SUBMERGED FLOATING TUNNEL

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Abstract - *The **Submerged Floating Tunnel (SFT)** is an innovative solution for crossing waterways, utilizing buoyancy to support the structure at a moderate depth of **20-50 meters**. Constructed from **steel and concrete**, the tunnel is designed to remain submerged while being supported by **columns, tethers anchored to the seabed, or pontoons floating on the surface**. This ensures stability while avoiding high water pressure and surface traffic interference.*

*Traditional alternatives, such as **bridges** and **immersed tunnels**, are impractical in deep waters. With ocean depths reaching up to **8 km**, constructing bridge columns of such height is unfeasible. Likewise, immersed tunnels face extreme pressure conditions, nearly **500 times the atmospheric pressure** at such depths. The SFT, positioned at a safe **30-meter depth**, provides an optimal solution without structural challenges or obstruction to maritime traffic.*

1. ***Structural Components of SFT***
2. ***Tube** – The main tunnel structure, built for strength and durability.*
3. ***Anchoring System** – Uses **seabed tethers** or **floating pontoons** to maintain stability.*
4. ***Shore Connections** – Integrates the tunnel with existing road networks.*

By combining buoyancy principles with advanced engineering, SFTs offer a sustainable, efficient, and feasible method for underwater transportation in deep and wide water bodies.

1.INTRODUCTION

Submerged Floating Tunnel is a buoyant structure which moves in water. The relation between buoyancy and self-weight is very important, since it controls the static behavior of the tunnel and to some extent, also the response to dynamic forces. Minimum internal dimension often results in a near optimum design. There are two ways in which SFT can be floated. That is positive and negative buoyancy. The Submerged floating Tunnel is a tube like structure made of Steel and Concrete utilizing the law of buoyancy. It supported on columns or held in place by tethers attached to the sea floor or by pontoons floating on the surface. The Submerged floating tunnel utilizes lakes and waterways to carry traffic under water and on to the other side, where it can be conveniently linked to the rural network or to the underground infrastructure of modern cities.

1.1 REASON FOR CHOOSING FLOATING TUNNEL

Floating tunnel is the totally new concept and never used before even for very small length It can be observed that the depth of bed varies from place to place on a great extent. The maximum depth is up to 8 km. also at certain sections. The average depth is 3.3 km. The two alternatives are available for constructions are bridge above water level or tunnel below ground level. Since the depth is up to 8 km it is impossible to construct concrete columns of such heightfor a bridge. And also, the pressure below 8km from sea surface is nearly about 500 times than atmospheric pressure so one cannot survive in such a high-pressure zone. So, the immersed tunnels also cannot be used. Apart from this, many tourists visit the places near the coastal line of a country or places situated near the water bodies. Tourists love to travel in this place as due to their rich natural diversity and beauty but it's hard to travel through them because of the rough topography due to mountainous regions. Due to which construction of roads and 8 railway routes are implemented by destroying someparts of this natural beauties which within is a threat to the biodiversity of that region. Therefore, floating tunnel is finalized which is at a depth 30m from the sea level, where there is no problem of high pressure and also no need of destroying the natural beauties as traveling can be done through water. There is sufficient space for any big ship to pass over it without any obstruction.

1.2 BASIC PRINCIPLE OF SFT

Submerged Floating Tunnel is a buoyant structure which moves in water. The relation between buoyancy and self-weight is very important, since it controls the static behavior of the tunnel and to some extent, also the response to dynamic forces. Minimum internal dimension often results in a near optimum design. There are two ways in which SFT can be floated. That is positive and negative buoyancy.

Positive buoyancy:

In this the SFT is fixed in position by anchoring either by means of tension legs to the bottom or by means of pontoons on the surface. Here SFT is mainly 30 metres below the water surface.

Negative buoyancy:

Here the foundations would be piers or columns to the sea or lake. This method is limited to 100 meters water depth .

SFT is subjected to all environmental actions typical in the water environment:

wave, current, vibration of water level, earthquake, corrosion, ice and marine growth. It should be designed to with stand all actions, operational and accidental loads, with enough strength and stiffness. Transverse stiffness is provided by bottom anchoring.

2. DESIGN ISSUES

For design of an SFT the following basic considerations should be taken into account:

- The cross-section must give sufficient space for traffic, evacuation, ventilation, ballast, inspection, maintenance and repair work.
- The alignment must be such that there is no interference with ship traffic passing above
- The tunnel must have a simple and well-defined static system which can be properly represented in the design calculations
- The joints should have no less strength or integrity than the tube between the joints
- The structure must have a ductile behavior in the potential failure modes
- Ma The anchoring system should be redundant
- The tunnel must not be unduly susceptible to local damage

2.1 ACCIDENTAL SCINARIO

Irrespective of how the SFT is designed possible accidental scenarios have to be identified and dealt with to minimizeor possibly to eliminate their consequences. Pontoons may be subject to both local and more overall damage due to ship collision. Dividing the pontoons into compartments and introduction of weak links between pontoon and tube may be the answer to such threats. The tunnel tube may be subjected to scenarios such as sinking ships, impact fro msubmarines, hooking of trawling gears and anchor lines, internal fire and explosion and water filling due to rupture of possible internal water mains. The ultimate consequence of these scenarios is massive water filling of the tube. The tunnel should be designed so that all potential failure modes be ductile. Other safety enhancing measures may be to use double hull, steel lining in case of concrete tubes and also to shape the tube so it has the apex at

2.2 CONNECTION

The connections of the tube to the shore require appropriate interface elements to couple the flexible water tube with the much more rigid tunnel bored in the ground. This joint should be able to restrain tube movements, without any unsustainable increase in stresses. On the other hand, the joints must be water tight to be able to prevent entry of water. Additional care in shore connections is required, especially in seismic areas, due to the risk of submarine landslides

2.3 STRUCTURAL DESIGN OF SFT TUBE

SFT tube keeps balance under the action of buoyancy and cable tension bears vehicle load, wave-current load, temperature load and so on. In the system transformation during prefabrication, floating, installation and operation, the stress of tube is complex, so the tube design should carry on longitudinal and transverse analysis under these working conditions. SFT tube load is divides into permanent load, variable load and accidental load. The permanent includes structure weight, buoyancy, hydrostatic pressure, concrete shrinkage etc.

The variable load includes vehicle load, water head load, wave-current load, temperate load, construction loadetc. The accidental load includes seismic, sunken ship load, blast load, leakage etc. SFT tube is designed under ultimate limit state and serviceability limit state just as traditional hydraulic structure design, moreover, the stress and displacement should be analysed and checked under progressive damage Limit state and fatigue limit state based on structural reliability theory.

MODEL OF SUBMERGED FLOATING TUNNEL

3. CONCLUSIONS

The submerged floating tunnel will set up new trends in transportation engineering and which shows with the advances in technology that will reduce the time required for travelling. And make the transportation more effective by hiding the traffic under water by which the beauty of landscape is maintained and valuable land is available for other purposes. Benefits can be obtained with respect to less energy consumption, air pollution and reduced noise emission. For wide and deep crossings, the submerged floating tunnel may be the only feasible fix link, replacing present days ferries and providing local communities with new opportunities for improved communication and regional development.

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