



Submarine impact on a submerged floating tube bridge

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Abstract

The Norwegian Public Roads Administration have been given the task of building fixed links to replace the ferries along the Coastal Highway Route E39 on the west coast of Norway. One of the concepts that has been looked at is a Submerged Floating Tube Bridge (SFTB), also called Submerged Floating Tunnel (SFT). This is a concept where the roadway is placed in a tube that is fully submerged in water, but is not resting on the seabed like an immersed tunnel. The buoyancy of the tube is therefore critical in carrying the vertical loads in this concept and must be maintained at all times, so not to lose the structure. An unusual extreme load that has to be taken into consideration in this aspect is ship impact from a submarine. This is of particular interest because one of the fjords where the Submerged Floating Tube Bridge has been studied, is the Bjørnafjord, a fjord where the Norwegian Navy have practice ground for their submarines. Impact analysis have been performed between the Submerged Floating Tube Bridge and a submarine of the same size as the Norwegian Navy operates, to find out the potential for damages to the structure, as well as damages to the submarine.

Keywords: Safety, collision, bridges, marine structure.

1 Introduction

Along the western coast of Norway, the Norwegian Public Road Administration is developing a huge project: creating fixed links along the E39, a European road connecting Kristiansand to Trondheim. The 1100 km coastal highway is nowadays including seven crossings particularly challenging, due to the deepness and the wideness of the fjords. For those, it is not possible to think about 'traditional' bridges and new technologies have to be developed.

The Bjørnafjord is one of these fjords, with his 5-6 km crossing in an area where the seabed can reach up to 600 meters. For crossing the Bjørnafjord, three different bridges have been proposed: a floating bridge, a suspension bridge

with tension leg platforms and a submerged floating tube bridge (SFTB).

2 The SFTB Crossing the Bjørnafjord

2.1 Overview of the structure

The SFTB proposed for the Bjørnafjord is a twin tube bridge submerged at a specific depth in the sea: in the case of the Bjørnafjord (Statens Vegvesen, 2016) at 30 meters below the sea level. The tubes allow to have two carriageways in each direction, in addition to a cycle and pedestrian path below the road level. The tubes are connected with cross braces, to guarantee the necessary horizontal stiffness and every 250 meters the cross section allows to go from one tube to the other, for safety purposes.