Temporary formworks as torsional bracing system for steel-concrete composite bridges during concreting of the deck

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Designing and constructing bridges is a complex task and so far, history has given us quite a few bridge collapses. Some of them happened due to inadequate bracing during concreting of the deck. With the use of temporary formworks as attached stabilizing elements the load bearing capacity can be increased and can lead to a safer construction phase.

Background
A steel-concrete composite bridge consists of two main parts; steel girders and a concrete deck, as seen in Figure 1.

![Figure 1](image1.png)

Figure 1 – Cross-section of a twin I-girder steel-concrete composite bridge

During design of steel-concrete composite bridges a critical design stage occurs during casting of the concrete deck. Wet concrete places a lot of weight on top of the bridges’ bare steel girders. As can be seen in Figure 2 the girders are often very slender and if not stabilized laterally they may twist sideways which can cause the collapse of the bridge, with possible casualties as a result.

![Figure 2](image2.png)

Figure 2 – Twist and collapse of girders loaded with wet concrete

To stabilize the system permanent bracing is often needed to resist twist in the system, e.g. with a crossbeam like in Figure 3 as torsional bracing.

![Figure 3](image3.png)

Figure 3 – Cross-section of a composite bridge with girders stabilized with a crossbeam

Temporary formworks are also needed to hold the wet concrete at place before it has hardened. Figure 4 shows how the formwork system supports the concrete by resting on the lower flanges of the girders.

![Figure 4](image4.png)

Figure 4 – Formwork system supporting the wet concrete during casting of the deck

Temporary formworks used today are not attached to the girders and have therefore no stabilizing effect because they cannot...
prevent twist of the system. However, if the temporary formworks could be attached and be shown to work as stabilizing elements; material could sometimes be saved and the construction phase could be safer.

Case study
Within the study some often used formwork systems were evaluated as torsional bracing. It was shown that the most suitable system to be attached to the girders as stabilizing element was a system called CUPLOK.

In cooperation with Hassan Mehri (PhD student with an ongoing project on the same subject) and the Swedish scaffolding company Britek (provider of the CUPLOK formwork system) numerical analyses were made. The CUPLOK system was examined on three different bridge models. Two twin I-girder systems, similar to Figure 1, were analyzed where one of them consisted of very slender beams and the other one of quite bulky beams. The third system was not a twin I-girder system but instead made up of a single girder with trapezoidal cross-section as seen in Figure 5.

Concluded results
The concluded results from the study are shortly summarized as:

- CUPLOK is a suitable temporary formwork system to be used as torsional bracing during casting of the concrete, after that it has been attached to the girders.
- The CUPLOK system has an increasing effect on the torsional stiffness when attached to twin I-girder systems.
- The stiffening effect is bigger for an I-girder system with slender beams compared to a system with more bulky beams.
- No stiffening effect could be seen when the CUPLOK system was attached to the trapezoidal bridge model.