Structural assessment of corbels and half-joints in existing bridges

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Abstract

In new bridges the use of half-joints and corbels is not recommended from a durability viewpoint. However, in existing bridges they are frequently present. The design and detailing rules for concrete have changed over the last decades. A dilatation joint is always present above a half-joint or corbel. During service-life this joint deteriorates and almost always starts to leak and water with de-icing salts penetrate to the structure underneath. This initiates a large risk on corrosion of the reinforcement steel. However, this steel in this construction detail is crucial for the bearing capacity of the structure itself. What many structural engineers don't know is that the actual detailing of the reinforcement within the half-joint or corbel in relation to the position of the loads determines the stress in the reinforcement a7nd thus the capacity. In addition to this engineering effect, standards and insights have also developed over time. On the bases of some examples of existing corbels and half-joints the different ways to calculate such a structure are described in the paper. The well-known strut-and-tie model as well as the shear-cut-method from the Dutch CUR 40 are compared to non-linear finite element models. It is concluded that (as usual) the devil is in the detail.

Keywords: Structural Assessment, concrete corbel, concrete half-joint, detailing, shear.

1 Introduction

With his patent [1] in 1866 Heinrich Gerber became the inventor of the Gerber beam. In his patent he emphasises the advantage of a statical determined structure: the settlement of supports and the temperature influences do not result in internal forces. At that time easy calculation by hand was also an advantage. As reinforced concrete was only barely invented, it was not used for buildings let alone bridges. So, the first applications of Gerber beams in bridge design were made from steel. With the introduction of prefabrication and prestressed concrete after the Second World War, the concrete Gerber beam became popular in bridge design. As the construction depth can't be altered at the location of the hinges, the total depth is divided into two halves. Therefore, concrete Gerber beams are known as half-joints or dapped-end beams. From a structural point of view a half-joint is quite like a corbel or saddle.

Up till the seventies calculations were mainly done by hand. Traffic was low and de-icing salts were hardly used, so there wasn't much deterioration at the joints. Although the bending moment at the half joint is zero, the shear force is maximal.

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