

Bridge Design Competitions and Landmark Bridges in Finland.

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1. Introduction

In this paper the topic “Landmark bridges” is discussed in context of bridge design competitions and architecture. Details and a variety of bridge design competition proposals, winners and parallel entries are presented with figures. Finland is a very good example when it comes to organising modern and fair bridge design competitions. This is due to Finland’s renowned bridge engineering expertise and a long history of having bridge design competitions, from small to large scale bridges. This paper gives space for that discussion and outlines fair and modern bridge design rules. Finally, some possible future trends for the bridge design competition sector are predicted and proposed.

2. Story behind the competition

Bridges have always played an important role in the society. Architectural styles have not been the main creative forces in bridge design as in buildings. Changes in outer appearance of the bridges have been more bound to the material used and the laws of nature than styles. Engineers have been very innovative and they made the most important work and developed the construction technology ahead.

In the history of European architecture there was a period from about 1450 to 1800, renaissance and enlightenment, when the society especially appreciated the built environment. This period, when the main building material was stone, had its influence also on bridge design.

Relation between architecture and bridges has not always been as evident as today. High tech style influenced only a short period in architecture in 1980’s, but its influence on bridges is still evident. This period meant chance for the architects to participate the bridge design competition teams. This has also meant more freedom for the bridge form. Some

bridges have become environmental works of art- sculptures that have become symbols for their cities.

When the bridge site is noteworthy, the standard solution may not be enough. In these situations the client (the future bridge owner) can order the bridge design work from a renowned bridge engineering company to make sure that the result will be a good one. But there are cases, when the client may want to take even one more step, and organise a bridge design competition to find the best solution for the bridge site. These cases normally meet one or more of the following conditions:

- The bridge site is exceptionally noteworthy and a landmark is looked for
- New innovations and ideas are looked for
- Strong interest for the future bridge from general public is expected
- The bridge site is demanding, and opinion from wide range of experts is wanted
- Positive publicity for the project and for the bridge sector in general is wanted
- New and young bridge designers are encouraged to improve their knowledge and skills

It is very crucial that the client understands the responsibility and the hard work that is needed for having a successful bridge design competition. Having a bridge design competition normally means long preparations, considerable amount of time and money, and maybe pungent discussion after the competition. In Finland the bridge design competitions are run under the guidance of RIL (Association of Finnish Civil Engineers), using the rules published by RIL [2]. The RIL rules are not just for bridge design competitions, but for design competitions of all kind of civil engineering structures. For the sake of clarity, though, the term bridge design competition rules is used in this paper for the RIL rules.

3. Different competitions

The client can choose from many types of competitions, and it should be carefully studied which kind of competition is the most suited for the case in question. The bridge design competitions can be divided according to the content of the competition and according to the right of participation. The former division includes

- Design competition (including the first round and possibly the second round)
- Designbuild competition
- Buildoperatetransfer competition.

According to the right of participation the bridge design competitions are divided into open and limited (invited) competitions. Open competitions are open for all who fulfil the minimum requirements set by the client and competition organiser. These competitions can be very valuable in stimulating innovations. Also they give a chance for young designers or small consultancies which might not have the resources or experience to prequalify for limited competitions [1].

What if the big and renowned bridge design companies estimate their probability to win so small that they do not even participate? And if the big ones omit the competition, what will be the quality of the proposals, are there any feasible designs? Must the final design work

be given to the winner of the competition even if this is totally an unknown name? If the doubts above trouble the client too much, it is better to have a limited competition. In this type of competition the number of participants is limited customarily to 2 to 6 participants.

The competition can also be a mix of an open and a limited competition. At the first stage of this kind of competition the design teams must follow the prequalification submission guidelines laid out by the client. The client will then select (prequalify) of all the applicants a certain number of design teams to the limited competition stage. In this stage the selected design teams will make their proposals, of which the jury chooses the winner. There can also be a second round: instead of choosing the winner the jury chooses from the proposals perhaps 2 to 5 finalists, which will first refine and complement their proposals, before the final winner is chosen. The most famous bridge design competition of this type in recent years has been the Stonecutters bridge competition in Hongkong.

In contentwise the “traditional design competition” is the most common type of bridge design competition and perhaps the best one from the bridge designer point of view. In the limited competition the first round is normally enough to find the winner for the competition.

4. Design team

The discussion about the lineup and leadership of the design teams in bridge design competitions has been going on for some time. Traditionally bridge design and construction has been bridge engineers’ field, but nowadays the architects are expanding to the sector. This has aroused a lot of criticism among the bridge engineers who blame architects for bringing to bridge designs features that do not belong to the bridge engineering. Some of the criticism may be justified, but not much is achieved by trench war, engineers on the other side and architects on the other. It is needless to say that bridge design is very demanding domain in structural sense, and perhaps the architects do not have the necessary structural knowhow, but certainly they have eye for the aesthetics. On the other hand, also the bridge engineers may have eye for the beauty, but one thing where the engineers lose clearly, is the communication skills and media impact.

The problems arise if in a bridge design competition rules it is stated that in the participating design team there must be an architect or – even worse – the design team must be led by an architect. There has already been competitions, where only architect led teams were allowed to enter. The trend has been noted in other European countries, particularly France. The cooperation between architects and engineers can be desirable in a bridge design competition, but it must not be forced cooperation. Nor should any bridge design consultancy be excluded from the competition just because of not having an architect in the team. In the long discussion of Bridge design & engineering No. 34 [1] the bridge engineers’ point of view is captured by German engineer Jörg Schlaich: “Don't invite architects with engineers of their choice, but do invite engineers with the partners of their choice, if any – architects, landscape architects, product designers or whoever.” In Finnish bridge competition rules there is no mention that the design team should be led by an

architect or engineer. Instead, it is stated that the competition proposal must have a head designer, who's level of education and experience are high enough, taking into account the nature of the competition. So far in Finland no design team led by an architect has ever won a bridge design competition, but there are some Finnish architects that work regularly on the bridge design field, either as in house architects or consultants, and their impact on the visual appearance of the winning proposals is acknowledged.

5. Competition rules

Bridge design competitions organised in Finland obey the rules of RIL, no matter if the competition is a national or international one. Also in Germany there are written guidelines for bridge design competitions [3]. Global rules for bridge design competitions do not exist, but in the international bridge engineering community there exists consensus about certain competition issues. If a client wants to have a successful bridge design competition with enthusiastic participation, he/she should take this consensus into account when drafting the competition programme. The short list of counsels includes the following six items:

1. Clear rules and programme for the competition: fair, evenhanded and transparent
2. Recompense in balance with the requirements of the competition
3. Final design work to the winner of the competition
4. No obligation to have architect(s) in the design team
5. Experienced and impartial jury, with a lot of expertise in bridge engineering
6. Good communication with the public

The Finnish bridge design competition rules are very comprehensive and of great help for the bridge competition organiser. The new publication from year 2000 is a revised and improved version of the 1981 release. The first RIL rules were drafted already in the beginning of 1960's. After the year 1980 there have been 13 bridge design competitions organised in Finland according to RIL rules. The bridge design competition rules published by RIL exist at the moment only in Finnish.

6. Examples of bridge design competitions in Finland

The history of Finnish bridge design competitions is long. Already in 19th century there had been competitions, but they were mostly bridge construction competitions with given designs. The first real design competitions were organised in 1920's in the city of Tampere. The latest competition, the Laukko Bridge in 2008, was also for Tampere city. During the period of 90 years the spirit of the competitions has changed: The competitors are now expected to represent innovative, economical and beautiful bridges which respect the environment.

Jätäkänkynttilä- Lumber Jack's Candle

In 1980's the Finnish bridge design competitions already had established, written rules. A very famous bridge design competition took place in the city of Rovaniemi in northern Finland early 1980's. The competition was a limited one, where four bridge design engineering companies were invited. The winning proposal was the first cablestayed bridge

for road traffic in Finland [9]. The reputation of the bridge “The Lumberjack’s Candle” is due to its form which reflects the local culture. In the northern part of Finland a traditional way of having light during the long and dark winter has been the lumberjack’s candle, two bits of tree trunk set side by side with a fire between them. In the winning proposal the pylon of the cablestayed bridge was shaped to resemble that particular kind of candle. Also the arrangement of the cables have received a lot of positive response from international bridge community. “The Lumberjack’s Candle” became soon after its completion the landmark of Rovaniemi city. In the night illumination the bridge really reminds the original lumberjack’s candle, as can be seen in Figure 1.



Figure 1. “The Lumberjack’s Candle” bridge.

Tähtiniemi Bridge- Heinola`s Star

Tähtiniemi Bridge is internationally renowned for its beauty, mostly because of the harp arrangement of the stay cables [3]. However, the bridge is not just beautiful, it carries four lanes of freeway, and the deck area is the Finnish record. Like “The Lumberjack’s Candle” became the landmark of Rovaniemi, also the Tähtiniemi Bridge became the symbol for the city of Heinola soon after its completion in 1993. In the proposal the pylon was designed to be built of steel, but in the detailed design phase the material was chosen to be reinforced concrete. In competition phase there was suggested to have 2x12 light spots representing the time flow, hours on the left hand side and 5 minutes on the right. Unfortunately this useful kinetic light idea was not executed.



Figure 2. Tähtiniemi Bridge in summer.

Kärkinen Bridge

This bridge crosses the lake Päijänne in the point that is one of the most beautiful lake scenes in Finland. This was the reason to arrange an open design competition.

The deck is a composite structure with steel girders. The total length of the bridge is 780 m with spans $32,6 \text{ m} + 9 \times 42 \text{ m} + 240 \text{ m} + 3 \times 42 \text{ m}$. Effective width of the deck is 12 m and the free space under the deck is 18,5 m. The concrete towers are different height rising 69 and 96m above the water level. The bridge price was 17,6 M€ in 1997.



Figure 3. Kärkinen Bridge in summer.

Vihantasalmi Bridge

In 1999 a world record was made in Finland when the Vihantasalmi Bridge was inaugurated. The bridge, which was a result of an open design competition organised in 1996, was at the turn of the millennium the biggest wooden bridge on a highway network in the world. There was a prequalification in the competition. Any consultancy could participate but in the prequalification phase five finalists were selected. The fact that the winning proposal was a wooden bridge, was not a coincidence: the whole competition was organised to find especially a wooden solution to replace the old and functionally obsolete bridge. Although made of wood, the requirements for the service life of the new bridge were the same as for all road bridges in Finland, namely 100 years.



Figure 4. Vihantasalmi Bridge.

Crusell Bridge

Crusell bridge is a result of the international invitation competition. Five firms were invited- three from Finland and two abroad. For the winner was announced a very bold asymmetric cable stayed bridge 'Ski jumper' without any intermediate pilars designed by englishmen. Unfortunately the bridge was so expensive that the city of Helsinki could not afford it. Our second entry was also a cable stayed bridge 'Sea swords'. It had success only until in the second phase of the competition to which also two girder bridges were chosen. The cable stayed bridge was chosen to be built, because it was challenging enough in the cityscape and it was about 40 % cheaper than the winner but 2,5 times so expensive than the cheapest girder bridge.



Figure 5. Crusell Bridge in photo montage. The bridge is now under construction.

The crucial fact for the englishmen was that city had put no cost limit for the bridge. In programs it is usually only mentioned that the bridge must be economical. Economical in which cateogry? We know that girder bridge is cheapest, if the girder is stiffened by arch the bridge will cost about 1,5 times so much and if by suspended structure the basic cost must be multiplied by 2,5 even 3,5. If the city had announced the money they can afford for the bridge the englishmen had suggested cheaper one.

The spans are 100 + 50 meters. The superstructure of the bridge is about 1,2 m high and 15,5 m wide composite plate. It allows good panorama view under the deck compared to one level suspension (3,0 m). The design of the towers and deck follow the same aerodynamic principle which emphasises the oboectlike design reflecting the high tech architecture of the area.

The slim form of the towers reflect the shape of an aeroplane and takes a minium space from the deck . The steel core of the tower is clad by stainless steel plates hiding partly the ends of the ropes.



Figure 6. The winner of Särkijärvi bridge design competition.

Särkijärvi Bridge

The city of Tampere organised a bridge design competition in order to find a bridge for a bridge site in a very delicate landscape, to lead traffic over the lake Särkijärvi to the future city district Vuores. In addition to the future traffic solution, the objective of Särkijärvi bridge design competition was to find a positive symbol for the city district Vuores, where in the future will be about 13500 inhabitants. The judgment criteria of the competition proposal were safety, technical applicability, the aesthetic, economy and minimum disturbance to the nature. The width of the lake on the bridge site is 170 metres and the depth 17 metres. In the competition programme it was stated, that on the bridge there will be two 8 metres wide carriageways of which the other one can be changed into doubletrack light railway. For bicycle and pedestrian traffic 4 metres wide lane had to be designed in the proposals. For boating purposes at least 30 metres wide and 10 metres high navigation channel had to be reserved. On the shorelines the pedestrian traffic must be able to pass under the bridge. Eleven teams expressed their interest, and for the competition five of them were invited. The proposals were displayed for the public, so that the public had a possibility to express opinions about the proposals before the final decision of the jury.

The jury commented that the winning proposal is wellbalanced and harmonious entity, though a little bit expressionless. It fits into the scenery and especially the Vshaped intermediate piers can be considered to be very successful, both technically and aesthetically. However it gives space for the lake scene, and in the proposal the typical girder bridge type has been developed successfully. The winning proposal is a three-span composite girder bridge (72 + 96 + 72 metres) in total 240 metres. The construction of the piers has been solved in such a way, that the piling does not disturb the clear and good quality water of lake Särkijärvi. The bridge is possible to be constructed in phases, first only one carriageway and later if needed the second carriageway or the light railway. The construction costs of the winning proposal the jury estimates to accumulate to 9.5 M€.



Figure 7. The winner of Laukko pedestrian bridge design competition. The bridge is under construction.

Laukko bridge in Tampere

The latest bridge design competition example comes from Tampere city center. First there was a design competition sponsored by Ruukki Ltd for groups addressed to groups consisting of students of architecture and bridge engineering. Because no reasonable suggestion was found a national invitation competition was arranged. Five of the enrolled firms were chosen to take part.

The aim of the competition was to receive a positive landmark bridge for Tampere that appreciates the cityscape. For the best solution was appointed an asymmetrical cable stayed bridge crosses which jumps by one leap over the vivid flood. The total length of the bridge is 145 meters (100+25+20). The height of the steel pylon is about 50 meters above the water level.

The jury comments the bridge in the following way. `Very impressive bridge in the cityscape. The pylon competes in height with the stadium light towers. The lean of the pylon, the ropes and curving deck form a strong new sculptural element in the cityscape. Moving along the bridge opens new vistas for a pedestrian.` The approximated cost for the bridge was 2,8 M€ (2770 €/m²) in 2008.

7. Future of bridge design competitions

The longest bridge spans in the world are being constructed on the eastern hemisphere at the moment. Many of those bridges are results of design competitions, where top class

design teams, including international experts from different disciplines, have sought for innovative but feasible solutions to bridge the strait, river or ravine.

The best expertise does not necessarily have to be found inhouse or in one country only. The requirements of the bridge design competitions of today are so diverse, that at least part of them are outside of the core business of bridge engineering companies. For example the construction of scale models or the image and illustration processing are activities that are normally bought from the professionals of those disciplines. This networking and cooperation of specialists from different disciplines can be temporary (for one competition only) or more permanent, but it is increasing. This trend is not only seen in the huge international bridge design competitions where the finalists are always international consortiums, but also in smaller scale bridge design competitions.

One possible path for the future of bridge design competitions is that there will come a division of the bridge design competitions in two: own competitions for architects and own for engineers. It can be clearly seen already know, that the pedestrian bridges where the live loads are not as heavy as on road bridges, the architected teams are increasing, if not taking over. Many recent competition winning pedestrian bridges look very whimsical from the traditional bridge engineering perspective and more architectural artworks than bridges. According to the bridge engineers and many architects too, the recent development can turn against itself. The trend of bridge design teams trying to invent a new aspect to bridge design is being seen worrying. Words like 'rococo' or 'camp' have been used to describe the competition entries [1].

The categorisation of competitions can develop even further. As one of the original objectives of bridge design competitions has been to bring out new talents, ideas and innovations, and develop the bridge sector, it may lead in the future to competitions with age limitations and profession limitations. On the background there can be political, educational or economic reasons.

The division of bridge design competitions into national and international ones is an existing division that will most certainly remain also in the future, although in the European Union there are rules concerning public procurement, which of course must be taken into account in the member countries. Of all the possible paths of future bridge design competitions one at least looks very probable. There will be a shift from the greenfield to the existing assets.

The bridge design competitions are an important part of engineering and architectural practice. As much as there is discussion about the subject and the different issues and details within, there is almost no demand to get rid of the design competitions. The bridge engineers do want to extent their knowledge, to innovate, to find new solutions to the old problem, to fully apply the possibilities of the modern ICT. The recompense should be in balance with the requirements of the competition, if real bridge engineering achievements

are wanted. The impartiality, fairness and transparency of the competition should be guaranteed.

The cooperation of experts from different disciplines should be encouraged, but not forced. Also, it should be clear that the main function of a bridge is to make safe travel over an obstacle possible, and that function should be safeguarded with minimum negative human, cultural, economic and environmental impacts during its whole life. With these few counsels in mind the client can set the scene for a competition, where the top class design teams will compete earnestly for the fame and glory. The better the competition the better the results. In an ideal case, the end result would be a real masterpiece, which provide comfort for all the stakeholders: owners, drivers, beholders, culture, environment and even the bridge maintenance engineer.

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