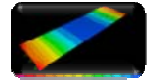


Forgetting Design Basics May Mean ‘Neglecting Project Cost’



Value Engineering of a Simple Bridge but “Not Simple” Lesson

Main Issue Addressed in This Article

Structural engineers do not have many choices for materials like architects, interior and landscape designers. Limiting our self to the most widely used construction materials, the options available are masonry blocks, concrete, steel, composites, timber & aluminum. Further narrowing down the material list for vehicle bridges, we end up with concrete, steel and composites. What could be the cost impact of designing a simple span bridge as RC Deck + Steel girder type compared to designing that as RC+Steel composite system?



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Background

The bridge used as case study in this short article is located in one of our high-end real estate project in Southern Thailand. The client’s primary requirements were:

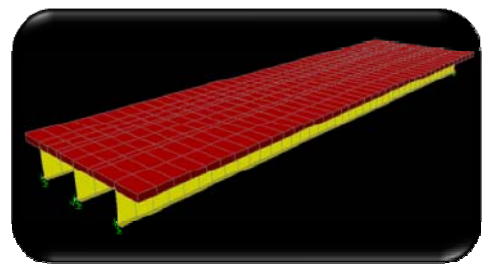
Bridge dimensions of 20 (L) x 6 (W) x 6 (H) to carry concrete supply truck load during construction and light vehicle loads in long-term. During construction load carrying capacity could be enhanced by temporary support, to be removed after the project is over.

Two Design Solutions

Two independent parties were involved in the structural design of the above bridge. The design summaries are as follows:

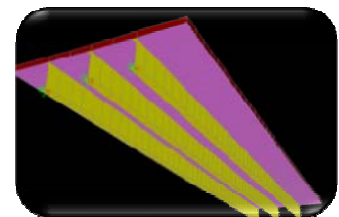
Design 1:

- 5 – H 300x900 longitudinal girders
- 2xH 300x300 transverse bracing @ 2 m interval
- Crossing cable bracing at end spans
- Deck slab thickness 250 mm.



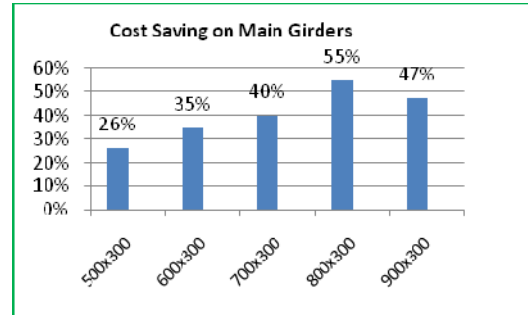
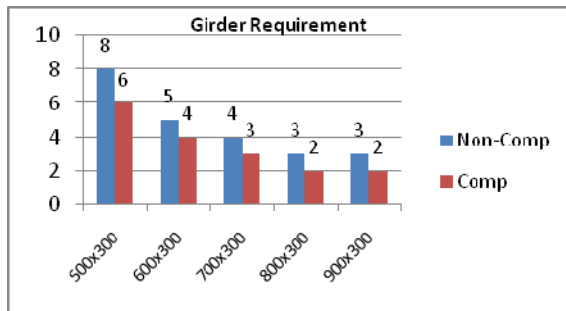
Design 2:

- 3 – H 300x700 longitudinal girders
- Only one H 200x300 transverse bracing at mid-span (bottom)
- Deck slab thickness 200 mm.



Cost Difference

As one can easily figure out from the above two solution that, there is a significant reduction in total weight of the steel from Design 1 to Design 2. Using Thai market rates, the construction cost for Design 1 is estimated to be about 6 M Baht where as that for second one is only 2.5 M Baht.



What is the Reason?

The simple and straight forward answer is that the tremendous difference in cost is arising out of a basic design consideration, "Whether to design the design bridge as a "RC Deck + Steel Girders" system or as "RC-Steel Composite" system. Design 2 was designed as composite system. More technically, as the standard steel sections (such as H300x900) are very thin and weak in carrying compressive load (lateral torsional buckling or local element buckling), their performance can be remarkably enhanced by bracing them by the concrete (more bulky), which need to be there as deck anyway, to share the compressive load. In other words, the gross transformed section properties (such as I_{xx} , Z_{xx} , et) are 2 to 3 times higher than those of steel alone.

Is that Apparently Big Saving Coming with Some Hidden Cost?

No. There are no additional or hidden costs except adding few shear studs (16mm dia x 20cm@2m) of very small cost at the top of the steel girders to achieve the composite action with concrete deck.

What We Learnt From This?

This article should remind the structural designers that a big cost saving (at least in terms of percentage) can be achieved just by understanding and utilizing the fundamental differences between the normal RC + steel (each standing alone) design and the composite design. The little extra time & effort required (say about 2-3 hrs) can undoubtedly be justified by the great saving (at least 3 MB in this case). Another way to grasp the essence of this article is that one should not jump to a particular material and structural system without exploring other competitive options.

Your Comments, Feedbacks, Suggestions etc we welcome:

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