Introduction and History

The road and the bridge system joining Europe and Asia contains these elements:
- The Bosphorus Bridge
- The third Golden Horn Bridge
- Three via ducts on Ortaköy-Balmumcu ridges.
- One flyover, between Esentepe – Mecidiyeköy
- Two tunnels in Beylerbeyi and Edirnekapi
- 12 different level junctions
- 37 attaching bridges
- 10 km. of motorway.

Of all this detail, the most attractive one is definitely the Bosphorus Bridge. The word «Ringroad» also contains the bridges, but the names of the two bridges have been added to the heading because of their speciality.

We think at this point it will be appropriate to look briefly at some suggestions and sketch projects made in the past, to join the two continents, Europe and Asia. Although it is obvious that crossing the Bosphorus with various vessels was possible since ancient times, the means of providing a continuous passage was first realized by Persian king «Darius» 2483 years ago. The historia from Halicarnassus, Herodotus states it thus: Darius, broadsiding various vessels, constructs a float bridge, in the location between present day Fortresses, and passes an army of 80,000 over it to the European side to fight the Greek kingdoms. The architect of this float bridge was Mandrokal of Kornet.

Later, till the end of 16th. Century no one touches the Bosphorus as far as a bridge is concerned. At that time, Licardo of Genoa presents the suggestion of a bridge to join the side to Sultan Beyazid II, also pointing out the difficulties of this project. Still at those years Beyazid wishes to have a bridge constructed on the Golden Horn. Leonardo de Vinci prepares a project for this bridge, 350 m. long and 41 m. high, of the kind that opens for sea traffic when necessary. Correspondence related to this is present in the Topkapı Palace Museum archives.

After a quiet period till 1900, a Frenchman, F. Arnodin prepares a pre-project for a railroad line to cross the Bosphorus. This project has two alternatives. The first one starting from Bakirköy, crossing the Bosphorus from Sarayburnu to Bakirköy, reaches Bostancı. The other one, also starting from Bakırköy, heads north and crosses the Bosphorus from Rumelihisar to Kandilli, ending still in Bostancı.

The object of this project is to provide an uninterrupted traffic of trains between the two continents. At the time no one even dreamed of a bridge for land vehicles.

Still in those years a French Railroad Company, «Compagnie Internationale du Chemin de Fer du Bosphore» presents a pre-project to Abdulhamid II, suggesting a railroad bridge between the Fortresses to connect the European lines with the Baghdad railroad. In this project, named «Hamidiye Köprü- sü», there are special bastions on the bridge where minarets, dones and defence battery positions can be placed. At first the project is taken very seriously; so that a German-Hungarian firm starts drilllings for the bridge footings. However, the inconsistent policy of that time results in other big countries interfering, and the work is stopped.

After the gap created by wars, in 1936, a Turk, Nuri Mühürzade prepares a project for a bridge. This bridge, to join Sultanahmet and Salaçak with a connection to Sirkeci, running a length of 2650 m. creates great enthusiasm at first, but is rejected later, on basis of a conclusion that it is not economical.

Studies that the present bridge may be considered based upon were started in the year 1953. A Commission consisting of officials from Ministry of Public Works, University of Istanbul, and Municipality makes some research and concludes that the study of the bridge must be given to a dependable firm of Consultant Engineers.

In 1955, General Directory of Highways, contacting American «Leuw Gather International Inc.» Consultant engineering firm, asks a report be prepared about the Bosphorus Bridge and Ringroad.

In May 1956 this report is completed. According to this, a bridge in the same location as present, and a network of connecting roads on either side is proposed. Besides, considering subjects in relation with the feasibility of the project and its effects on Turkish Economy, it is suggested that the construction be started in 1970 and the third Golden Horn bridge and surrounding roads be started at once.

Due to economical reasons, these suggestions are not realized immediately. A while later the General Directory of Highways, gives the Bosphorus Bridge project to «D. B. Steinman», firm of Consultant Engineers. Although the project is completed in 1960, because of financial hardships, the process is not commenced. General Directory of Highways, considering the Istanbul traffic and population increase studies it has been carrying on since 1958, announces the necessity of a solution for crossing the Bosphorus and Freeway, putting the project in the second «five years plan» (1968-1973).

However the project earlier prepared by the firm «D. B. Steinman» proves inconvenient as far as new methods of construction and elements of building go, and the research and project is then given to «Freeman, Fox and Partners» in early 1968.

In March 1968 an agreement is reached with the French firm «Bureau Central d'Etude Pour les Equipements d'Outremer.»

In April 1968, after signing a contract with «De Leuw Cather» revision of the feasibility study of the Bosphorus Bridge is given to this firm. The study gets completed in November 1968, the project takes its final shape and Ringroad practise starts in 1969. Coming to Golden Horn Bridge, the studies for this, which is really a part of the Ringroad master project,
starts in the year 1955. When the Istanbul Ringroad and Bosphorus Bridge project is taken into the second five year plan, works develop faster. Project preparation starts in 1968 and the job is given to «Japan Bridge Consulting Co. Ltd.» firm of consultant engineers. In March 1971, from five groups of contractors nine bids are taken. Of these, the joint offer of a West-German - Japanese firm is accepted, and in September 1971 the contract is signed and the construction is started.

The Freeway and the Bridges?

It is a fact that Istanbul network of roads have become inadequate long since. The main streets that have to carry the weight of traffic are in definite and restricted directions. These main streets are jammed at definite hours, generally from all directions and especially at Galata and Atatürk Bridges.

Asia and Europe passages remains restricted by the capacity of the car ferry, and at traffic rush hours it causes great loss in time and material. With industrial and commercial development after World War II and increase in the income level, uncalculated rush for big cities, and other reasons like these, like every other big city, the transportation problem in Istanbul has gone into a dead end, and is still going.

At first, commercial and industrial establishments have put both ends of Golden Horn in a bad condition. Space getting less and land prices going up, the industry has gone outside the city walls and commerce has rather shifted in the direction of Beyoğlu, Taksim Şişli, Mecidiyeköy. With the transportation advantages provided by Highways, the inner-city industrial districts have shifted in the direction of Thrace and Kocaeli highways after the 1950's and will shift further.

Istanbul holds 9 % of the nation's population, 24 % of total number of vehicles, 40 % of tourists, 54 % of college and university students. In contrast, since means of easing the transportation have not been provided, having to face such a dilemma should be considered natural. In recent years, if narrow inner-city roads and streets in major directions had not been widened, Sirkeci-Yeşilköy strand, Vatan and Barbaros avenues, Bosphorus roads had not been opened, transportation would be in greater trouble. Highway connection roads of the city, with the means of General Directory of Highways, as compared to inner-city, have developed in a much more balanced pattern and is going on developing. Below are the daily figures of crossing vehicles on the Golden Horn Bridges, considered a narrow gorge of traffic, until the year 1968 when the Freeway studies matured.

<table>
<thead>
<tr>
<th>Year</th>
<th>Galata Bridge</th>
<th>Ataturk Bridge</th>
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<tbody>
<tr>
<td>1955</td>
<td>30 000</td>
<td>22 000</td>
</tr>
<tr>
<td>1963</td>
<td>48 000</td>
<td>42 000</td>
</tr>
<tr>
<td>1968-May</td>
<td>60 000</td>
<td>60 000</td>
</tr>
</tbody>
</table>

These two bridges, only 900 m. apart are in a fully loaded situation right now. As of 1963, on the Galata Bridge during rush traffic hours there hasn't been a «peak» increase. The increase in the total number of vehicles passing is only due to an abnormal lengthening of the period.

Coming to population increase in Istanbul, from 805,000 in 1940, it has reached 2,141,000 in 1965. In 1985 and 1990 it is expected to increase to 4,5 and 5.5 millions respectively. These amounts shouldn’t be considered far exceed, because some guesses made in earlier years have been immensely exceeded in actual figures. For example guesses in 1955 showed that the population would be 2,300,000 in 1990, but this figure has already been reached in 1965.

Having thus regarded the population, let us take a look now, at the number of vehicles. Total number of vehicles in Turkey in 1960 was 172,000, and in 1971, 530,000. Though these figures are quite low, the rate of increase is considerably high. Number of vehicles in Istanbul in 1952 was less than 10,000. During the studies of the Bridge project in 1968, it exceeded 80,000. With a rough calculation, this amount may be expected to reach 225,000 in 1985 and 320,000 in 1990.

Still, vehicles that traffic between Europe and Asia are not only those registered in Istanbul, apart from these, there are vehicles from other cities, foreign tourists’ vehicles and transport trucks and busses present, and it should be kept in mind that this can amount to quite a large figure.

Number of vehicles that have crossed the Bosporus in the recent years and that are expected are given in the lines below, in rounded figures.

Cross Bosphorus traffic in years :

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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic</td>
<td>4 306 000</td>
<td>5 493 000</td>
<td>6 124 000</td>
<td>6 814 000</td>
<td>8 030 000</td>
<td>9 402 000</td>
<td>10 278 000</td>
<td>14 829 000</td>
<td>20 104 000</td>
<td>25 758 000</td>
<td>31 769 000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It may be hard to believe in these figures, but regarding the actual increase between 1968 - 1971 it is not possible to consider these figures incredible. Is it not possible to encounter this increase with the system of car ferry? No it isn’t. Let us take a look at it. Regarding 1968 Freeway studies. 17 car ferries were operating in Istanbul at that time. In 1973, when the bridge is planned to open for traffic, at least 35 ferries would be necessary. But the problem could not be solved solely by increasing the number of ferries in operation. Parallel to this, there would be the construction of additional piers, vehicle entry.
ISTANBUL PERIPHERAL FREEWAY

and parking spaces, means of access to these, and similar supplements. To realize these, according to studies of the same year, would require an investment of over 400 million T.L. In 1995, there would have been 90 ferries and a further expansion of additional facilities mentioned above.

Additional investments aside, the ferries would jam the current-wise traffic of Bosphorus, and result in not full efficiency of the ferries. For example, in 1958, there has been 67 meetings of the main Bosphorus traffic and crossing ferries, effecting 1950 vehicles, causing a calculated loss of almost 12 000 vehicle-hours. Abolishing of ferries completely after the bridge opens cannot be considered. Considering the Freeway entries and exits will be at definite and restricted spots, ferries will more or less remain in service. At the beginning vehicle operators may tend to prefer the bridge, even when it is inconvenient for them, with sheer enthusiasm. But later, the car ferry service will take its share.

The starting of car ferry service across the Bosphorus was quite long ago. Two out of 39 vessels of «Şirket-i Hayriye» - maritime company founded in 1860, by two gentlemen, Fuat and Mihhat - were ferriboats, (Nr. 26 Suliya, nr. 2 Sahilben) and supplied the demand adequately for that time. According to a rumour, the idea of founding this establishment came to these two gentlemen while taking a bath in the hot baths. They may not have jumped out shouting «Eurisko» like Archimides, but they have later proved to be men of remarkable intelligence by becoming Keçecizade Fuat Pasha, Councillor to Prime Ministry, (Sadaret, in those days) and Müverdi Cevdet Pasha, Minister of Justice.

Although not important enough as to be counted one of the motives effecting a bridge construction, bad weather conditions preventing the scheduled trips from time to time result in a loss of many vehicle-hours. Besides, perishable goods being transported might be damaged, and this a fact that all these setbacks will vanish once the bridge has opened for traffic. Reaching one district from another in the city takes a long time since the city roads are in no condition to carry present traffic. With transport periods in effect, calculated time consumed in some major districts is given below:

<table>
<thead>
<tr>
<th>DISTRICTS</th>
<th>WITH CAR FERRY</th>
<th>WITH RINGROAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taksim-Erenköy</td>
<td>0 min.</td>
<td>35 min.</td>
</tr>
<tr>
<td>Aksaray-Üsküdar</td>
<td>75 min.</td>
<td>35 min.</td>
</tr>
<tr>
<td>Beyazıt-Karşıyö</td>
<td>80 min.</td>
<td>40 min.</td>
</tr>
</tbody>
</table>
The History - Making Bosphorus Bridge

Topkapı-Kuzluyak: 105 min. 22 min.
Bakirköy-Bostancı: 135 min. 50 min.

The periods given in the first column are according to hours of day when the present roads are comparatively free. In hours of rush traffic, holidays and weekends, long hours are wasted waiting in car ferry queues. Above times are for cruising vehicles. For heavier vehicles of transport, more time elapses in the course.

Since the Bosphorus Bridge cannot be considered on its own, uninterrupted connections to the city roads, and Ankara and Edirne highways are necessary. Because of this reason the 22 km Freeway for which the detail has been given in the «Introduction and History» section, is a necessity.

It will be appropriate at this point to briefly confront the Freeway project with the Greater Istanbul Regulatory Plan.

Looking at Istanbul Regulatory Plan, we see the general principles are:

— To take the warehouses and bus terminals in Eminönü outside the city walls.
— To take the covered wholesale market to Zeytinburnu.
— To take the railroad passenger and especially cargo stations and warehouses from Sirkeci to Zeytinburnu.
— To create the convenient means for industrial development and housing projects connected to these, to develop in the country towards Gebze and the Inland.
— To take the dock facilities on Rumeli side to Zeytinburnu and further;
— To provide a lengthwise growth of suburbs inbetween Kadıköy and Gebze instead of a circular growth.
— To change the part of Bosphorus, north of Ortaköy-Beylerbeyi line, into a touristic resort and a national park.

Realization of these principles, above all depends on the solution of the transportation problem. Things like connecting the city to Anatolia and Thrace roads, making the Ankara State Highway a four-lane free-way inbetween Bostancı and Gebze, constructing a Motorway on the main route of the old Izmit road, bringing Vatan Caddesi—which isn’t connected any-where—upto a capacity where it can provide connect-connection for residential areas till Küçükçekmece and making it into Istanbul-Edirne Expressway are partly started and partly in planning stage, but it is also necessary to connect these external roads effi-ciently. The only solution is the Freeway, and its two main parts, the Bosphorus Bridge and the Golden Horn Bridge.

However, it is already being mentioned that the Freeway will not wholly solve the transportation problem. For example in news supplied by Citizens Association of Istanbul, a tunnel with dual channels is suggested between Salacak and Sarayburnu, one of them to be used for railroad lines and the other for subway. The suggestion is accepted by the Bureau of Greater Istanbul Regulatory Plan. A tunnel like this, with its side facilities will cost approximately one billion TL and will pay itself in about ten years. The project will be financed by domestic and foreign sources, not placing any burden on the government. According to statistics of 1970, on the average 2 785 000 people travel each day in Istanbul. Of these, 280 000 traveled by suberb lines, 30 000 by Maritime Li-nes City Routes, 680 000 by various minibus lines, 650,000 by taxi and dolmuş (a chartered taxi), 85,000 by public bus lines, 750,000 by munici-pality bus lines and the rest by private vehicles. Since this amount increases every year, this suggestion of the Asso-ciation may be considered seriously when the time comes.

The Bosphorus Bridge
The bridge, which from many aspects is the most important construction of the Ringroad has its pillars (steel towers) located on Ortaköy and Bey-lebeyi shores, and the part suspended inbetween the pillars is 1074 m. long. The part that is not sus-pended but supported by concreèe blocks is 231 m. long at Ortaköy and 255 m. at Beylerbeyi, so the overall length reaches 1560 m. The exact width of the bridge is 33.40 m. Central part has a vessel cle-arance of 64 m. from the sea-level, and is 400 m. in width. The bridge span is the same as that of the «Severn» bridge, constructed in England in 1966. This type of span is cheaper and lighter as compared to the familiar beam type, and the aerodynamic structure puts the wind load down to 1/3. Cross-sectional depth is three meters. Suspension cables consist of 11200 high resistance, galvanized steel wires, 5 mm. thick, joined in 19 groups on location. Thus, two suspension cables, each 58 cm. in diameter and having a weight of 3000 tons inbetween the pillars, will carry the bridge span. These cables are carried on pillars of high resistance steel, having an exact height of 165 m. Each of these pillars have two feet, which are bound together with three horizontal beams in width. The bridge span sits on the lowest of these beams.

In the pillars there are elevators with a capacity of 20 people to pedestrian access to the bridge. The shore sides of the pillars are connected to side foot-dings by tension cables. These cables direct 15000 tons of pulling force to the ground by side footings, weighing 60 000 tons on Ortaköy side and 50 000 tons on Beylerbeyi. The bridge as all of the Freeway has six lanes, the only difference being 2.50 m. pedestrian sidewalks on each side.

The bridge span is covered with 50 mm. of special asphalt. For interested readers, given below are supplementary data taken directly from the brochu-res of General Directory of Highways;

Basics of the Project: As for traffic load, the values given by the connected English Load Standard (Nr. 153) are increased by 10 % and accepted, besides a special vehicle load of 180 tons is considered. For the wind load, maximum wind velocity is taken 45 m/sec. Even though no considerable earthquake region, the bridge has been calculated so that the base ground can endure acceleration of 0.1 g.

Suspended Span: The box width-section system is lighter as compared to those in which the rigidity beam is organized as a cage. This provides economy in the cost and dimension of the cables, pillars and anchorages. Another important specialty of the box width-section is, owing to its progressed aerody-namic shape, the wind effect; it takes is 1/3 that of the cage system. Considering 70 % of the side wind pressure affecting the span is transmitted to the pillar tops by the cables, the importance of the spe-cially mentioned gains more value as regards pillar calculation. Other than that in the box construction, the area to be painted decreases, and it is simple to arrange a service car for repainting when necessary. The span plate which functions as the master rigidity upper cap, is made of high resistance steel 12 mm. thick and is rendered solid by vessel shaped, lengthwise supports, at intervals of 300 mm. These solidifying vessels lie longated inbetween diaprams arranged in width at every 4.50 m. All connections made both at the workshops and at the worksites are weldings

The span was prepared in 17.90 m. pieces in Bosphorus, at the Goksu worksite, pieces being
brought to the projection of their locations on the bridge, then mounted by pulleys placed on the main cable.

To ensure the bridge does not sway under effecting windload, a 1/50 ratio of a 100 m. part of the span was tested in a wind tunnel in Teddington National Physical Laboratory in England.

The Suspenders: The suspensions that connect the span to the main cable have a minimum braking resistance of 300 tons, and are made of high resistance steel wire, single curl spiral. These are arranged slanting, to make an angle with the vertical, in order to direct the horizontal load formed in between the cable and the span. This arrangement of the suspenders was first applied to the Severn Bridge, increasing the structural extinguishing ability of the bridge, to decrease the abundance of small aerodynamic vibrations.

Main Cables: The main cables will be formed by the method of pulling, also used in most of the other main suspension bridges. Each cable will consist of 19 curl groups form anchorage to anchorage and four thinner supplementary tension curl groups on the pillar, top, inbetween the saddle and the anchorage. There are 548 steel wires in each main curl, and 190 in each of the supplementary curls. The wires are 5 mm. in diameter, galvanized, high resistance steel with a minimum breaking resistance of 160 kg/mm². There are nearly 11,200 wires in the tense main cable from pillar to anchorage. The project load these will carry is 15,400 tons.

Pillars: The pillars which form a fulcrum for the cables are 165 m. in height and are of high resistance steel. Pillars have two feet, connected by three portic beams, one being on top, second inbetween top and span level, and the third right below the span. The pillar feet are 7 m. when looked at from the sides, and 5.20 m. at the base, gradually narrowing to three meters on top, when looked at from the direction of traffic flow. The width-section of the pillar feet is an empty rectangle. The sides consist of welded plates, rendered stronger by special one sided T-profiles. Another advantage of this single-cell type construction is that it creates the means for a twenty men elevator built in each pillar foot to go from the base to the level of the bridge span. Besides in each pillar, it has been found convenient to have a small service elevator between the bridge span and he upper portic beam level.

Pillar Bases: Around the pillars, the basement line is three meters above the sea level, and the concrete pillar foundations go down to solid rock line from the 2.50 m. line. All pillar feet have independent foundations. On Ortaköy side, bases of the pillar foundations are 17 and 24 m. below the sea level, and on Beylerbeyi it is five and 10 m.

Anchorage Blocks: Anchorage blocks, that function in directing the 15,400 ton pull power in both of the main cables to the ground, have two chambers. In these chambers the curl of the cables are opened and anchored in two blocks. Each chamber and anchorage block is set in foundations dug in rock, in the main cable direction.

Anchorage block chambers are joined from behind by a concrete wall. The top of the blocks are covered with a concrete beam pavement, to be a part of the road.

TECHNICAL DATA

Overal length of bridge .................. 1560.00 m.
Main central arch clearance .............. 1074.00 m.
Ortaköy side clearances 40 × 3 × 45 + 56.00 = 231.00 m.
Beylerbeyi side clearances 4 × 63.75 = 255.00 m.
Cable axis base ......................... 28.06 m.
Pedestrian parapets interim .............. 33.90 m.
Traffic lanes .................. 6x3.50 m.
Sidewalks ...................... 2x2.50 m.

DETAILED DATA

Cross sectional area of each cable in the main central arch .................. 0.205 cm²
Cross sectional area of each cable in side arches .................. 0.219 cm²
Net width - sectional area of suspenders .................. 19.50 cm²
The height of suspended construction (rigidity beam) .................. 3.00 cm²
Rigidity beam cross sectional area .................. 0.851 m²
Centre of weight distance to upper leaf .................. 1.180 m
Inerti momemtums Ixx .................. 1.238 m⁴
Iyy .................. 63.610 m⁴
Torsion rigidity factor .................. 3.35 m⁴
Dead load for each meter on suspended part .................. 14.30 t/m
Max. pull on each cable .................. 15.400 t.

LOAD ACCEPTANCES

As dynamic load 10% increased English Standards are applied. 45 m/sec is taken as maximum wind load velocity.

For earthquakes, at the bridge foundation location, ground acceleration is taken 0.10 g horizontally and 0.05 g vertically.

IMPORTANT CONSTRUCTION MATERIAL NEEDED
Concrete .................. 71.000 m³
Cement .................. 20.000 t.
Concrete ornamenting steel .................. 3.900 t.
Construction steel .................. 16.900 t.
Main cables and suspenders .................. 6.100 t.
Excavation for anchorage blocks and the foundations .................. 65.000 m³

THE PLACE OF THE BOSPHORUS BRIDGE IN THE WORLD AND IN EUROPE

The Bosphorus bridge rate the first among bridges in Europe and fourth in the world. The main characteristics of the main bridges of the world according to the spaces inbetween the pillars is given below:
Name, location, date of opening and specialty of the bridge:

Verrazane-Narrows, New York USA, 1965
- two storey, eight lanes, clearance 69.5 m.

Golden Gate, San Francisco, USA, 1937
- six lanes, clearance 68.6 m.

Mc Kinac, Michigan, USA, 1957
- four lanes.

Bosphorus, Istanbul, Turkey 1973,
- six lanes.

George Washington, New York, USA, 1931
- Eight lanes originally, another eight lane storey added in 1962

Tagus River, Lisbon, Portugal, 1967

Fourth Road, Scotland, 1964

Severn, England, 1966

Inbetween pillars: (in m.)

| 1296 m. | 2037 m. |
| 1280 m. | 2145 m. |
| 1158 m. | 2544 m. |
| 1074 m. | 1560 m. |
| 1066 m. | 1450 m. |

Full length: (in m.)

| 1013 m. | 2229 m. |
| 1006 m. | 1822 m. |
| 988 m. | 1598 m. |

Mentioning world's bridges, it will be worthwhile to point to Oakland Bay Bridge in San Francisco; having a total length of over 11 km. Its length inbetween pillars is 705 m. This bridge has two levels, the upper one being six lanes for motor cars and
the one below three lanes for trucks and buses, and
two railroad lines.

The Golden Horn Bridge
The second important building of architecture
in the structure of the Freeway is the Golden Horn-
Bridge, connecting Halicioglu and Ayvansaray.
Total length 995 m., width 31.20 m., heigh from
water level 22 m., widest clearance between the
steel pales 139.50 m., -this part being closer to Ha-
licioglu.-

The bridge, as all of the Freeway has six lanes.
In addition there are pedestrian sidewalks, three me-
ters on each side. The 922 m. part on the Ayvansaray
bank has nine spaces and is of continuous steel with
orthotropic laying. The 153 m. part on Halıcıoğlu side is of five spaces and pre-stressed concrete. The height of two main steel beams 24 m. apart is 5.50 m. The main beams are supported in length and width by 14 mm. wide steel plates. These two main beams will be connected by beams in width, and 4.50 m. apart and the orthotropic span will be set on these beams. The bridge span will be covered with a special asphalt, 50 mm. thick. The pales which are steel cylinders in shape will have a diameter varying from 80 to 90 cm. A protective coat will be applied to prevent rust, besides the cathodic prevention measures taken. Concrete headings are put on the tips of the steel pales outside water level, on which the footing elevations will be placed. The foot-

Due to the nature of the Golden Horn, drillings made here have proved that the load bearing capacity of the base is rather low. In most parts of the Golden Horn, a weak layer of mud about 60 m. is encountered. The first 5-10 m. of this is a very soft layer caused by water pollution. Below the layer of mud is a gravel layer, and below this another gravel layer that can be accepted as strong rock formation. In a region near Halıcıoğlu the drillings had to go down to 90 m., so instead of a footing pale, the largest space was left here.

It is forecasted that 90,000 vehicles will pass this bridge in 1990 and the crossing vehicles will not be subject to fee.

Motorway

The İstanbul Freeway that reaches 22 km. with the Bosphorus Bridge and the Golden Horn Bridge has all the advantages of the advanced road technology, is a motorway of 19 km, 13 km. on the European side and the rest on the Asian side. The motorway has six lanes and including the refuge in the middle, it is 34.00 m. wide. The three lanes are 10.50 meters
The motorway is being covered with concrete asphalt. To provide connection with main city roads, bridges and different level junctions are being constructed at different locations.

The motorway starts from about 1 km. west of the point that the International Highway E-5 crosses Büyükdere Avenue at Mecidiyeköy. Then on this Avenue it is elevated by a flyover, to the level of Ali Semi Yen Stadium, going via Gayrettepe - Esentepe, under Barbaros Boulevard, down to Ortaköy from the adjoining Bosphorus Bridge over the via-ducts. The flyover between Mecidiyeköy and Esentepe is 900 m. long, and under this, the widened Büyükdere Avenue will continue and meet Barbaros Boulevard at Zincirlikuyu.

Anatolian Part of the motorway starts at Beylerbeyi side of the bridge, climbing the outskirts of Büyük Çamlıca, via Altunizade, curves around the outskirts of Küçük Çamlıca, meeting Ankara Expressway at about three kilometers east of Haydarpaşa Harbour.

The connection of the Motorway with the inner city will be provided by different level junctions that have bridges. Four of these junctions will be located between Topkapı and Ayyansaray, five between Halicoglu-Ortaköy, and three between Beylerbeyi and Ankara Expressway at about three kilometers east of twelve. Part of these are completed. On the Motorway two tunnels are being built; one at Edirnekapı
Semi'tary, the other a Beylerbeyi. Both tunnels will have six lanes as the Motorway, and means of illumination, air-condition and control will be supplied.

The traffic regulations of the Freeway

Istanbul Freeway is a fully closed system. In other words, no vehicles or pedestrians will be able to enter this road at any point but the definite junctions. The roadsides will be closed by wire fencing and at places with walls. No U-turns, stopping or parking is allowed on the Freeway.

The Freeway, all of which will be lighted, will be automatically connected to Police, Red Crescent and Accident Centres for emergencies, by a three button telephone network placed in intervals of 1 - \( \frac{1}{2} \) km.

In the Freeway, system, except for the sidewalks on Bosphorus and Golden Horn Bridges, pedestrian walking will be strictly forbidden. Since it is a closed road, it will not be possible to enter it. It is wished that it works this way in practise. It is remembered that when the Karaköy Subway Passage was first opened, for a long time, despite all efforts of the security forces, we couldn’t quite get accustomed to the system. At last traffic authorities have lost control and the wire fences have been ruined, become inefficient, and at least 1/6 of the pedestrian crossing has shifted to the road which is for vehicle traffic.

The Freeway fences being much higher and stronger compared to those at Karaköy and under more serious control, will probably not produce the same results.

In case someone who has found means of entering the Freeway in any ways gets hurt in an accident, even the most emotional accident expert should not find the vehicle operator \( \frac{7}{6} \) at fault.

A definite fee is being collected from vehicles crossing the Bosphorus Bridge. The pedestrians will pay an amount to cover the operational cost of the elevators. It will not be possible to park on the bridge for sightseeing or fishing. The bridges may lose value more or less for some of us due to this kind of restrictions, but probably some sacrifice of these pleasures will be necessary on a road where 100 km/hr speed and a traffic of 70,000 vehicles/day are expected.

Istanbul Freeway service center is being established in Yıldız, and teams will be on duty around the clock.

According to the Transportation Code published in 1972 June, complying with regulations on expressways and on motorways will strictly be enforced. It is hoped that these new regulations will decrease the number of traffic accidents, in which Turkey has reached the fifth place in the world, and the consequent casualties. A serious practise of this Code will be witnessed on Ankara expressway and Istanbul Freeway.

Cost of the Freeway

Although calculations of the ringroad cost at different times and conditions have varied, it can be summarized as below, pending on latest information:

<table>
<thead>
<tr>
<th>Work Unit</th>
<th>Million TL.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Service</td>
<td>25</td>
</tr>
<tr>
<td>Property Nationalizing Payments</td>
<td>500</td>
</tr>
<tr>
<td>Area Preparation</td>
<td>43</td>
</tr>
<tr>
<td>Motorway Construction, junctions, side roads</td>
<td>421</td>
</tr>
<tr>
<td>Bosphorus Bridge</td>
<td>440</td>
</tr>
<tr>
<td>Golden Horn Bridge</td>
<td>200</td>
</tr>
<tr>
<td>Returned expenses of both Bridges</td>
<td>80</td>
</tr>
<tr>
<td>Artistic Constructions</td>
<td>241</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>1 950</strong></td>
</tr>
</tbody>
</table>

Over 38 million dollars of the Freeway project is financed by foreign resources. Of this, about 22 million goes to the Bosphorus Bridge, 12 million dollars to Golden Horn Bridge over three million to the motorway and the rest to engineering services, included in the total cost given above.

It should be kept in mind that as the project proceeds, some new and unpredicted costs may occur.

Rentability of the project and the self repayment period

The economical rentability of the Freeway project is about 14 \% and for an investment which is substructural in nature this rate is quite high. Although there may be increases in the labour and material cost, no serious change in total cost is predicted except for the effect of the devaluation, and no decrease is expected in the rentability.

Self repayment period of the ringroad supplied only by the Bosphorus Bridge toll fares. According to this, the income is calculated as follows:

<table>
<thead>
<tr>
<th>Years</th>
<th>Net income in Million TL.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>112</td>
</tr>
<tr>
<td>1980</td>
<td>205</td>
</tr>
<tr>
<td>1990</td>
<td>364</td>
</tr>
<tr>
<td>1995</td>
<td>450</td>
</tr>
</tbody>
</table>

If these calculations are considered approximately correct, roughly at about 1997 it will have repaid itself since its cost is around two billion TL. The net income given above is calculated with the hypothesis that all car ferry services will be abolished. If ferry service continues, the net income will decrease, and the self repayment period will get longer.

Those who cross the bridge comfortably today find themselves in the narrow gorge of traffic on the European side. Our wish is that the Golden Horn Bridge is also completed on time as planned and the Freeway is put in service as a whole.