Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 82 (1999)

Artikel: The development of composite cable-stayed bridges
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DOI: https://doi.org/10.5169/seals-62143

The Development of Composite Cable-Stayed Bridges

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He specialised in all aspects of the design and construction of long-span, mainly cable-stayed bridges all over the world.

Abstract

The first modern cable-stayed bridge was built in Sweden at Strömsund in 1955 with a composite beam.

Since the 80's composite cable-stayed bridges have dominated over all-concrete and all-steel ones. The main reasons are economy in materials and ease of construction. By using concrete rather than steel in compression and by using a concrete slab rather than an orthotropic deck, substantial savings against all-steel bridges are realised.

The construction of a composite beam can use small parts – main girders, cross girders, precast slabs – which can easily be lifted. They can simply be joined by bolting or welding the steel girders and by connecting the precast slabs with cast-in-place joints. Thus smaller lifting equipment and the absence of match-cast joints together with savings in cable steel favour composite beams against all-concrete ones.

In order to distinguish the different types of composite beams we split them into four groups:

- Composite main girders have a concrete roadway slab on top of a steel grid or beam (31 examples)
- A steel (or composite) beam in the centre spans is combined with concrete side spans (8 examples)
- Composite cross girders comprise a beam with concrete main girders and concrete floor slab supported by steel cross girders (2 examples)
- Composite roadway slabs are orthotropic steel decks stiffened by a substantial layer of concrete (3 examples)

Composite bridges are currently not only numerous, but they are the last 3 record span holders: the Yang Pu Bridge in Shanghai with 602 m in 1993, the Normandy Bridge in France with 856 m since 1995 and the Tatara Bridge in Japan in 1999 with 890 m. Important double deck composite bridges are the Kap Shui Mun Bridge in Hong Kong and the Öresund Bridge between Sweden and Denmark, see Figure 1.

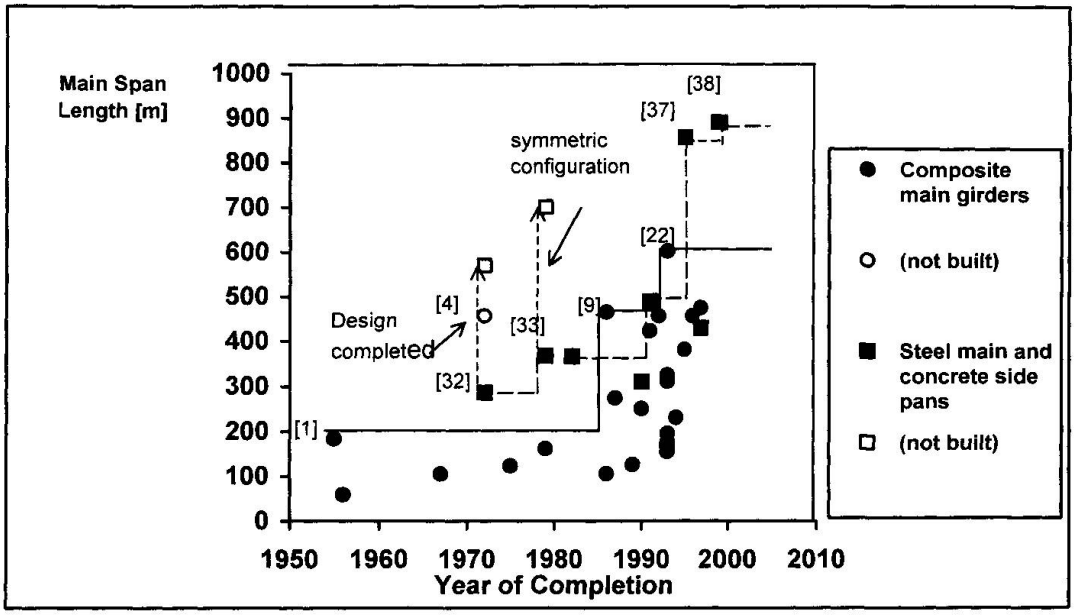

Figure 1. Development of span lengths, from Tables 1 and 2

Composite beams are most economic for main spans between about 350 m to 600 m, concrete approach bridges with a steel (or composite) main span govern between 650 m to 1000 m, see Figure 2.

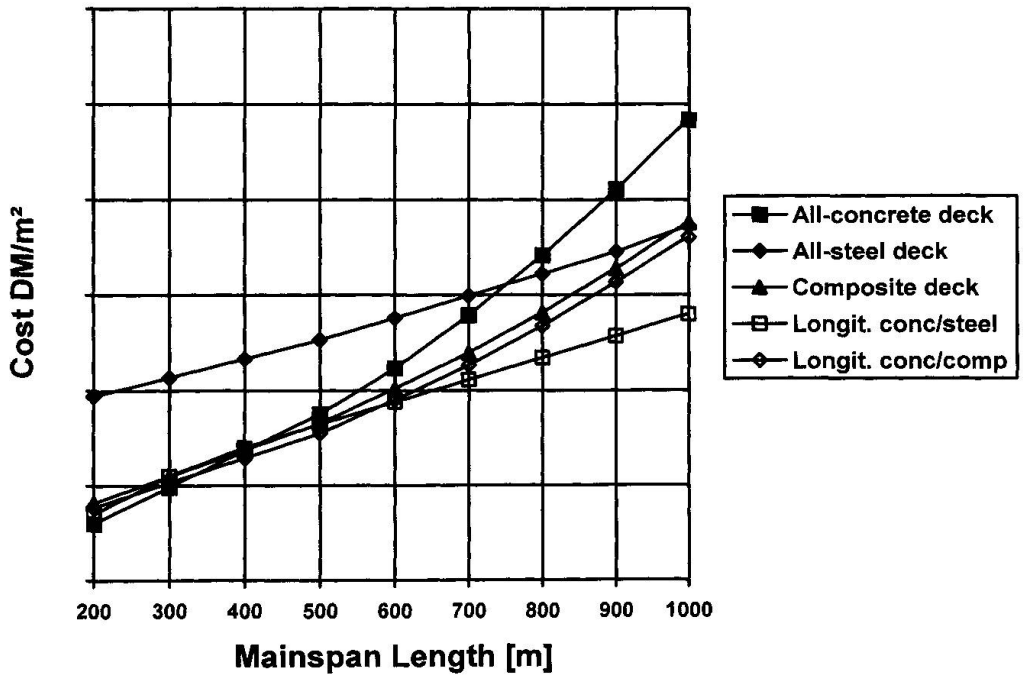

Figure 2. Unit costs for different types of cable-stayed bridges