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#### 4. Repairing Work of the Käyräjoki Bridge (Finland)

##### Main characteristics of the bridge:

- arched span 26,50 m
- overall length 54,00 m
- width of the roadway 7,75 m
- width of the walkway 3,25 m

Owner and contractor: Roads and Waterways Administration  
District of Kymi

Designer of the repairing works: Consulting Engineering Company  
Jorma Huura Ky, Tampere, Finland

Date of construction: 1963

Date of repairing: 1983



Fig. 1 The Käyräjoki bridge before repairing

The Käyräjoki bridge (Fig. 1) is located in a dell which causes that water is flowing on to the bridge more than otherwise. During wintertime the bridge is exposed to the salt-frost action. The bridge was built in 1963 when concrete was not air entrained. Consequently the concrete in the edge beams was scaling very badly twenty years after construction of the bridge.

During designing of the repairing work, the widening possibilities of the bridge were also studied. The calculations proved that the bridge could be made wider by one meter so that the total width of the walkway became 3,25 m. The cantilever edge was designed to carry 100 kN concentrated load which corresponds to the axle load of the vehicles used for road maintenance.

The edge of the existing structure was strengthened by two-meter-long steel plates which were clued by epoxy resin to the surface of the bridge deck (Fig. 2). The thickness of the joint between the plate and the concrete surface was 1 mm. Epoxy resin was injected into the joint. The shear strength requirement of the epoxy resin was  $1.0 \text{ MN/m}^2$ . The injection was done before removing the moulds and the scaffoldings. The work was based on the research done by Technical Research Centre of Finland. The corresponding method has been used afterwards successfully in various repairing works.

It was calculated that the distance of the cracks in the slender cantilever would be 1,5 meters. On the other hand, it was supposed that the cracking of the concrete

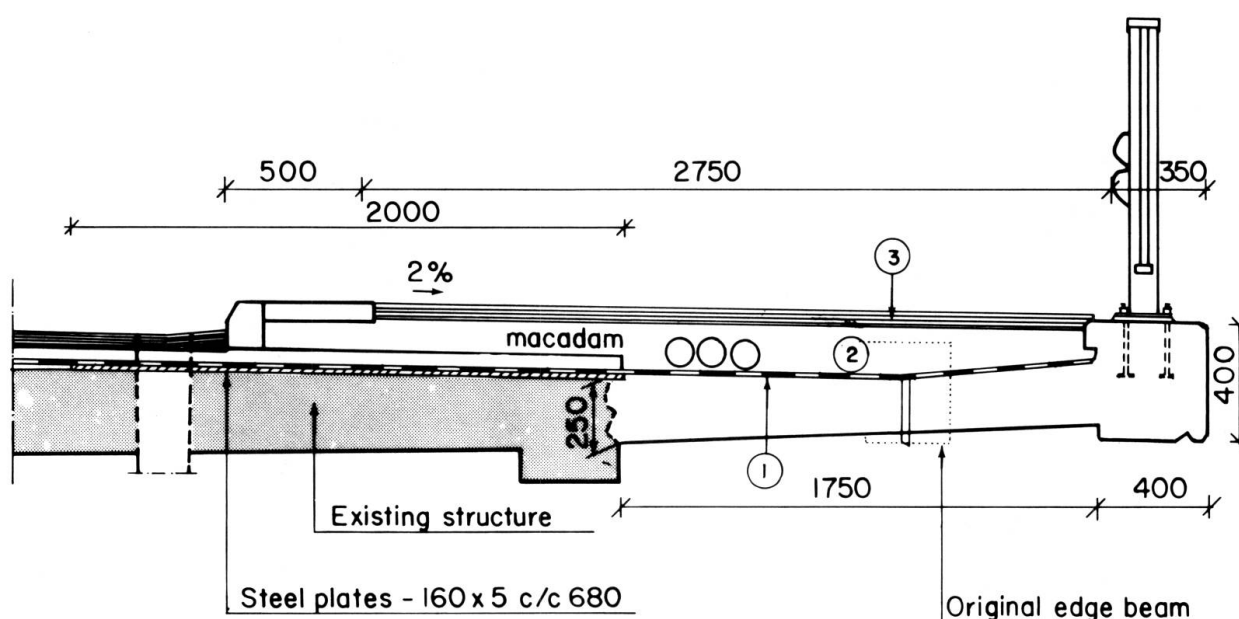


Fig. 2 The cross section of the cantilever edge with the clued steel plates

could be avoided by over-dimensioning the reinforcement, by proper mix design and by careful planning and execution of the concreting and curing works. These assumptions proved to be right.

The reinforcement bars of the old structure were exposed about one meter and the new bars were anchored into the old concrete structure (Fig. 3). The quantity of the cement in concrete was  $300 \text{ kg/m}^3$  and the water-cement ratio was 0,50. The size of the aggregate was between 0 and 16 mm. Air entraining agent (aircontent 4,5–5,5%), plasticizer and retarder (retardation 24 h) were used. The concreting work started at noon and the work was finished the following morning at 6 o'clock. The air temperature was between +15 and +18°C.



Fig. 3 The reinforcement of the cantilever



Fig. 4 The new sidewalk after the repairing work

The protecting and surfacing layers of the repaired bridge deck were accomplished as follows (Fig. 2):

1. The waterproofing was made of rubberbitumen membrane, which was covered by ordinary bitumen sheets.
2. The levelling and drainage layer was made of macadam (without binder).
3. The wearing course was laid of asphaltic concrete.

The total costs of the repairing works were US \$ 100 000. Under these circumstances, the construction costs of a new pedestrian bridge would have been US \$ 200 000. This means that the savings were US \$ 100 000.

The repairing work was made five years ago and the concrete structures are still in good condition. It is amazing that there are no cracks in the slender edge cantilever whatsoever.

(Jorma Huura, Kalevi Falck)