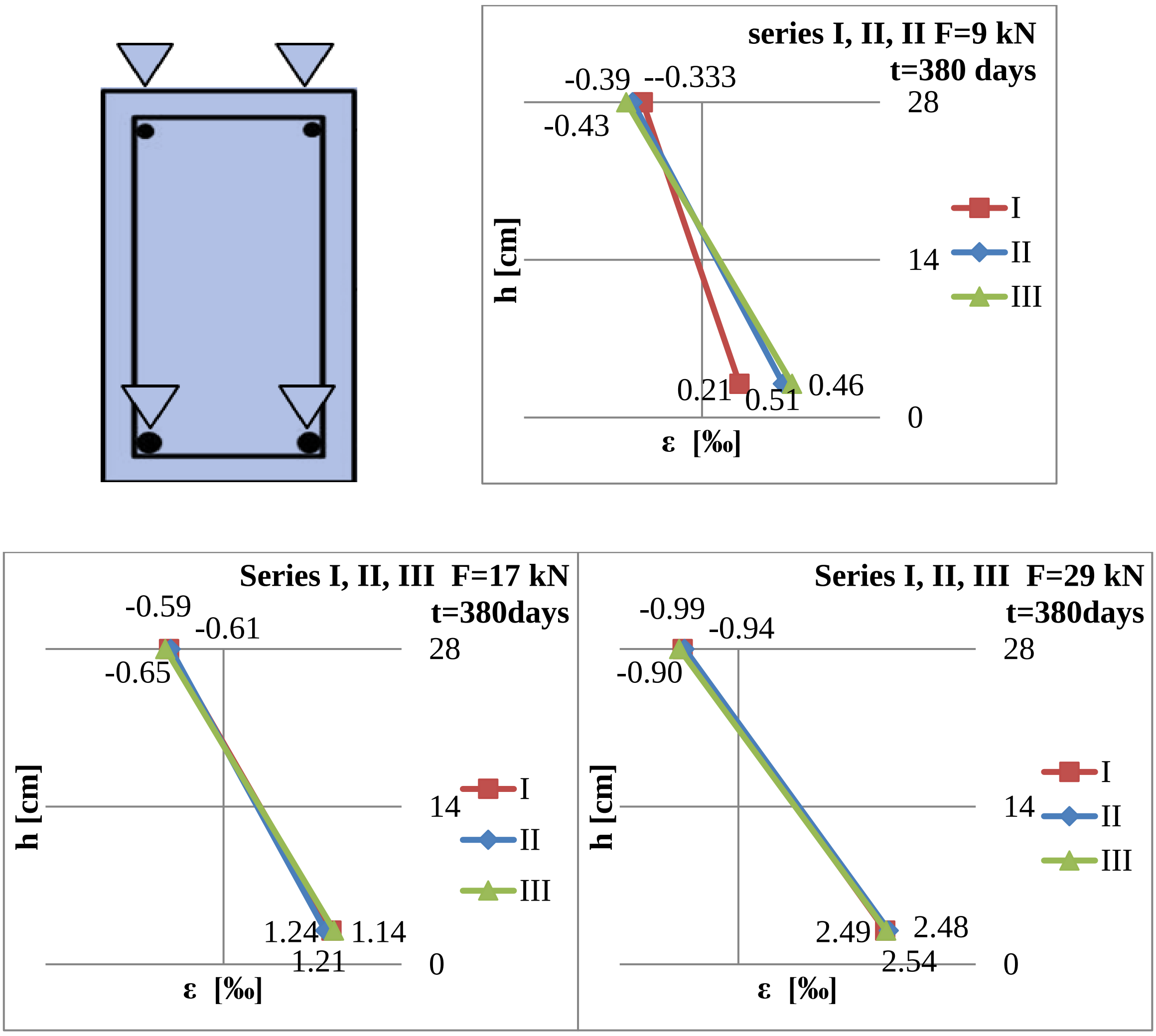

Figure 10 Position of measuring deformations in cross-section of beams and results of deformations in reinforcement and deformations in concrete by force action F = 9kN (g), F = 17kN (g + p) and f = 29kN for beams tested in concrete age t = 380 days

5. CONCLUSIONS

Based on the table results and the results presented through the diagrams we come to these conclusions:

- During the testing of self-compacted concrete samples and normal concrete for the determination of the modulus of elasticity we have smaller values of the results in the samples from the self-compacted concrete.
- We also have lower values of the results from the tensile spliting test of the samples from the self-compacted concrete in relation to the results of the samples from ordinary concrete.
- During the application of the load at the level of g + p at the age of the concrete t = 28 days the results of the largest difference deformations represent for the deformations in the concrete between the repaired beams and the beams from the self-compacting concrete 9.20%, while the smaller difference is presented in the deformations results in reinforcement between repaired beams and beams from normal concrete
- During the application of the load at the level of g + p in the age of the concrete t = 380 days the results of the largest difference deformations represent for the deformations in the concrete between the repaired beams and the beams from the self-compacting concrete 9.20%, while the results of the deformations in the armature of the repaired beams in this case they are larger than in normal concrete beams (3.85%) and self-compacting beams 4.74%.
- From this experimental research we can conclude that we can easily use self-compacting concrete to repair various elements of reinforced concrete structures.

REFERENCES

[1] EN 206-9:2010, Concrete, Part 9: Additional Rules for Self-compacting Concrete (SCC) Khayat KH, Feys D, (2010) Design, Production and Placement of Self-Consolidating Concrete, Proceedings of SCC 2010, Montreal, Canada, September 26–29,

[2] Sadiku H, Determination of impact load of self-compacting concrete elements in long-term process, Ph. D. Thesis, Skopje, Macedonia (2010)

[3] BRISARD Sébastien, Sétra (Service d'études techniques des routes et autoroutes Technical Department for Transport, Roads and Bridges) BUI Ngoc-Vu, Sétra CHARLES Pascal, Sétra Methodologikal guide EUROCODE 2 aplplication to CONCRETE HIGHWAY BRIDGES october 2007

[4] A.Šneideris & G. Mar čiukaitis MSc (Eng) (2000) STRAIN-STRESS ANALYSIS OF REINFORCED CONCRETE BEAMS STRENGTHENED WITHOUT UNLOADING BY EXTERIOR REINFORCEMENT, Statyba, 6:5, 307-314, DOI:10.1080/13921525.2000.10531607

[5] Mangat and F. J. O'Flaherty Factors affecting the efficiency of repair to propped and Magazine of Concrete Research, 2000, 52, No. 4, Aug., 303±31unpropped bridge beams P. S. Sheffield Hallam University

[6] EN 1992-1-1 (2004) (English): Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

[7] BS EN12390-5:2009Part 5: Flexural strength of test specimens

[8] BS EN 12390-3-2002 Part 3: Compressive strength of test specimens

[9] BS EN 12390-6:2000 Part 6: Tensile splitting strength of test specimens

[10] Domone PL. A review of the hardened mechanical properties of selfcompacting concrete. Cem Concr Compos 2007;29(1):1–12.