

Introduction of the Program

Our program is to research the repair of the Golden Horn Bridge, which located in Turkey. And our outline is divided into 7 parts.

Part 1 and 2 are introducing some basic information about the Golden Horn Bridge. Part 3, 4 and 5 are mainly talking about the bridge's problems and some of the alternatives that are out thereto fix the problems. To help decide on the best alternative static and economic analysis was applied and the results are shown in part 6. Finally, we will give the conclusion and evaluation of the whole project in part 7.



Background of the Bridge

The Golden Horn Bridge is one of only three bridges in Turkey. In 1974, with the technical and financial assistance of Japan, the bridge was built on Golden Horn Bay and also on the European Highway No.5, which is the most important Highway in Turkey. The Golden Horn Bridge divides Istanbul, the Metropolitan Municipality in Turkey, into two parts. One side is government offices and the commercial districts, and the other side is mainly residential.

<http://en.structure.de/structures/datta/index.cfm?ID=s0005858>

Problem Statement of the Bridge

The Golden Horn Bridge is the most important bridge in Turkey, but it has taken over 1.5 times the traffic volume it was constructed to hold. Because of this, the bridge is often congested over 10 hours in one day. For this reason, the bridge should be widened with the hope of reducing the congestion on the bridge and ensuring a smooth transport, which will make the bridge more useful and efficient in all economic activities.

Indicator		1996	1997	1998 (project completion year)	1999
Annual average daily traffic volume (1,000 vehicles/day)	Actual results	165	180	220	225
	Forecasts	153	157	160	164
Time required for traveling the Edirnekapi-Okmeydani section* (minutes)	Normal time	15	15	5	5
	Peak time	25	25	12	10
Average driving speed for the Edirnekapi-Okmeydani section** (km/h)	Normal time	13.7	13.7	41.1	41.1
	Peak time	8.2	8.2	17.1	20.5

Additionally, with the development of Turkey, the increase of the dumping liquid and solid waste from the residential buildings and industry into the shore of the Golden Horn has increased. This is bad because phosphorus, nitrogen and chlorine such as the $\text{NH}_3\text{-N}$, $\text{NO}_3\text{-N}$, TP and dissolved things such as $\text{PO}_4\text{-P}$ amounts have increased in the water. These substances are damaging a bridge that is already corrupt. For these two primary reasons, the bridge should be necessarily repaired and revitalized.

Alternatives of Repairing the Bridges

A. widen the bridge to reduce the congestion

Everyone knows that every bridge has their own useful life, so it's not common for the bridge to be widened. Sometimes the methods of widening the bridge are to add lanes or add the decks. Either of these methods will increase the capacity of the Golden Horn Bridge.

For the Golden Horn Bridge, it has been suggested that two 995-meter-long, 12.1-meter-wide side bridges be built. One of them is on the existing bridge, and the other will be constructed using steel-box and PC concrete girders. When the widening is completed, the traffic volume will have grown 22.2%, the total traffic will grow 2.4% as before.



B. Repaint to prevent corrosion

The Golden Horn Bridge is built on the Golden Horn Bay where there are superfluous chloride ions in the water. These ions cause the onset of the corrosion in the concrete structure. To avoid the corrosion, galvanized coatings should be used to protect the steel. Another method to protect the bridge from corroding is to stop the chloride ions from ever contacting the bridge. In order to do this, the Golden Horn Bridge should be constructed with noncorroding materials, and the anchorage areas should be protected by using some impermeable materials. These methods should protect the concrete in the water, and all these methods can reduce the rate of the corrosion.

<http://www.enka.com/motorway.asp>

Cost (assume the bridge needs to last 40 years)

A. Simply repair the current bridge.

1. It will Cost 10% of current project equaling $13.756 \text{ billion(yen)} \times (.1) = 1.3756 \text{ billion(yen)} / 117.68 = \$11,689,326.00$
2. The first bridge only lasted 19 years, so a repaired bridge will not outlive 19 years. How much longer a repaired bridge will last varies, and is difficult to estimate, but for this bridge 12 years seems reasonable.
3. The current bridge failed due to too heavy of a traffic load, and the traffic load is only projected to increase (show statistic). So a repaired bridge would actually last only 7-10 years longer.
4. Repairing the bridge also does not help alleviate the traffic problem, which is also another cost (both tangible and intangible).
5. All things considered simply repairing the bridge is not an option regardless of cost. The congestion problem is too serious to overlook. The bridge already cannot handle the current load and load is expected to only get worse. The bridge would be in constant need of repairs

which would further impeded traffic. Repairing the bridge is the inexpensive, but inconceivable choice. Not expanding the bridge will defeat the bridge's purpose.

B. Rebuild a completely new and wider bridge

1. A new bridge would need to be larger than the original bridge in order to handle the increased traffic load. The new bridge would need to be approximately twice as large as the original.
2. The cost of two new two lane bridge would be $13.756 \text{ billion} \times (.9) = 12.238 \text{ billion (yen)}$ (90% of the current project). But the new bridge needs to be twice as big. The cost should actually be $2 \times 12.238 \text{ billion (yen)} = 24.476 \text{ billion (yen)}$ / $117.68 = \$207,987,763.43$.
3. The useful life is hard to estimate, but if the bridge is large enough to handle future loads it should last a long time, however estimating how long is very difficult. 40 years should be a reasonable estimate.
4. A new, larger bridge, should also reduce the extra traffic costs.
5. Assume there is no salvage value and that the maintenance will be similar to the last options maintenance cost and can thus be omitted from the cost analysis.
6. Calculate EUAC(\$9,005,870.16)

C. Repair current bridge and build two new two lane bridges.

1. The old bridge just had some joint, steel and concrete problems that were caused by excessive loads. Repairing these problems is nothing new and should not be too difficult. The technology and methods needed to do this already exists.
2. Two new, smaller, bridges could be built on either side to help the traffic flow and reduce the load on the old bridge.
3. This should reduce the extra traffic costs just as much as building a completely new big bridge.
4. The new side bridges should last 40 years, but the repaired portion might need extra work in the future. How long before anything needs repair is again hard to say but 20 years seems like a reasonable choice. I would assume the repairs would be comparable the first repairs done on the bridge which cost about \$11,689,326.00.
5. The cost to construct this outcome is $13.756 \text{ billion yen}$ / $117.68 = \$116,893,329.90$ with an extra \$11, 689, 326.00 added 20 years later.
6. Calculate EUAC. (\$5,215,800.11)

Impact

a. environment impact

- i. Repairing the bridge
 1. No need to clear other areas of land for new bridges.
 2. Will not reduce traffic so it will not reduce pollution
- ii. Widening the bridge
 1. Reduce air pollution
 2. Grass and trees planted on sides of bridge improve landscape
- iii. New bridges

1. Reduce air pollution
 2. need to clear new areas of land in order to build roads and bridges
- b. greater efficiency in economic activities
- i. Smooth traffic flow will be achieved thus shorter commuter times and greater efficiency.
 - ii. International and intercity distribution will be more efficient because HGV's will be allowed on the bridge.
- c. Impact on historical structure
- i. Castle walls and a cemetery from Constantinople period stand next to access road. Several headstones will need to be relocated and several steps need to be taken in order to minimize the impact on the castle walls

Conclusion

Our research shows that there are two main causes of damage to the bridge, the steel corrosion created by the electrochemical reaction with its environment and the heavy traffic load. There are two alternatives to solve these problems. The bridge can be rebuilt or the bridge can be repaired, widened, and painted.

According to our economic and environmental analysis, it is easy to see the plan to repair current bridge has more benefits than the plan to rebuild an entirely new bridge. Repairing the bridge is the most cost effective plan and it also offers the least amount of environmental impact while still remaining dependable and reducing the traffic.