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Advantages of precast concrete in highway infrastructure construction

Radan Tomek, MSc. et MSc.*

Czech Technical University in Prague, Faculty of Civil Engineering, Thákurova 7, 166 29 Praha 6 – Dejvice, Czech Republic

Abstract

Prefabrication of any structure component off-site during highway construction (or reconstruction) offers major time and user cost savings in comparison with the traditional cast-in-place methods of construction. Precast prestressed road pavements' technology offers dramatic increase in durability, while it also substantially decreases the construction time and the user costs. Precasting bridge parts and elements offsite is also very beneficial as bridges are generally among the most expensive objects constructed and also serve as a natural bottleneck for the traffic flows and so speeding up the construction process is beneficial again. It also brings substantial safety advantages, lowers disruption to traffic and increases overall convenience for the road users. But this technologically, economically and environmentally advantageous approach also has its opponents – prevailingly from the contractors' side due to the inability to create every project unique and so with higher possible mark-up. The objective of this paper is to analyze and appraise the advantages and benefits of the innovative prefabrication approach in contrast to traditional cast-in-place construction method, and to come up with a set of conclusions and recommendations for the general practice.

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1. Introduction

Current aging highway infrastructure in Europe in general is being used by increasing volumes of road traffic. As an example to illustrate above stated - volume of traffic on the most important Czech highway D1 approximately

* Corresponding author. Tel.: +420-224-354-817.
E-mail address: radan.tomek@fsv.cvut.cz

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doubled between years 2010 and 2016. Even though an increase in traffic volumes on the rest of European highways is not that high, it is a steady reality in every country, only with a few years' pause as the result of world financial recession between 2008 and 2012, according to Eurostat [1]. Economic recovery since this hiatus in a long-term traffic volume growth can be tracked by another Eurostat's data on total number of vehicles, i.e. total car fleet in almost all of the EU member states which has grown over the last five years again [2].

1.1 Alternative means of transport

Changing the ways the public uses personal means of transport is a very complex issue. So far it has been partly successful regarding long distance travel as a result of high capital investments into the fast train railroad. Otherwise lowering the number of passenger cars on highways for the short and mid haul was not achieved either. Regarding heavy transport, efforts to relieve the overloaded highway network by shifting its volumes to the railroad so far mostly fail. This is mainly due to the high demands on flexibility and speed of supply required by the manufacturing and the retail industry and also due to various complications that transport companies must face while switching from road to track and back.

1.2 Growing need of road maintenance

European highway network is aging faster than expected during its planning and construction. Such an unexpectedly increasing usage and consequent hard wear of the whole road infrastructure requires big volumes of repair and reconstruction works. Logically, the needs of its maintenance grow proportionally to its increasing usage. At the same time, this maintenance must be performed on a continuous basis while serving steadily growing traffic flow with minimal disturbances. Road network users demand that this refurbishment and new construction is done faster and with limited road closures, traffic congestion, delays and detour complications. This applies for all the European highway networks in general, but for the high-traffic areas the most.

1.3 Proposing the problem solution

The current situation of steadily increasing demand for highway construction capacities can be without any doubt defined as extraordinary. Analyzing existing capacities of the construction industry in Europe, as of March 2017, they still have not got over 80% of their pre-recession volumes [3]. To answer the demand for investment and maintenance construction services, the current capacities are evidently not sufficient. There is a solution for such an extraordinary capacitive demands in the analogy to the residential housing problem in the sixties and seventies: application of the prefabricated construction systems using the technology of precast prestressed concrete elements.

2. Precast prestressed concrete

Public highway administrations are challenged to find ways to build new and more durable routes and to restore those already existing. These administrators are also looking for ways to quickly and with minimal impact to its users. They must provide these repairs as durable as possible. Precast concrete road pavement and bridge construction systems - cast off-site (in a plant or next to the site) and installed rapidly off the rush hours - have that potential to transform highway network construction and maintenance. Not only do they cut limitations to the traffic and enhance safety during construction, they also bring in the higher quality product meaning the increase in its durability.

To summarize above stated, precast prestressed concrete technology brings unmatchable durability for the newly constructed road pavements and bridges (for both – substructure and superstructure; tunnels are not addressed in this paper due to their relatively rare occurrence and technical specificity) and along with this feature also the lowest level of disruption to the traffic during its implementation.