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Development of precast concrete bridges during the last 50 years in Slovakia

Petra Bujňáková[a,]*, Miroslav Strieška[a]

[a]*University of Žilina, Department of Structures and Bridges, Univerzitná 8215/1, 01026 Žilina, Slovakia*

Abstract

The precast prestressed bridges represent the major part of all highways bridges that were built last decade in Slovakia. This is mainly due to the technical and economic advantages of this type of structures. Despite the well know advantages of precast bridges, there exists a demand for innovative solutions that would improve the competitiveness of this type of structures.
The paper focuses on the recent changes during the last years in design and fabrication process and describes some failures of the first precast prestressed girders in Slovakia.

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Keywords: precast prestressed girder; failure condition; high performance concrete

1. Introduction

The last 50 years have been characterized by development of precast prestressed girders in Slovakia. Many types of precast prestressed girders were involved when the appropriate shape was found. The knowledge of the material

* Corresponding author. Tel.: +421-41-513-5674; fax: +421-41-513-5690.
E-mail address: petra.bujnakova@fstav.uniza.sk

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properties have been changed during this time period. The design standard Eurocodes "EC2" was implemented and replaced the national standard codes. Many advantages of precast concrete bridges such as wider girder spacing, longer span length, shallower section and the shorter construction time moves these bridges into position when they are often being applied.

2. Precast prestressed girders in Slovakia

In the 1950s, the precast reinforcement bridge girders have been initiated to use in Czechoslovakia. The first prestressed girders „Vloššák" have been produced since 1957 [5]. The inverted "U" girder was post-tensioned with a smooth wires P ϕ 4.5 mm and additionally prestressed in the transverse direction to create the orthotropic bridge deck. The standardisation project in the 1960s developed the standard precast girders KA-61 (a box girder) and I-62 (I-girder). This girders were post-tensioned without transverse tensioning. The transverse members have been replaced by sideways reinforcing steel in the upper and bottom flange and concreted. The concrete grade B500 (concrete class C35/45, [1]) was commonly used in the precast prestressed girders. The properties of first prestressed girders are shown in Table 1.

Table 1. The properties of first prestressed girders [5].

Type of girder	Height (m)	Length (m)	Width (m)	Reinforcing steel	Prestressing wires
Vloššák	0.24 – 0.5	3.7 – 10.15	0.5 – 1.0	10400B	5-17 ϕ P4.5 mm
KA - 61	0.45 – 1.05	9 – 21.0	0.94	10400B	6-12 ϕ P4.5 mm
I - 62	1 – 1.25	21 – 30	1.15	10400B	24 ϕ P 4.5 mm

The rapid development of prestressing technology increased in the early 1980s. The length of girder increased to 30 m. The maximum length of post- tensioned girders made from three members is 42.0 m. The post – tensioned girders tend to be used at greater spacing around 1.5 m. The typical cross section "T" and "I" shape were adopted, see Tab. 2. The I – girders were preferred for maximizing flexural strength and minimizing weight.

Table 2. The properties of post- tensioned girders.

Type of girder	Concrete class	Maximum girder spacing (m)	Maximum length (m)
I - 73	C 35/45	1.58	30
I - 90	C 35/45	1.50	30
I - 96	C 35/45	1.50	42/ 3 pieces
T 93	C 45/55	2.4	30

The pretensioned precast bridge girders were designed and manufactured in 1990s. These girders were preferred for fabrication process that provides many benefits compared to post-tensioned system. The maximum length of pretensioned girders was 30.0 m. The majority of Slovak highway bridges were made of standardized "I", "T" and inverted "T" shaped cross section girders with cast-in place concrete deck slab. Once the deck was concreted, the structural section becomes composite without great deflection. The simply supported precast girder has been the most common structural system used for the construction of precast bridges.

Most multi-span bridges were constructed using expansion joints that provide a simply supported condition for a span. Some multi-span bridges were constructed with simple-span "I" girders. The negative continuity moment over the intermediate support was accomplished by the reinforcement placing into the cast-in-place deck. The continuous bridges have improved the maintenance costs, appearance and riding qualities.

Figure 1 shows representative cross section of pretensioned girders and Table 3 lists typical properties of pretensioned bridge girders.