An Immersed Tunnel, better than a Long Span Bridge?

Rob VERGOOSSEN
Expert Concrete Structures
Royal HaskoningDHV
Rotterdam, the Netherlands
rob.vergoossen@rhdhv.com

Rob Vergoossen, born 1975, received his civil engineering degree from Delft University of Technology in 1999.

Hans DE WIT
Director Tunnel
Engineering Consultants
Nijmegen, the Netherlands
H.deWit@Tec-tunnel.com

Hans de Wit, born 1962, received his structural engineering degree from the Univ. of Eindhoven in 1986.

Eelco VAN PUTTEN
Consultant Immersed Tunnels
Tunnel Engineering Consultants
Nijmegen, the Netherlands
E.vanPutten@Tec-tunnel.com

Eelco van Putten, born 1977, received his civil engineering degree form Delft University of Technology in 2002.

Summary

Traditionally long span bridges are applied for river crossings and often in delta areas and in soft soil conditions. As an alternative to a bridge, in countries like the US, Japan and the Netherlands many of these fixed links have been constructed as a tunnel with the immersed tunnel technique. In these countries this technique is quite mature and common practice. However, over the past years there is also a growing interest for this technique in other countries. Recent tunnel projects have shown that immersed tunnels are feasible and competitive to a long span bridge under more challenging circumstances. Immersed tunnels have been constructed successfully in water depths up to 58 m below sea level, in very poor soil conditions, with increasing lengths, increasing design lives and in offshore conditions.

Keywords: Immersed Tunnel, competitive.

1. Introduction

The rapid expansion of global economy has increased the need for a good quality (international) transport network. Natural boundaries and obstructions such as sea straits, large estuaries and inland waterways can increase costs and time for transportation. In many cases the realization of a fixed link can improve the conditions for transport and relieve the existing road network.

When crossing waterways the most apparent options seem to be a bridge or a bored tunnel. This is often simply being most familiar with them. However, undeniably the immersed tunnel is an alternative technique that can provide economic, high quality and competitive solutions to cross waterways. Especially when crossing waterways in an urban environment or when high vertical clearance of deep navigation channels are required, like in main ports. The last decade new developments and innovations have stretched the limits for the immersed tunnel as a competitive alternative for large fixed links. The Øresund Link between Denmark and Sweden (Fig. 1) gave the immersed tunnel technique the first boost towards revival, rapidly followed by other major links in which the immersed tunnel technique is applied on a large scale. The last impressive example is the Fehmernbelt Link, the link between Denmark and Germany comprising an immersed tunnel of almost 19 km. This solution was preferred over a long span bridge.

Fig. 1: Øresund Link (bridge&tunnel) between Denmark and Sweden

https://doi.org/10.2749/222137813808627136
Distributed by structurae

In this paper the pros and cons of immersed tunnels are discussed and explanations are given for the fact that an immersed tunnel can be competitive to a long span bridge in many fixed link projects. Some striking examples are briefly described to illustrate the above and the potentials of the immersed tunnel for major strait crossings.

2. Why and when is an immersed tunnel competitive to a long span bridge or bored tunnel?

Immersed tunnels do not suit every situation. However, if there is water available to cross or to use as a transport medium they usually present a feasible alternative to bridges or bored tunnels at a competitive price. They offer a number of advantages such as:

1. Immersed tunnels may have special advantages over bored tunnels for water crossings at some locations since they lie only a short distance below water bed level. Approaches can therefore be relatively short. Compared with high level bridges or bored tunnels, the overall length of the crossing will be shorter (Fig.2);

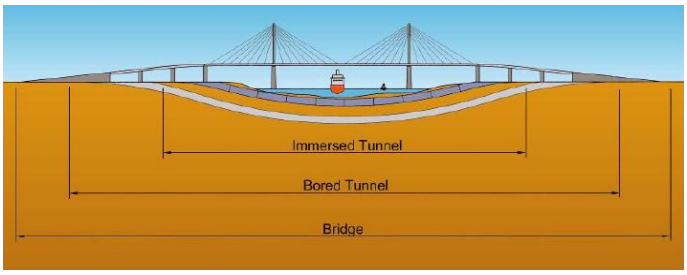

Fig. 2: Comparison Link options

2. Immersed tunnels will have less impact on their environment (visual, noise and disruption) than high level bridges. This is especially the case if access to a port is involved and vertical clearances of about 70 m may be required. The connection to the local road or rail network is generally easier to perform for an immersed tunnel than for high level bridges or a bored tunnel which has to be located on a deeper level;

Fig.3: Impact of a high level bridge on environment

3. Hydraulic impact and blockage effects become more and more an issue in a lot of places when it comes to the realization of a crossing. Especially in rivers with large discharges and substantial sediment transport the presence of obstacles in the river, such as bridge piers, may result in serious scouring and sedimentation, resulting in banks or even small islands and the changing of embankments during periods of high discharge;

3. Discussion

The biggest difference between a tunnel and a bridge is the fact that a bridge is visual. Engineers and architects help shape the visions of the decision makers and create Landmarks. Which politician does not want to leave a legacy such as a structure as the Golden Gate Bridge.

But this visual strength can also become its weakness, because creating landmarks can be an important selling point to politicians, the general public is more conservative. Not so long ago information went slow and decision makers could take their time in order to shape the public opinion. But nowadays the speed of communication is phenomenal and still growing. When a protest campaign against a bridge structure starts it will grow fast, making politicians vulnerable. When they want to be re-elected, it will become safer to approve the construction of a tunnel, which has in general a lower public resistance. An example for this is the ‘Lange Wapper’ project in Belgium in the port of Antwerp.

4. Conclusions

The conclusion of this paper is not that an immersed tunnel is the way forward. Only that for each long span bridge solution there might be a feasible immersed tunnel alternative to be assessed as well. Recent projects described in this paper such as the Fehmarnbelt-link prove this.