12 BRIDGE CORNICE WITH GRC LOST FORMWORK

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SUMMARY: There are several road and highway bridges currently under construction in the Czech Republic that will have cornices composed of GRC lost formwork connected with cast-in-situ concrete inside. The reasons are both aesthetical and technical (easy assembly, higher resistance against the agressive environment). To verify the behaviour of the composite GRC with normal concrete, we are doing special research into its properties. The final task will be the manufacture of an experimental bridge cornice 8m in length, composed of these two materials. The cornice contains everything a cornice actually built on a bridge would, including anchoring elements to the superstructure and steel barriers. The experimental cornice will be cut into many specimens and a wide range of tests will then be carried out – strength in compression, bonding strength between GRC and normal concrete, resistance against chlorides, creep and shrinkage of the composite, pressure of steam in the contact between the two materials, and so on. The results will ultimately be used for the design of the actual cornices on the bridges.
KEYWORDS: Bridge, composite, cornice, durability, mechanical properties, specimen, tests.

INTRODUCTION

Glassfibre reinforced concrete (GRC) is used in the Czech republic mostly for buildings – both residential and industrial – as claddings, composite balcony parapets etc. In several cases this material has been used also for bridges, both for aesthetic and technical reasons, the latter comprising, for example, easy and quick assembly and longer durability.

So far, GRC has been used for bridges in the following cases:

- As a lost formwork for bridge piers with quite a complicated shape (e.g. bridge in Plzeň, Figure 1)
- As a lost formwork for the creation of the internal shape of deviators for external prestressing reinforcement (SMP segments, since 2002, Figure 2)
- As a lost formwork for bridge parapets with imitation of natural granite (e.g. a bridge in Vsetín, Figure 3)
- As a non-composite cornice panel (e.g. a bridge in Brno)
- As a part of composite cornices acting together with cast-in-situ concrete (e.g. bridges in Frýdek – Místek, Figure 4, in Zářečí and bridges over Odra river).

Figure 1 - Bridge in Plzeň with GRC lost formwork of pier heads

TESTING OF THE GRC

Because it is envisaged to use such composite cornices on several large motorway bridges in the near future, a research project has been commenced, which should validate the behaviour of the composite construction consisting of the GRC and the cast-in-situ concrete. This project is coordinated also with the requirements of the Department of Motorways of the Czech republic.

Figure 2 - Segments SMP with GRC internal lost formwork of deviators

Figure 3 - Bridge in Vsetín with GRC lost formwork of parapets imitating natural granite

This research project was started with several elementary tests of the basic material – glassfibre concrete. For these test, GRC sheets were prepared by the spray manufacturing method. The GRC used for the tests was composed of:

- sand of grain size 1mm 10kg
- cement 52.5–10kg
- alkali-resistant glass fibres – 3.5–5%
- additives.

Figure 4 - Bridge in Frýdek – Místek with GRC lost formwork of composite cornices

The thickness of the plates used for preparation of the specimens was 20mm or 40mm, depending on the tests which these specimens were used for. The results of tests on these specimens are consistent with usual property values of GRC:

- specific gravity – 2050kg/m^3
- tension strength in bending – 35MPa
- compression strength – 60MPa
- Poisson's ratio – 0.25
- impact energy – 5N/mm^2
- modulus of elasticity – 25GPa
- shrinkage – test in progress.

The second step of this research project consists of testing of the composite of GRC and the cast-in-situ concrete. Because specimens were prepared in actual conditions rather than in laboratory conditions, a 7m long part of a road bridge cornice to the scale 1 : 1 was prepared (Figure 5). This structure was composed of:

- basic reinforced concrete plate
- GRC lost formwork of the bottom and of the lateral part of the cornice (Figure 6)
- cast-in-situ concrete.

This structure was cast outside, at a concrete-producing factory. By this means, it was ensured that the conditions of concreting and of hardening of the fresh concrete were practically the same as on an actual bridge. The only difference compared with an actual cornice was that the structure did not include any reinforcement as this could influence the results of the tests.

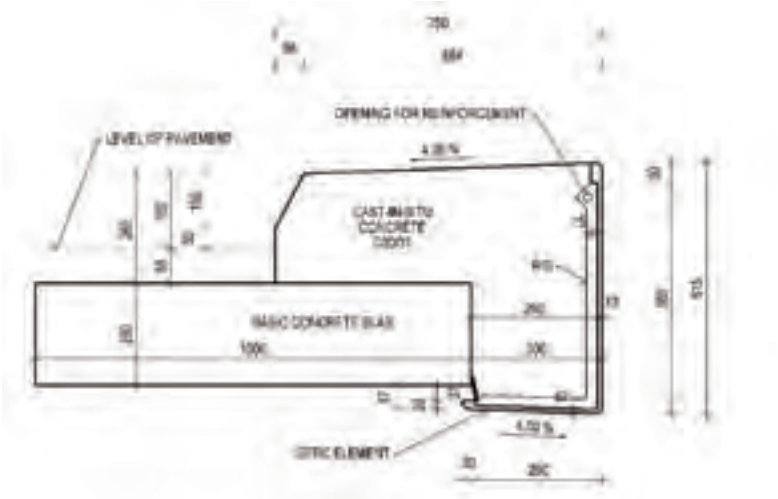

Figure 5 - Scheme of the test composite cornice

Figure 6 - GRC lost formwork of the composite test cornice

After hardening, this structure was cut into pieces of length 1m and transported to the research institute, where the tests are still being carried out. The structure is tested from the point of view of strength and also of its durability. The test programme includes especially the following tests:

- bonding strength between GRC and cast-in-situ concrete (Figure 7)
- pull-out tests of chemical anchors, which can be used, for example, for fastening noise barriers
- grouting of non-concreted internal spaces, which can be created by bad pouring and handling of fresh concrete. For this reason, artificial internal spaces were prepared with parts of polyethylene bottles
- penetration of chlorides to the reinforcement of the cast-in-situ concrete through the GRC
- repair of damaged GRC elements.

Figure 7 - Bonding strength test on a part of the test cornice

Figure 8 - Specimen after a bonding strength test

CONCLUSION

At this stage, the tests of the bonding strength between the GFRC and the cast-in-situ concrete have been finished. In all cases, the strength has quite a high value of about 1–1.5MPa and all the specimens were broken in the layer of the GRC. So, the bonding strength was in every case fully sufficient (see Figure 8). Detailed results are shown in Table 1.

Table 1 - Results of the test of bonding strength between GRC formwork and cast-in-situ concrete

Test no.	Dimensions (mm)		Area (mm^2)	F_{max} (kN)	f_t (Mpa)
	a	b			
S1/1	51.8	50.9	2636.62	4.1	1.56
S1/2	52.8	63.0	3326.40	4.9	1.47
S1/3	54.0	54.6	2948.40	3.1	1.05
S1/4	50.8	52.2	2651.76	4.2	1.58
S1/5	54.1	52.0	2813.20	4.2	1.49
				Average	1.43

The remaining tests are still in progress; their results will be published after finishing them.

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