APPENDIX 6.2

Levels of Service (USA Federal Highway Board)

The concept of levels of service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and / or passengers. A level-of-service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

Six levels of service are defined for each type of facility for which analysis procedures are available. They are given letter designations, from A to F, with level-of-service A representing the best operating conditions and level-of-service F the worst.

1. *Level-of-service definitions* - In general, the various levels of service are defined as follows for uninterrupted flow facilities:

Level of service A represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.

Level of service B is the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.

Level of service C is the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by the interaction with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.

Level of service D represents high-density, but stable, flow. Speed and freedom to maneuver are severally restricted, and the driver or the pedestrian experiences a generally poor level of comfort and convenience. Small increases in the traffic flow will generally cause operational problems at this level.

Level of service E represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to give way to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

Level of service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of breakdown. It should be noted, however, in many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow which causes the queue to form, and level-of-service F is an appropriate designation for such points.

These definitions are general and conceptual in nature, and they apply primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user s perception of service quality and the operational variables used to describe them.

APPENDIX 6.2.1 - THE TEN 'CASE STUDY' BRIDGES - SHEET ONE

THE COSTS OF REHABILITATION AND REPLACEMENT

Bridge Name	Direct Costs of Repair US$	Direct Costs of Replacement US$	Repair as % of replacement cost	Traffic Control &Diversion Costs US$	Total Repair Costs for Agency US$
Buca UG(Izmir) (slip road westbound only)	7000	406000	1.7%	2000	9000
Hilal-II (Izmir) Dual Carriageway	340000	2760000	12.3%	10000	350000
Babadat (Ankara) (Two lane but needs widening on safety grounds)	52000	155000	33.5%	73000	125000
Selyeri (Samsun) (West bound carriageway)	37000	162000	22.8%	10000	47000
Akcay (Samsun) (Two lane Gerber Bridge)	78000	648000	12.0%	73000	151000
Koparan II (Samsun) (Two Lane)	32000	162000	19.8%	73000	105000
Asagi Cakalli (Samsun) (Northbound carriageway)	153000	430000	35.6%	10000	163000
Gelincik (Trabzon) (Two lane)	57000	189000	30.2%	2000	59000
Sardere (Antalya) (Two Lane)	36000	290000	12.4%	88000	124000
Candir Hasanpasa (Bursa) (Two Lane)	117000	702000	16.7%	73000	190000

APPENDIX 6.2.1 (CONTINUED) - COSTS PER LINEAR AND DECK METRE - SHEET TWO

Bridge Name	Bridge Length metres	Costs to Replace US$	Cost/ metre US$	Bridge Width metres	Deck Metres Squared	Cost/ Deck Metre US$
Buca UG(Izmir) (slip road westbound only)	33.00	406000	12303	18.20	601	676
Hilal-II (Izmir) Dual Carriageway	347.80	2760000	7936	13.50	4695	588
Babadat (Ankara) (Two lane but needs widening on safety grounds)	25.20	155000	6151	10.00	252	615
Selyeri (Samsun) (West bound carriageway)	21.70	162000	7465	9.60	208	778
Akcay (Samsun) (Two lane Gerber Bridge)	106.90	648000	6062	10.00	1069	606
Koparan II (Samsun) (Two Lane)	27.45	162000	5902	9.80	269	602
Asagi Cakalli (Samsun) (Northbound carriageway)	71.55	430000	6010	10.10	723	595
Gelincik (Trabzon) (Two lane)	32.50	189000	5815	10.10	328	576
Sardere (Antalya) (Two Lane)	43.15	290000	6721	12.70	548	529
Candir Hasanpasa (Bursa) (Two Lane)	113.90	702000	6163	10.40	1185	593

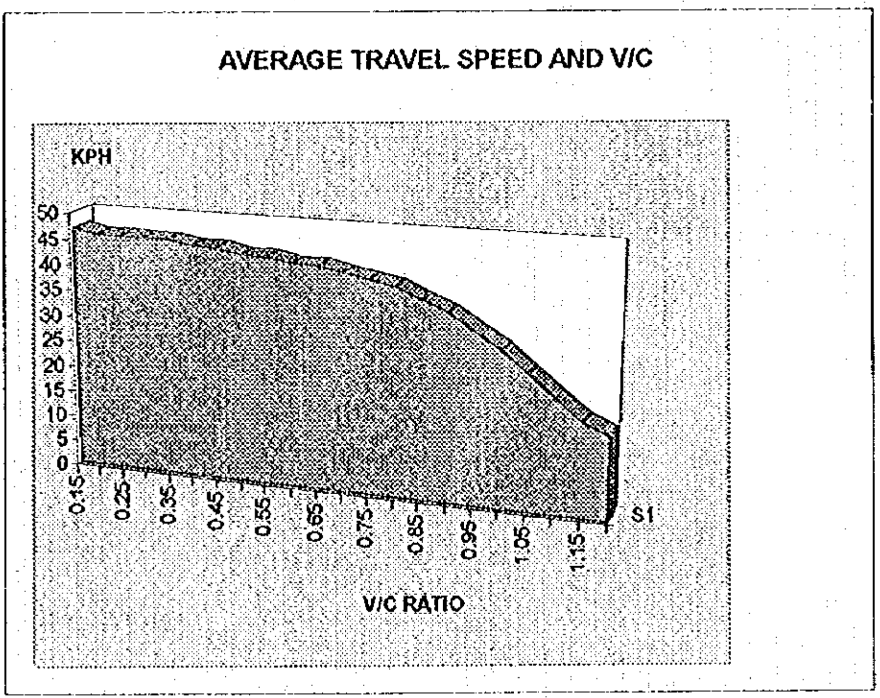
APPENDIX 6.2.2 - TIME NEEDED TO CARRY OUT REPAIRS AND REPLACEMENT - SHEET THREE

Bridge Name	Repair Time - days	Replace-ment Time - Months	Routine Maintenance as % capital Cost	Years of life if no maint-enance project	Years of life with project
Buca UG(Izmir) (slip road westbound only)	15	6	0.50	10	27
Hilal-II (Izmir) Dual Carriageway	100	18	1.00	7	45
Babadat (Ankara) (Two lane but needs widening on safety grounds)	100	5	1.50	3	16
Selyeri (Samsun) (West bound carriageway)	35	6	0.70	10	19
Akcay (Samsun) (Two lane Gerber Bridge)	80	6.5	0.50	5	16
Koparan II (Samsun) (Two Lane)	100	5	1.30	10	32
Asagi Cakalli (Samsun) (Northbound carriageway)	200	8	2.00	3	41
Gelincik (Trabzon) (Two lane)	250	5	1.00	10	25
Sardere (Antalya) (Two Lane)	80	5.5	1.20	1	40
Candir Hasanpasa (Bursa) (Two Lane)	120	8	0.70	1	27

APPENDIX 6.2.3

ASSUMPTIONS IN ESTIMATING VEHICLE DELAY AT ONE LANE TRAFFIC CONTROL

	Symbol	Equation	Value
Traffic Signal Cycle Time	C		120 seconds
Lost Time	l		10 seconds
Green Ratio	g/C		0.46
Saturation Flow Rate	s		1400 pcphg
Capacity (one direction)	c	c=s*(g/C)	642 pcphg
Actual flow rate	v		250 pcph
Critical v/c ratio	X	v/c	0.39
Uniform delay	d1		16.3 seconds/pc
where	d1 = f (0,38 C* ((1-g/C)^2)/(1-(g/C)*X))		
Incremental delay	d2		0.2 seconds/pc
where	d2 = f (173 *X^2*((X-1) + SQRT((X-1)^2+(16X/c)))		
Average Stopped Delay	d	d = d1+d2	16.5 seconds/pc
Total Approach Delay	D	D = 1.3*d	21.4 seconds/pc
Length of the road segment			1.100 kilometres
Free Flow Speed			60 kph
Running Time (free flow)			66.0 seconds
Average Travel Speed			45 kph



APPENDIX 6.2.4

ESTIMATION OF THE SPEED/COST CURVES

Equation: C=Function((a+b/V+cV^2)*(1+mH+nH^2))+(d+e/V+fV^2)

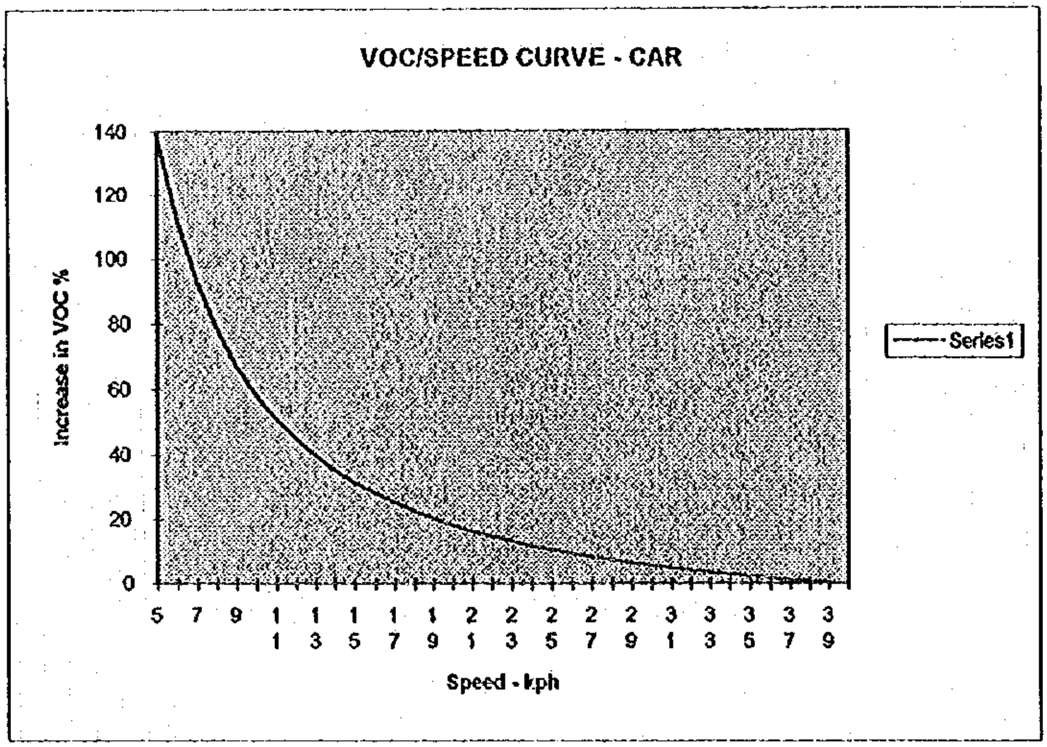
where C=cost per vehicle kilometre
V=average link speed in kilometres per hour
H=average link gradient in
m/km
a,b,c,d,e,f,m,n=parameters defined for each vehicle category

Source: Derived from Transport Research Laboratory, UK and COBA

OptimumVehicle Speeds in Turkey

	Car	Bus	Truck	Trailer	
KPH	88	73	61	65	Double Surface Treatment - Good

Source: KGM Planning Division



APPENDIX 6.2.5

VEHICLE OPERATING COSTS IN TURKEY - 1995

(TL per Vehicle Kilometre excluding taxes)

Surface Type	Terrain Type	Car	Bus	Truck	Trailer
Asphalt concrete IRI 2000	Flat	3351	17670	13120	22936
	Rolling	3367	18958	15207	26749
	Mountainous	3410	21800	18963	33168
Surface Treatment in good condition IRI 2400	Flat	3401	17897	13534	23535
	Rolling	3417	19189	15625	27350
	Mountainous	3460	22036	19387	33784
Surface Treatment in Bad Condition IRI 2700	Flat	3440	18072	13843	23984
	Rolling	3456	19367	15937	27801
	Mountainous	3499	22218	19704	34246
Stabilised in Good Condition IRI 5000	Flat	3921	20072	16440	28507
	Rolling	3934	21370	18562	32079
	Mountainous	3971	24186	22327	38482
Stabilised in Bad Condition IRI 10000	Flat	5333	24391	21776	36468
	Rolling	5345	25869	23880	39734
	Mountainous	5376	28731	27677	46297

Source: KGM Planning Division

ANNEXES

ANNEX 1

ECONOMIC ANALYSIS - CASE STUDY OF BUCA UST GECIT BRIDGE (IZMIR)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Buca Ust Gecit Bridge is located on State Road D 300, some 5 kilometres from the centre of Izmir, on the main road to Buca. It is situated within the urban area of Izmir, and provides a grade separation between the road between Buca and Izmir, and the road from Izmir to Aydin. The upper road is dualled with three lanes in each direction , whilst the road underneath the bridge is a single carriageway with one lane downhill and two lanes uphill. The pavement is in good condition, and the road carries the following traffic over the bridge:

Table - A1.1 - Estimated AADT 1996 at Buca Ust Gecit (Izmir)

Vehicle Type	Number	Composition %	General Traffic Composition in Izmir %
Cars	22645	45.29%	58.00%
Buses	5715	11.43%	9.00%
Trucks	20560	41.12%	32.00%
Trailers	1080	2.16%	1.00%
Total	50000	100.00%	100.00%

Source: Consultants' Estimates derived from discussions with KGM Izmir Division

The Bridge itself is some 33.00 metres in length, with a carriageway width of 15.70 metres and sidewalks of 1.25 metres. The Bridge must have formerly crossed the Selyeri River but now it crosses the road to Buca. The Bridge was designed to a specification of AASHTO H20-S16. (20 tonnes on the first two axles - tractor truck - and 16 tonnes on subsequent axles). It is a reinforced concrete bridge of continuous beam construction.

Built in 1972, the Buca Ust Gecit Bridge has provided 23 years of service. With modest repairs, it can provide a further 27 years of service.

1.2 The future for the road

Traffic is already substantial on the road because of its important intra-urban function. With the rapid urban growth and the rapid growth in vehicle ownership, it seems likely that the road will continue to play an important role in the total urban network.

Forecasts of traffic along the road are as shown on Page 5 of this Annex. The detailed assessment of the capacity of the road and thus the bridge indicates that full capacity will be reached even providing service to a level 'F' by the year 2000.

Forecasts of traffic along the Buca Ust Gecit bridge are based upon an estimate of 50000 AADT in 1996 and forecasts of future growth with the following growth rates through to 2014:-

Cars	10.0%
Buses	6.0%
Trucks	6.0%
Trailers	5.9%

Traffic going underneath the bridge is estimated at 25000 AADT in 1996.

1.3 Proposed Remedial Works

The Bridge urgently requires repairs to a girder which has been damaged by accidents. These can be done without closing the bridge, but the slip road would have to be closed and traffic below the bridge would have to be reduced from two lanes uphill into one lane. Repairs would include:-

- repairs to a girder
- repairs to some expansion joints

The costs of the repair are only about US$ 7000 but the traffic disruption costs during the fifteen days it will take to effect the repair are likely to approach US$ 100000.

2. ECONOMIC ANALYSIS

2.1 Evaluation

In this case study the economic assessment relates to a relatively simple situation in terms of evaluating the cost-effectiveness of a repair against a replacement.

2.2 Alternative detours

Closure of the slip road will impose considerable congestion costs because these small urban detours basically imply a shortage of road capacity.

2.3 Cost-Effectiveness Analysis

Because the repair cost amounts to only 2% of the replacement cost (both excluding traffic disruption costs) repair is much the more cost-effective option.

2.4 Cost/Benefit Analysis

The Cost Benefit Analysis indicates that the repair work would enjoy a substantial rate of economic return (EIRR of 43%) when one considers the 'next best alternative', which is basically diversions into the already overcrowded urban road network. Such a result is not surprising when one considers that the bridge should still have a long life after its repair, and when one also considers the key role that it plays in the urban road network.

3. GENERAL CONCLUSIONS FROM THE ECONOMIC CASE STUDY

Buca Üst Gecit has suffered from a special problem of inadequate height clearance for the bridge (poor design of the slip road) and lack of traffic management measures to cope with drivers who ignore traffic warnings. Increasingly, traffic management will need to be addressed in Turkey.

The bridge itself has to be repaired because the costs of taking out of commission such a significant piece of the urban road network are huge for the Turkish economy because of the congestion costs which it would impose on road users.

ANNEX 2

ECONOMIC ANALYSIS - CASE STUDY OF HILAL II BRIDGE (IZMIR)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Hilal II Bridge is located on State Road D 300, less than two kilometres from the commercial centre of Izmir, on the main road to Ankara. It is situated right within the urban area of Izmir, and broadly performs the function of an inner ring road. It carries out a dual function of providing a grade separation with the railway which goes into the port of Izmir, as well as a crossing of the Melezcayi River. Prior to Hilal II, there was a level-crossing with the railway and a much smaller bridge over the river. The road is a dual carriageway with three lanes in each direction. The pavement is in good condition, and the road is estimated to carry nearly 60000 vehicles per day over the bridge:

Table - A2.1 - Estimated AADT 1996 at Hilal II (Izmir)

Vehicle Type	Number	Composition %	General Traffic Composition in Izmir %
Cars	27174	45.29%	58.00%
Buses	6858	11.43%	9.00%
Trucks	24672	41.12%	32.00%
Trailers	1296	2.16%	1.00%
Total	60000	100.00%	100.00%

Source: Consultants' Estimates derived from discussions with KGM Izmir Division

The Bridge itself is some 347.80 metres in length, with a carriageway width of 11.50 metres and sidewalks of 2.00 metres on each carriageway. The bridge took over from a level crossing on the railway and a small road bridge across the river, which is now a footbridge. The Bridge crosses the Melezcayi River which varies in width between 4 and 13 metres (but under the bridge is a typical flow of 30 metres), and has a depth varying between 0.30 and 1.70 metres. The bridge averages some 4.00 metres above the river bed. The bridge was designed to a specification of AASHTO H30-S24. (30 tonnes on the first two axles - tractor truck - and 24 tonnes on subsequent axles). It is a reinforced concrete bridge of simple beam construction.

Built in 1990, the Hilal II Bridge has provided only 5 years of service. It is now suffering from the ASR reaction, and remedial work is necessary.

1.2 The future for the road

Traffic is already substantial on the road because of its important intra-urban function. With the rapid urban growth and the rapid growth in vehicle ownership, it seems likely that the road will continue to play an important role in the total urban network. Indeed, full capacity is likely to be reached within five years. Traffic on the bridge is basically travelling

- between the centre of Izmir and in the direction of Ankara, Manisa and Karsiyaka
- between Ankara, Manisa, Karsiyaka and Aydin
- general intra-urban traffic

Whilst traffic is likely to continue to grow on the road, the capacity of the total urban network will be increased by the

- the motorway to Aydin running to the east and south of the present road
- the new Inner urban freeway from the Halkpinar Interchange through to the Port, and possibly in the longer term (10-15 years) continuing around the bay to link to the Izmir-Cesme Motorway.

Forecasts of traffic along the Hilal II bridge are based upon an estimate of 60000 AADT in 1996 and forecasts of future growth with the following growth rates through to 2014:-

Cars	10.0%
Buses	6.0%
Trucks	6.0%
Trailers	5.9%

The detailed assessment of the capacity of the road and thus the bridge indicates that full capacity will be reached even providing service to a level 'F' by the year 2000.

Underneath the road runs the railway, which has about 140 movements per day. Most of these movements are by relatively small passenger trains serving suburban areas. The long and heavy cargo trains tend to operate at night. The small urban passenger trains generally require the two level crossings near the bridge to be closed for between half a minute and one minute. With around ten movements per hour the roads are closed for about 5-7 minutes per hour.

The railway would continue to get priority even in the advent of the closure of Hilal II. Consequently , congestion would be exacerbated not only

- by the lack of basic road capacity with the withdrawal of the supply by Hilal II, but also
- by the lack of a grade separation for the railway which would enforce closure of some key roads for about 10% of the time.

1.3 Proposed Remedial Works

The Bridge requires repairs to all parts affected by the ASR attack. These can be done without closing the bridge, but it would be necessary to have two lane operation as opposed to three lane for some of the time to reduce vibration. Repairs would include

- repairs to columns
- repairs to crossbeams
- repairs to abutments

The costs of the rehabilitation works are estimated at US$340000, which is some 12% of the costs of replacement (US$ 2760000).

2. ECONOMIC ANALYSIS

2.1 Evaluation

In this case study the economic assessment relates to a relatively simple situation in terms of evaluating the cost-effectiveness of a repair against a replacement.

2.2 Alternative detours

At this moment in time there is no reason to assume that it would be necessary to close the Hilal II bridge for repairs. However, should closure be necessary, it would be essential to

- either to organise the work so as to use the parallel carriageway bridge. Of course, this would impose considerable congestion costs in an urban situation.
- or to use other detours which would involve using nearby urban roads, and would also result in considerable congestion.

2.3 Cost-Effectiveness Analysis

Because the repair cost amounts to only 12% of the replacement cost (both excluding traffic disruption costs) repair is much the more cost-effective option. The NPV of the repair option including traffic disruption costs is estimated at US$ 1.3 million, compared with US$ 2.6 million for the replacement cost, assuming that all traffic disruption costs can be avoided by building the replacement alongside of the existing bridge. Probably, this is an unrealistic assumption.

2.4 Cost/Benefit Analysis

The Cost Benefit Analysis indicates that the repair work would enjoy a substantial rate of economic return (EIRR - 24.5%) when one considers the 'next best alternative', which is basically diversions into the already overcrowded urban road network. Such a result is not surprising when one considers that the bridge should still have a long life after its repair, and when one also considers the key role that it plays in the urban road network.

3. GENERAL CONCLUSIONS FROM THE ECONOMIC CASE STUDY

Hilal II has suffered from an exceptional materials problem in that the ASR reaction in the concrete appears to have been exacerbated by sand materials from a particular source. It would appear that this type of problem can only be overcome by suitable specifications on materials to be used in the future.

The bridge itself has to be repaired because the costs of taking out of commission such a significant piece of the urban road network are huge for the Turkish economy because of the congestion costs which it would impose on road users. Basically , road congestion costs make an economy less competitive in a global world market place.

ANNEX 3

ECONOMIC ANALYSIS - CASE STUDY OF BABADAT BRIDGE

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Babadat Bridge is located on State Road D 200, some 45 kilometres south west of Polatli and 15 kilometres north west of Sivrihisar, on the main road from Ankara going towards various towns to the west including Eskisehir, Antalya and Izmir. The road is a two lane paved road in good condition carrying the following two way traffic:

Table - A3.1 - AADT 1993 at Babadat Bridge

Vehicle Type	Number	Composition %	General Traffic Composition in Izmir %
Cars	2982	40.73%	44.00%
Buses	1249	17.06%	12.00%
Trucks	2677	36.56%	38.00%
Trailers	414	5.65%	6.00%
Total	7322	100.00%	100.00%
Source: KGM Transport and Cost Analysis Division			

The Bridge itself is some 25.20 metres in length, with a carriageway width of 8.50 metres and sidewalks of 0.75metres. The Bridge crosses the Babadat River which varies in width between 2 and 18 metres, with a depth between 0.8 and 2.5 metres. The Bridge is 4.0 metres above the river bed. The Bridge was designed to a specification of AASHTO H20-S16. (20 long tons on the first two axles - tractor truck - and 16 long tons on subsequent axles). It is a reinforced concrete bridge of continuous construction.

Built in 1964, it has provided 31 years of service but it is now at the end of its economic life unless urgent remedial action is taken. In fact, replacement may be necessary.

1.2 The future for the road

Traffic is growing rapidly on the road. Probably, it will need to be a dual carriageway within a few years. Most of the traffic is travelling between Ankara and the longer distance points such as Bursa and Eskisehir, Antalya and Izmir. The construction of a motorway on this route looks likely in time. Also the realignment of the road appears to be a possibility. The detailed assessment of the capacity of the road and thus the bridge indicates that a dualling to provide a level of service of 'D' standard would be necessary in 2000, requiring construction in 1999. To meet a 'C' level of service, dualling is already required now in 1995. The road is heavily used by trucks.

1.3 Proposed Remedial Works

The Bridge is now in a dangerous condition. If nothing is done, it is likely to collapse in the next three to four years. Urgent action will have to be taken. This action will include:-

- replacement of columns
- replacement of slabs

The bridge will have to be closed, and road service will have to be provided by a temporary bridge. The costs of repair are estimated at US$ 52000, approximately one third of the replacement cost. (US$ 155000). Repairs would take approximately 100 days.

2. ECONOMIC ANALYSIS

2.1 Different Evaluations

In this case study the economic assessment can relate to:

- Immediate repair work. This will entail building a temporary bridge whilst the main bridge is repaired
- The building of a parallel bridge to accommodate a future dualling of the road. Then to carry out the repair of the existing bridge

2.2 Alternative detours

In the event of the closure of the Babadat bridge, there are no obvious alternative routes. The most likely possibility would be a local detour perhaps requiring some special improvements to accommodate the traffic. For the purposes of the economic analysis of the 'alternative detour' we have used a notional figure of an additional distance of 2 kilometres. Rerouting on the main road network would result in detours in the 10-20 kilometre range depending on the route wanted by the traffic.

2.3 Cost-Effectiveness Analysis

The cost-effectiveness analysis indicates that replacement is in fact a better option than rehabilitation when the costs of temporary bridge diversion and traffic disruption are taken into account. This assumes that replacement construction work would be organised so as not to incur either diversion or disruption costs. The replacement bridge would be built alongside the existing bridge. On completion the traffic would be rerouted to the new bridge.

The Cost Benefit Analysis indicates that the repair project (even with the diversion and disruption costs) enjoys a substantial rate of economic return (EIRR 30.6%) against the 'next best alternative'. When compared with the notional detour of 2 kilometres, the EIRR rises to some 167%.

The economic rate of return on the project rises again if it is possible to delay the project through to 1997, such that the new bridge is built in 1997 and the existing bridge is repaired in

1998. Such an approach does take the risk of the bridge becoming unusable. A more prudent approach might then be to build the new bridge in 1996 and repair the existing bridge in 1997.

3. GENERAL CONCLUSIONS

This bridge is typical of small bridges on the main arterial roads. It has provided a reasonable economic life to date (31 years) but faults in the original workmanship at the time of construction mean that the remaining life is now no more than a few years. Such a bridge would certainly be closed in many countries as being unsafe.

Because of the poor state of the bridge, repairs are quite costly. In addition, because of the high level of traffic, diversion and disruption are also quite costly. However, the need to dual many of these arterial roads means that a real opportunity opens up to minimise these diversion and disruption costs by building the new bridge in anticipation of dualling and then repairing the existing bridges.

Ideally, KGM should have a programme for building bridges in advance of dualling.

ANNEX 4

ECONOMIC ANALYSIS - CASE STUDY OF SELYERI BRIDGE (SAMSUN)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Selyeri Bridge is located on Route D010 (State Road, Devlet 010), some 15 kilometres east of the centre of Samsun, on the main road between Samsun and Trabzon. The bridge could be described as near the urban fringes of Samsun. The road is a dual carriageway with three lanes in the eastward direction and two lanes in the westerly direction. The bridge that is the subject of this case study is the bridge carrying traffic in the westerly direction into Samsun city. The road is paved in good condition carrying the following two way traffic:

Table - A4.1 - AADT 1993 at Selyeri Bridge (Samsun)

Vehicle Type	Number	Composition %	General Traffic Composition in Samsun %
Cars	5175	64.66%	54.00%
Buses	683	8.53%	10.00%
Trucks	2001	25.00%	33.00%
Trailers	144	1.80%	3.00%
TOTAL	8003	100.00%	100.00%

Source: KGM Transport and Cost Analysis Division, and Planning Division

The Bridge itself is some 21.70 metres in length, with a carriageway width of 8.00 metres and sidewalks of 0.80 metres. The Bridge crosses the Selyeri River which varies in width between 13 and 20 metres (with a typical flow of 15 metres), with a depth between 0.2 and 1.85 metres. The Bridge is 3.1 metres above the river bed. The Bridge was designed to a specification of AASHTO H20-S16. (20 tonne on the first two axles - tractor truck - and 16 tonnes on subsequent axles)

It is a reinforced concrete bridge of simple beam construction, but parts of the bridge incorporate the orginal stone bridge. Built around 1960, the bridge has provided 35 years of service, mostly as a two directional bridge. The parallel dual carriageway bridge was built in 1990.

1.2 The future for the road

Traffic is growing rapidly on the road. Already it is a dual carriageway at this point. Most of the traffic is going to the various towns along the Black Sea Coast. Some traffic is international traffic going through to Georgia and other towns in the former Soviet Union or indeed in the Middle East, but it is not the main entry point for the Middle East (e.g. Iran, Iraq). The construction of a motorway on this route looks to be some years off. Indeed, because of the terrain, it would present formidable construction challenges.

Forecasts of traffic along the road are as shown in Page 5. The detailed assessment of the capacity of the road and thus the bridge indicates that a three lane carriageway to provide a level of service of 'C' standard would occur around 2013.

1.3 Proposed Remedial Works

The remedial work will include:-

- repairs to girders
- repairs to slabs
- repairs to expansion joints

The bridge will need to be closed, but necessary service can be provided by the parallel carriageway bridge. The costs of repair are estimated at US$ 37000 which represents just 23% of the replacement cost (US$ 162000).

2. ECONOMIC ANALYSIS

2.1 Different Evaluations

In this case study the economic assessment really relates to two possibilities:-

- Replacement as opposed to rehabilitation
- Widening to three lanes whilst rehabilitation work takes place.

2.2 Alternative detours

In the event of the closure of the this case study bridge, then the parallel carriageway would provide service. If, for any reason, this could not provide service then a temporary bridge (concrete box culvert) would be required. Alternative detours are difficult along this coast but for the purposes of the alternative detour economic analysis, we have used a notional detour of 2 kilometres.

2.3 Cost Effectiveness Analysis

Despite the age of the bridge, it is still economically cost effective to carry out a repair.

2.4 Cost Benefit Analysis

The proposed maintenance repair project delivers an economic rate of return (EIRR) of around 26%('next best alternative'). The 'alternative detour analysis' gives a higher rate of return of 55%. The deferral of capital expenditure approach gives an EIRR of less than 11%.

3. GENERAL CONCLUSIONS FROM THIS ECONOMIC CASE STUDY

The general conclusions from this case study are that the repair project can be delayed for some time and at a later date, say in the early 2000s, the repair project would earn a higher rate of economic return. This conclusion assumes that the traffic does not build up too rapidly so that the costs of diverting to the other carriageway become excessive. The bridge is in a periurban position and thus the question of traffic and traffic disruption costs would need to be kept under continual review.

If the repair can be planned for the early 2000s, then it may be advisable to coordinate the repair with a widening of the road to three lanes.

ANNEX 5

ECONOMIC ANALYSIS - CASE STUDY OF AKCAY BRIDGE (SAMSUN)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Akcay Bridge is located on State Road D 010, some 8 kilometres west of Uniye, and some 76 kilometres east of Samsun, on the main road between Samsun and Trabzon. The road is a two lane paved road in good condition carrying the following two way traffic:

Table - A5.1 - AADT 1993 at Akcay Bridge (Samsun)

Vehicle Type	Number	Composition %	General Traffic Composition in Samsun %
Cars	5175	64.66%	54.00%
Buses	683	8.53%	10.00%
Trucks	2001	25.00%	33.00%
Trailers	144	1.80%	3.00%
TOTAL	8003	100.00%	100.00%

Source: KGM Transport and Cost Analysis Division, and Planning Division

The Bridge itself is some 106.90 metres in length, with a carriageway width of 8.40 metres and sidewalks of 0.80metres. The Bridge crosses the Akcay River which varies in width between 4 and 13 metres (but with a typical flow under the bridge of 50 metres), with a depth between 0.30 and 2.10 metres. The Bridge is 4.1 metres above the river bed. The Bridge was designed to a specification of AASHTO H20-S16. (20 tonnes on the first two axles - tractor truck - and 16 tonnes on subsequent axles).

Built in 1961, it has provided 34 years of service. It is a reinforced concrete bridge of continuous Gerber construction. It is thought to have replaced a stone bridge. The joints (Gerber) are now in very bad condition.

1.2 The future for the road

Traffic is growing rapidly on the road. Most of the traffic is going to the various towns along the Black Sea Coast. Some traffic is international traffic going through to Georgia and other towns in the former Soviet Union or indeed in the Middle East, but it is not the main entry point for the Middle East (e.g. Iran, Iraq). The construction of a motorway on this route looks to be some years off. Indeed, because of the terrain, it would present formidable construction challenges. Parts of the road are already dualled and, and indeed this part of the road ought to be dualled now if a service provision at the level 'D' is to be met. It looks certain that dualling will be required by the year 2001.

1.3 Proposed Remedial Works

The remedial work to the bridge will include:-

- repair of the hinge part of the Gerber section (jack up girder, put in steel plate and new concrete)
- repair of deck slabs (epoxy injection), and repair of expansion joints

The damage to the bridge is largely put down to poor workmanship at the time of construction.

The bridge will need to be closed during repair and a temporary bridge built to deal with the traffic. Whilst the direct costs of repair are modest (US$ 78000), the diversion and disruption costs are substantial (US$ 73000) as traffic has to be diverted across a newly built temporary bridge.

2. ECONOMIC ANALYSIS

2.1 Different Evaluations

In this case study the economic assessment relates to two possibilities:-

- Replacement as opposed to rehabilitation
- Adding a second bridge in anticipation of dualling and then repairing the existing bridge.

2.2 Alternative detours

Long distance detours are difficult for this road, being a coastal road. A notional alternative detour route of 2 kilometres was used in the 'alternative detour' economic analysis. The 'next best alternative', again notional, was a temporary more flimsy structure as would be used for a temporary bridge during construction.

2.3 Cost Effectiveness Analysis

Despite the age of the bridge, it is still economically cost effective to carry out a repair. However, the considerable growth in traffic along the road, not least because of the opening up of the border with Georgia, indicates that dualling will have to take place within the next five or six years. The best solution is to build the dualled bridge first, within the next three to four years, and then effect the repair on the present bridge.

2.4 Cost Benefit Analysis

The proposed maintenance project delivers an economic rate of return (EIRR) of around 31%.('next best alternative'). The 'alternative detour analysis' gives a high rate of return of 92%. The deferral of capital expenditure approach gives an EIRR of 20%.

3. GENERAL CONCLUSIONS FROM THIS ECONOMIC CASE STUDY

The general conclusions from this case study are similar to those of the Babadat Bridge (See Annex 3). The coordination of a programme of bridge repairs with a programme for dualling the arterial roads is likely to lead to considerable benefits for the Turkish Economy.

ANNEX 6

ECONOMIC ANALYSIS - CASE STUDY OF KOPARAN II BRIDGE (SAMSUN)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Koparan II Bridge is located on State Road D 785, some 16 kilometres south west of Corum, on the main road between Samsun and Ankara. The road is a two lane paved road in good condition carrying the following two way traffic:

Table A6.1 - AADT 1993 at Koparan II Bridge (Samsun)

Vehicle Type	Number	Composition %	General Traffic Composition in Samsun %
Cars	1286	38.61%	54.00%
Buses	612	18.37%	10.00%
Trucks	1337	40.14%	33.00%
Trailers	96	2.88%	3.00%
TOTAL	3331	100.00%	100.00%
Source: KGM Transport and Cost Analysis Division			

The Bridge itself is some 27.45 metres in length, with a carriageway width of 8.20 metres and sidewalks of 0.80 metres. The Bridge crosses the Koparan River which varies in width between 4 and 35 metres (with a typical flow of 15 metres), with a depth between 0.50 and 1.10 metres. The Bridge is 3.1 metres above the river bed. The Bridge was designed to a specification of AASHTO H20-S16. (20 tonnes on the first two axles - tractor truck - and 16 tonnes on subsequent axles)

Built in 1977, it has provided 18 years of service. It is a reinforced concrete bridge of simple beam construction.

1.2 The future for the road

Traffic is growing on the road as the main link between the Black Sea towns and Ankara. The road is likely to be dualled within 10-15 years. Construction of a motorway looks to be some distance in the future.

Forecasts of traffic along the road are based on traffic growth at the following rates through to 2014:-

Cars	10.0%
Buses	6.0%
Trucks	5.0%
Trailers	4.9%

Average	7.4%

The detailed assessment of the capacity of the road and thus the bridge indicates that a dualling would occur in 2008 at service level 'D'.

1.3 Proposed Remedial Works

The remedial work will include:-

- repairs to the girders and slabs

The bridge will need to be closed to traffic and a temporary diversion bridge built. The costs of repair are estimated to be US$ 32000, approximately 20% of the replacement costs (US$ 162000). However, diversion costs would amount to US$ 73000.

2. ECONOMIC ANALYSIS

2.1 Different Evaluations

In this case study the economic assessment relates to a tradeoff between repair and replacement

2.2 Alternative detours

The 'next best alternative' is a temporary more flimsy structure as would be used for a temporary bridge during construction. An alternative detour route using the main road network would involve detours of more than 10-20 kilometres, indeed 18 kilometres via Alaca.

2.3 Cost-Effectiveness Analysis

The cost-effectiveness analysis indicates that repair is a more cost effective option than replacement.

2.4 Cost Benefit Analysis

The Cost Benefit Analysis indicates that the repair project earns a rate of return of nearly 17% (EIRR -'next best alternative') but that this rate of return increases if the project is delayed through to the early 2000s, say 2004. By then it may well be worthwhile tying in the repair of the bridge with the dualling programme for the road.

The alternative detour approach gives a much higher rate of return at nearly 80%, whist the deferral of capital expenditure approach gives a modest return at nearly 7%. The reason for this low return on this method is that the project is premature if carried out in 1996 and would be better carried out in the early 2000s.

3. GENERAL CONCLUSIONS FROM THIS ECONOMIC CASE STUDY

From this 'case study' the general conclusion can be reached that some of the repairs can wait for some years. Also, the conclusion is reached that yet again the repair programme, where the closure of the bridge is necessary, should be linked with the dualling programme.

ANNEX 7

ECONOMIC ANALYSIS - CASE STUDY OF ASAGI CAKALLI BRIDGE (SAMSUN)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Asagi Cakalli Bridge is located on State Road D795, some 30 kilometres south west of Samsun, on the main road between Samsun and Ankara. The road is a dual carriageway, each with two lanes. The bridge which is the subject of the case study is the north west bound direction towards Samsun. Interestingly, this is the more recently constructed bridge of the two but workmanship during construction was so poor that it is the one that is already in difficulty. Indeed the quality of workmanship was so poor that it could be described as unacceptable.

The pavement is in good condition and carried the following two way traffic:

Table - A7.1 - AADT 1993 at Asagi Cakalli Bridge (Samsun)

Vehicle Type	Number	Composition %	General Traffic Composition in Samsun%
Cars	3820	50.68%	54.00%
Buses	899	11.93%	10.00%
Trucks	2676	35.50%	33.00%
Trailers	142	1.88%	3.00%
Total	7537	100.00%	100.00%
Source: KGM Transport and Cost Analysis Division			

The Bridge itself is some 71.55 metres in length, with a carriageway width of 8.50 metres and sidewalks of 0.80metres. The Bridge crosses the Cakalli River which varies in width between 4 and 13 metres 9(with a typical flow of 10 metres), with a depth between 0 and 3.15 metres. The Bridge is 12.05 metres above the river bed. The Bridge was designed to a specification of AASHTO H20-S16. (20 tonnes on the first two axles -tractor truck - and 16 tonnes on subsequent axles).

Built in 1986, it has provided only 9 years of service. It is a reinforced concrete bridge of simple beam construction.

1.2 The future for the road

Traffic is growing on the road as the main link between the Black Sea towns and Ankara. The road is already dualled. Construction of a motorway looks to be some distance in the future.

Forecasts of traffic along the road are as shown in Page 5. The detailed assessment of the capacity of the road and thus the bridge indicates that full capacity would be reached in about 2012/2013. Tripling the carriageways may be necessary by the Year 2008.

The Expected average annual growth rates for traffic along this road are at the following level:-

Cars	10.0%
Buses	6.0%
Trucks	5.0%
Trailers	4.9%
Total	8.1%

1.3 Proposed Remedial Works

The remedial work will include:-

- repairs to the girders and slabs
- repairs to the columns and abutments

The bridge will need to be closed but service can be provided by the parallel carriageway bridge with traffic control being introduced. The costs of the rehabilitation works are estimated at US$ 153000.

The disruption costs in using the parallel carriageway are considerable especially as the traffic builds. Indeed it looks as though the repair will have to be done by 1999 to avoid the disruption costs becoming excessive.

2. ECONOMIC ANALYSIS

2.1 Different Evaluations

In this case study, the economic assessment relates to a tradeoff between repair and replacement.

2.2 Alternative detours

In the event of the closure of the Asagi Cakalli bridge and the inability to use the parallel bridge because of the traffic levels, then the alternative route would probably be through Asarcik, which involves a 13 kilometre detour.

However, these alternative roads are in relatively poor condition (road surface and curvature). They would provide an expensive alternative for the road users (increased time and vehicle operating costs) and for the agency, KGM, in that deterioration on these other roads is likely to enforce considerable repair work. No attempt has been made to calculate these costs but intuitively they appear to be considerable.

2.3 Cost-Effectiveness Analysis

The poor condition of the bridge and the need to repair by 1999 means that planning for repair should commence fairly soon. The proposed repair cost (excluding disruption costs) is some 36% of the replacement cost (US$ 430000), but it means that it is still cost-effective to make the repair even when the costs of disruption to road users are included. The costs of traffic disruption are high and build up quickly as repair is delayed.

2.4 Cost/Benefit Analysis

The Cost/Benefit Analysis indicates that the EIRRs are very well above the opportunity cost of capital (12%). For example, using the avoidance of the alternative detour via Asarcik (an extra 13 kilometres) as the measure of the benefits of the project gives a very large EIRR approaching 300%. Using the deferral of capital expenditure as the measure of the benefit of the maintenance project gives the lowest rate of return at around 14%. Whilst the measure of using the 'next best alternative' gives an EIRR of more than 100%.

The economic return for the project is exceptionally good because it is urgently needed and a good number of years of useful life can be achieved for the repair outlay. Because the Asagi Cakalli bridge crosses a deep ravine it means that the economic benefits being delivered by the bridge are high when one considers the alternative of having to drive up and down a steep ravine in order to cross by a more modest bridge.

3. GENERAL CONCLUSIONS FROM THE ECONOMIC CASE STUDY

The key general conclusion that arises from this case study is to note that the costs of traffic disruption can be very great as one pushes traffic on one carriageway onto another carriageway. The scale of the traffic disruption costs become a major factor in determining the timing of the repairs.

ANNEX 8

ECONOMIC ANALYSIS - CASE STUDY OF GELINCIK BRIDGE

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Gelincik Bridge (formerly known as Ivyan Sogukpinar) is located on State Road D 010, 6 kilometres east of Surmene, and 42 kilometres east of Trabzon, on the main road between Trabzon and Rize, carrying onto the former Soviet Union country of Georgia. The road is a two lane paved road in good condition carrying the following two way traffic:

Table - A8.1 - AADT 1993 at Gelincik Bridge

Vehicle Type	Number	Composition %	General Traffic Composition in Trabzon %
Cars	3339	69.93%	70.00%
Buses	340	7.12%	7.00%
Trucks	1048	21.95%	22.00%
Trailers	8	1.00%	1.00%
Total	4775	100.00%	100.00%
Source: KGM Transport and Cost Analysis Division			

The Bridge itself is some 32.50 metres in length, with a carriageway width of 8.5 metres and sidewalks of 1.30 metres. The Bridge crosses the Sogukpinar River which varies in width between 2 and 18 metres (but under the bridge a 30 metre flow is typical), with a depth between 0 and 1.2 metres. The Bridge is 4.25 metres above the river bed. The Bridge was designed to a specification of AASHTO H20-S16. (20 tonnes on the first two axles - tractor truck - and 16 tonnes on subsequent axles). It is a reinforced concrete bridge of simple beam construction. It is positioned alongside and downstream of the old bridge which was built fifty years ago and saw 25 years of service before it was deemed too small, being basically single lane.

Built in 1970, the Gelincik Bridge has provided 25 years of service. With modest repairs, it is assumed that it can provide a further 25 years of service.

1.2 The future for the road

Traffic is growing rapidly on the road largely because the road is now serving as an important connection to the former Soviet republic of Georgia. Whereas, for several decades there had been no social or economic contact between Turkey and Georgia, such contact is now beginning to develop. Probably, there will be a need for a dual carriageway within 5-15 years, though dualling is a problem because of the scarcity of land along this coastal road, and because of the fierce wave action of the Black Sea. Protection from the sea waves will make the dualling of the road relatively costly. The construction of a motorway on this particular alignment looks to be many years off because of the difficult coastal terrain.

Forecasts of traffic along the road are as shown on Page 5. The detailed assessment of the capacity of the road and thus the bridge indicates that a dualling to provide a level of service of D would occur in 2004.

The Bridge now requires maintenance repairs. These can be done without closing the bridge, but it would be necessary to have single lane operation for some of the time. Repairs would include

- repairs to a girder
- repairs to some slabs

The basic problem with the bridge relates to poor workmanship at the time of construction. The costs of rectifying the work is estimated at US$ 57000 and would take some 250 days.

2. ECONOMIC ANALYSIS

2.1 Evaluation

In this case study the economic assessment relates to a relatively simple situation in terms of evaluating the cost-effectiveness of a repair against awaiting a replacement when the road comes to be dualled.

The proposed repair costs amount to 30% of the replacement cost (US$ 189000) of a bridge, and should enable the existing bridge to complete a useful economic life of fifty years. Dualling maybe as much as eight to ten years away at service level 'D', and would probably be far more than the simple replacement cost because of the difficulty of putting the second carriageway on the seaward side of the current bridge. Such a new bridge would probably require significant piling, earthworks and armouring against the wave action of the sea.

2.2 Alternative detours

At this moment in time there is no reason to assume that it would be necessary to close the Gelincik bridge for repairs. However, should closure be necessary, there are two possibilities

1) To use the old bridge, now fifty years of age and upstream of the present bridge. This option would probably involve having to move the tea-collection warehouse and use part of the school playground. It would be a cumbersome solution (single lane bridge). It would probably be costly especially if the cooperation of the school and the tea collection centre is not forthcoming. Also the old bridge would have to be checked to ensure that it could carry the loads.

2) To build a temporary bridge of 'bailey' bridge type on the downstream side of the existing bridge. We have not costed this diversion but it would be expensive because of the need for piling and earthworks. The other alternative is to go upstream but then this would necessitate taking down some of the buildings, and this would be expensive.

More distant detours are not feasible because of the nature of the road as a coastal road.

2.3 Cost-Effectiveness Analysis

The cost-effectiveness analysis indicates that repair is the best option up until 2001 by when it becomes more cost-effective to build a replacement, assuming that this is physically possible without creating traffic disruption costs. Repair without closing the bridge creates very considerable traffic disruption costs because it will be necessary to operate traffic controls on a single lane. The disruption costs rise rapidly through time as the traffic increases. (See Appendix 2.3)

2.4 Cost/Benefit Analysis

The cost/benefit analysis indicates that the EIRR for the repair project is around 15%. It is a modest rate of return compared with many repair projects because the total costs of the project are quite considerable in relation to the costs of replacement. The EIRR rises if the project is delayed some 3 or 4 years but not so long as to create severe traffic congestion problems when it is repaired.

Using the concept of the notional detour as the alternative (some 2 kilometres) gives an EIRR of 45%, whilst the deferral of capital approach gives a low return of nearly 7%.

On balance the return is above the opportunity cost of capital but the costs are relatively high (direct repair plus traffic disruption) whilst the future economic life is relatively short.

3. GENERAL CONCLUSIONS FROM THE ECONOMIC CASE STUDY

This bridge is a typical bridge in this coastal location. This era of bridges took over from the previous era of road bridges, which had seen 25 years of service, when it was clear that a one lane bridge was no longer appropriate for the traffic. The bridges provide a high level of economic benefit in view of the difficulties in finding alternative detour routes.

However, economic development means that a dualling of the main road in some parts has already taken place. More and more will be dualled through the years. Traffic disruption costs will be high along this coastal road, making it essential to integrate the planning of bridge maintenance and the dualling of the road. If this is done well, the opportunities for savings in traffic disruption costs will be considerable, gaining significant economic benefits for the Turkish economy.

ANNEX 9

ECONOMIC ANALYSIS - CASE STUDY OF SARDERE BRIDGE (ANTALYA)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Sardere Bridge is located on State Road D 650 some 40 kilometres south of Dinar on the Afyon to Antalya Road. It is a two lane paved highway in good condition carrying the following two way traffic:

Table - A9.1 - AADT 1993 on the Sardere Bridge (Antalya)

Vehicle Type	Number	Composition - Percent	General Composition of Traffic in Antalya %
Cars	2079	47.21%	65.00%
Buses	338	7.67%	6.00%
Trucks	1927	43.76%	28.00%
Trailers	60	1.36%	1.00%
TOTAL	4404	100.00%	100.00%
Source: KGM Transport and Cost Analysis Division			

The Bridge itself is some 43.15 metres in length, with a carriageway width of 9.50 metres and sidewalks of 1.60 metres. The Bridge crosses the Sarderesi River which varies in width between 1.5 and 18 metres (typically 5 metres flow), with a depth between 0.2 and 1.5 metres. The Bridge is 5.6 metres above the river bed. The Bridge was designed to a specification of AASHTO H20-S16. (20 tonnes on the first 2 axles - tractor truck - and 16 tonnes on subsequent axles)

Built in 1985, it has provided only 10 years of service. It is a reinforced concrete bridge of simple beam construction.

1.2 The future for the road

Traffic is growing on the road as the main link between Ankara, and indeed between Istanbul and the Mediterranean coast around Antalya. Traffic is growing rapidly and the road will no doubt be dualled within ten to twenty years. Construction of a motorway looks to be some distance in the future.

The detailed assessment of the capacity of the road and thus the bridge indicates that dualling would be required as follows:-

Operating at service level C	1998
Operating at service level D	2004
Operating at service level E	2009

The expected rates of growth for the traffic are as follows:-

Cars	12.0%
Buses	5.9%
Trucks	5.0%
Trailers	4.5%
Total	9.7%

1.3 Proposed Remedial Works

The bridge is now in a dangerous condition and will become unusable in one or two years. The remedial work will include:-

- replacement of slabs
- replacement of expansion joints and girders.

The bridge will have to be closed, and service will have to be provided by a temporary bridge. The costs of the repair works are estimated at $36000 but a further $88000 will have to be spend in providing a temporary bridge.

2. ECONOMIC ANALYSIS

2.1 Different Evaluations

In this case study the economic assessment relates to a trade-off between repair and replacement.

2.2 Alternative detours

Detours would require a simple temporary bridge and indeed there are detour possibilities downstream of the bridge.

The simplest solution to the problem of bridge closure is to build a temporary concrete box culvert bridge across the river whilst repair works are carried out to the main bridge.

2.3 Cost-Effectiveness Analysis

The condition of this bridge is poor and its likelihood of being unusable within 1 to 2 years means that action cannot be delayed. Because the proposed repair cost (excluding disruption costs) is only 12% (US$ 36000) of the replacement cost (US$ 290000), it means that it is cost-effective to make the repair even when the costs of disruption to road users are included. The costs of traffic disruption are relatively modest because traffic levels are not so high as to create considerable traffic congestion problems.

2.4 Cost/Benefit Analysis

The proposed repair costs amount to only 12% of the replacement cost (US$ 290000) of the bridge, and should enable the existing bridge to complete a useful economic life of fifty years. Dualling maybe as much as nine years away at service level D , and consequently it is premature to build a parallel bridge to deal with future dualling.

The Cost/Benefit Analysis indicates that the EIRRs are well above the opportunity cost of capital (12%). For example, using the avoidance of the alternative detour via nearby roads (an extra 1.5 kilometres) as the measure of the benefits of the project gives a very large EIRR in excess of 600%. Using the deferral of capital expenditure as the measure of the benefit of the maintenance project gives the lowest rate of EIRR at around 23%. Whilst the measure of using the next best alternative gives an EIRR of nearly 41%.

The economic return for the project is good because it is urgently needed and a good number of years of useful life can be achieved for a modest repair outlay.

3. GENERAL CONCLUSIONS FROM THE ECONOMIC CASE STUDY

A principal problem for the bridge relates to the management of the river regime, which should be co-ordinated with the management of the aggregate removal operations in the river bed.

ANNEX 10

ECONOMIC ANALYSIS - CASE STUDY OF CANDIR HASANPASA BRIDGE (BURSA)

1. INTRODUCTION AND BACKGROUND

1.1 Background

The Candir Hasanpasa Bridge is located on State Road D200, some 14 kilometres south east of Inegol, on the main road between Bursa and Eskisehir. The road is a two lane paved road in good condition carrying the following two way traffic:

Table - A10.1 - AADT 1993 at Candir Hasanpasa Bridge (Bursa)

Vehicle Type	Number	Composition %	General Traffic Composition in Bursa %
Cars	1939	47.85%	59.00%
Buses	207	5.11%	5.00%
Trucks	1733	42.77%	34.00%
Trailers	173	4.27%	2.00%
Total	4052	100.00%	100.00%
Source: KGM Transport and Cost Analysis Division			

The Bridge itself is some 113.85 metres in length, with a carriageway width of 8.5 metres and sidewalks of 0.95 metres. The Bridge crosses the Candir River which varies in width between 4 and 13 metres (typically 10 metres flow), with a depth between 0.2 and 2.5 metres. The Bridge is 4.5 metres above the river bed. The Bridge was designed to the American specification of AASHTO H20-S16. (20 tonnes on the first two axles - tractor truck - and 16 tonnes on subsequent axles). It is a reinforced concrete bridge of simple beam construction.

Built in 1972, it has provided 23 years of service but it is now at the end of its economic life unless urgent remedial action is taken.

1.2 The future for the road

Traffic is growing rapidly on the road. Probably, it will need to be a dual carriageway within five to ten years, though dualling is a problem between the bridge and Bozuyuk because the road passes through a relatively narrow gorge. Most of the traffic is travelling between Bursa and Eskisehir, both of which are major industrial towns. The construction of a motorway on this route looks to be some years off because of the difficult terrain through the gorge.

Forecasts of traffic along the road are as shown on Page 6. The detailed assessment of the capacity of the road and thus the bridge indicates that a dualling to provide a level of service of 'D' standard would occur by the year 2003, and indeed to meet C standard, dualling would be required by 1997.

The Expected average annual growth rates for traffic along this road are at the following level:-

Cars	12.0%	
Buses	2.9%	
Trucks		8.0%
Trailers		7.9%
Total	10.1%	

The high rates of growth for the truck and trailer traffic reflect the industrial growth patterns in Eskisehir and Bursa.

1.3 Proposed Remedial Works

The Bridge is now in a dangerous condition. If nothing is done, it is likely to collapse in the next one or two rainy seasons. Urgent action will have to be taken. This action will include:-

- replacement of columns
- replacement of slabs

The bridge will have to be closed, and service will have to be provided by a temporary bridge.

The basic problem with the bridge relates to scour of columns by the river. It is possible that a significant factor in this scour problem will have been played by the quarrying works in the river bed upstream, and the collapse downstream of a weir. The costs of the rehabilitation works are estimated at US$ 117000.

2. ECONOMIC ANALYSIS

2.1 Different Evaluations

In this case study the economic assessment can relate to a number of different possibilities. These can be considered to be:-

- the impact of an actual collapse, which looks to be a serious possibility
- immediate repair work. This will entail building a temporary bridge whilst the main bridge is repaired
- the building of a parallel bridge to accommodate a future dualling of the road. Then to carry out the repair of the existing bridge.

2.2 Alternative detours

In the event of the closure of the Candir Hasanpasa bridge, there are alternative routes which could be considered, including:-

- the secondary road through Pazaryeri
- an alternative route via Yenisehir and Bilecik
- an alternative route via Domanic and Tavsanli (for Kutahya traffic)

However, these alternative roads are in relatively poor condition (road surface and curvature). They would provide an expensive alternative for the road users (increased time and vehicle operating costs) and for the agency, KGM, in that deterioration on these other roads is likely to enforce considerable repair work. No attempt has been made to calculate these costs but intuitively they appear to be considerable.

The simplest solution to the problem of bridge closure is to build a temporary concrete box culvert bridge across the river whilst repair works are carried out to the main bridge.

2.3 Cost-Effectiveness Analysis

The dangerous condition of the bridge and its likelihood of collapsing within 1 to 2 years means that action can not be delayed. Because the proposed repair cost (excluding disruption costs) is only 17% (US$ 117000) of the replacement cost (US$ 702000), it means that it is cost-effective to make the repair even when the costs of disruption to road users are included. The costs of traffic disruption are relatively modest because traffic levels are not so high as to create considerable traffic congestion problems.

2.4 Cost/Benefit Analysis

The proposed repair costs amount to only 17% of the replacement cost (US$ 702000) of the bridge, and should enable the existing bridge to complete a useful economic life of fifty years. Dualling maybe as much as eight years away at service level 'D', and consequently it is premature to build a parallel bridge to deal with future dualling. However, if it is intended to dual at service level 'C', then it would be worthwhile to rapidly build the parallel bridge.

The Cost/Benefit Analysis indicates that the EIRRs are well above the opportunity cost of capital (12%). For example, using the avoidance of the alternative detour via Pazayeri (an extra 2 kilometics) as the measure of the benefits of the project gives a very large EIRR in excess of 600%. Using the deferral of capital expenditure as the measure of the benefit of the maintenance project gives the lower rate of EIRR at around 39%. Whilst the measure of using the 'next best alternative' gives an EIRR of nearly 33%.

The economic return for the project is good because it is urgently needed and a good number of years of useful life can be achieved for a modest repair outlay.

3. GENERAL CONCLUSIONS FROM THE ECONOMIC CASE STUDY

The bridge urgently requires attention and can be made good for a fraction (17%) of the cost of a new bridge (US$ 702000). Collapse, which is imminent, would create an extremely expensive situation for the Turkish economy because traffic levels are substantial, and collapse would enforce a combination of long distance diversions and temporary adjacent diversions, all of which are costly for the road users.

Urgent repair has to be undertaken. The alternative is to urgently proceed with a parallel bridge in anticipation of dualling the road. But it would be necessary to ensure that the parallel bridge can be built before the existing bridge collapses. Of course, a new parallel bridge costs three times what a repair will cost.

The principal problem for the bridge relates to the management of the river regime, which should be co-ordinated with the management of the aggregate removal operations in the river bed.

Appendix 7

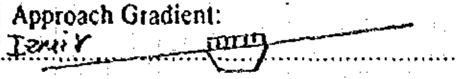
Data for Environmental Study

INSPECTION SHEET
Environmental and Natural Conditions

No. /

Date: Sept. 27. '95 | Time: 11:20AM | Weather: Cloudy
Bridge Name: Buca Üst Geçit | Bridge No: A1-300-02-2
KGM Division No.: 2 | Area: İzmir

Traffic Volume	[✓ Heavy], Medium, Light, Scarce	Approach Gradient:
Land Use	[✓ Urban], Suburban, Rural, Farming, Others	
Topography	Plain, [✓ Hilly], Mountainous, Valley, Coastal	

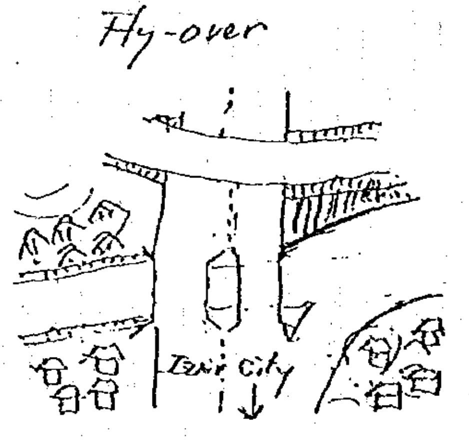


			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	–	–
		Up Stream	–	–
	a)Office Building, [✓ b)Apartment Building], [✓ c)Houses], d)Shops, e)Factories, f)Others	Down Stream	Houses	(Rock Slope)
		Up Stream	Houses	X
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	–	–
		Up Stream	–	–
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	–	–
		Up Stream	–	–
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	–	–
		Up Stream	–	–

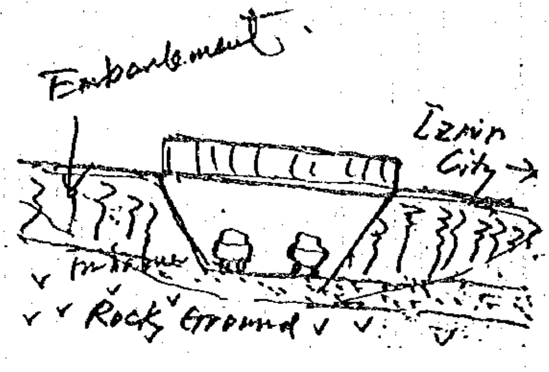
River and Ground Conditions

Water Clearness: Clear, opaque, muddy, brown, mix-sewage, [✓ no water.]
Riverbed Material: Silt and clay, sandy, gravel, rock, solid waste.
Current Velocity: m/sec | Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks: Very heavy traffic

INSPECTION SHEET
Environmental and Natural Conditions

No. 2

Date: Sept. 27. '95	Time: 11:40 AM	Weather: Cloudy	
Bridge Name: Hilal- II		Bridge No: A1-300-2-8	
KGM Division No.: 2		Area: Izmir	
Traffic Volume	[✓ Heavy], Medium, Light, Scarce		Approach Gradient:
Land Use	[✓ Urban], Suburban, Rural, Farming, Others		
Topography	[✓ Plain], Hilly, Mountainous, Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	School Mosque	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	Houses	Yards
		Up Stream	Houses	X
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	.
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	—

River and Ground Conditions

Water Clearness: Clear, opaque, muddy, [✓ brown], [✓ mix-sewage], no water.

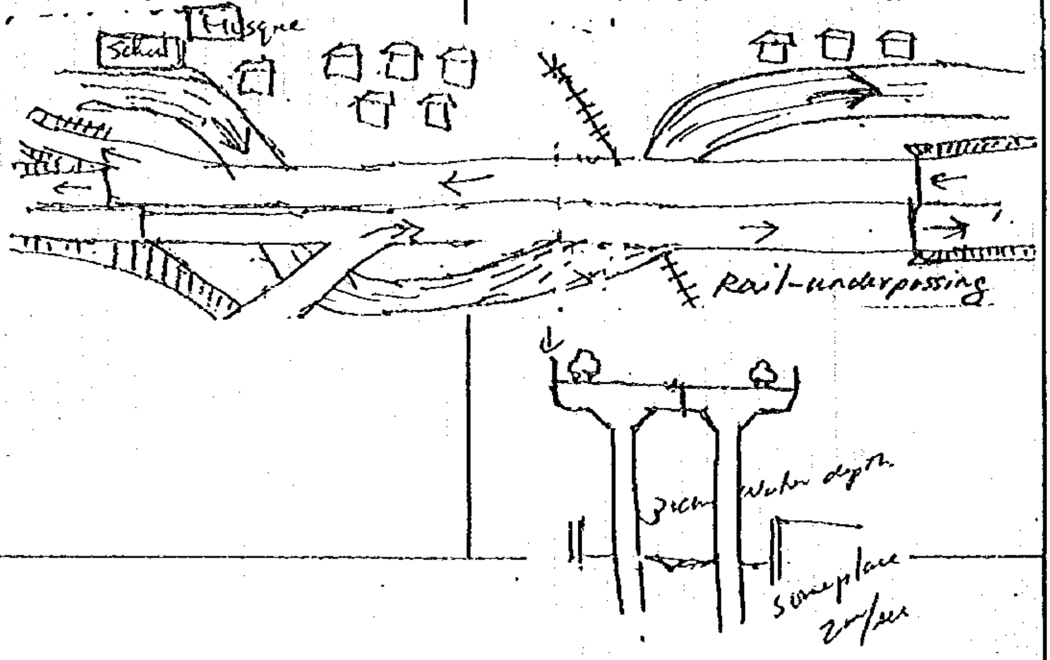
Riverbed Material: [✓ Silt and clay], sandy, [✓ gravel], rock, [✓ solid waste.]

Current Velocity: 0.5 m/sec. m/sec

Scouring:

Plan & Outcrops

Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 3

Date: Sept. 28 | Time: 5p.m | Weather: Fine

Bridge Name: Hudut - I | Bridge No: A1 - 300-04-5

KGM Division No.: 2 | Area: Izmir

Traffic Volume: Heavy, Medium, [✓ Light] Scarce

Land Use: Urban, Suburban, Rural, [✓ Farming] Others

Topography: Plain, Hilly, Mountainous, Valley, Coastal

Approach Gradient: Flat

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	·
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	wheat	wheat
		Up Stream	"	"

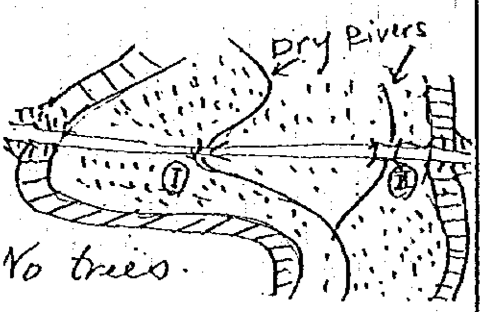
River and Ground Conditions

Water Clearness: Clear, opaque, muddy, brown, mix-sewage, [✓ no water,]

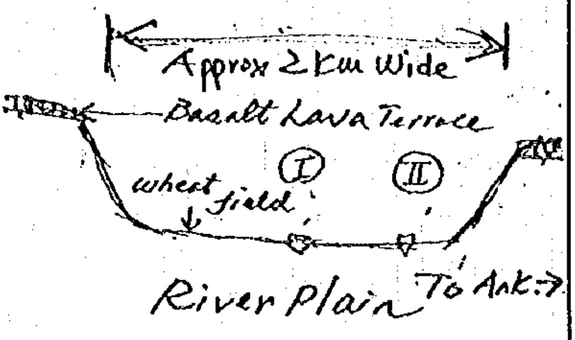
Riverbed Material: [✓ Silt and clay], [✓ sandy] gravel, rock, solid waste.

Current Velocity: — m/sec | Scouring: —

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 4

Date: Oct. 10.'95	Time: 2:50 p.m	Weather: Very Fine	
Bridge Name: Porsuk		Bridge No: SB-200-08-4	
KGM Division No.: 4		Area: Bursa	
Traffic Volume	Heavy, [✓ Medium], Light, Scarce	Approach Gradient: Flat	
Land Use	Urban, [✓ Suburban], Rural, Farming, Others		
Topography	[✓ Plain], Hilly, Mountainous, Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	Factory	Houses
		Up Stream	—	4
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, [✓ b)Cereals] c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	Firming	—

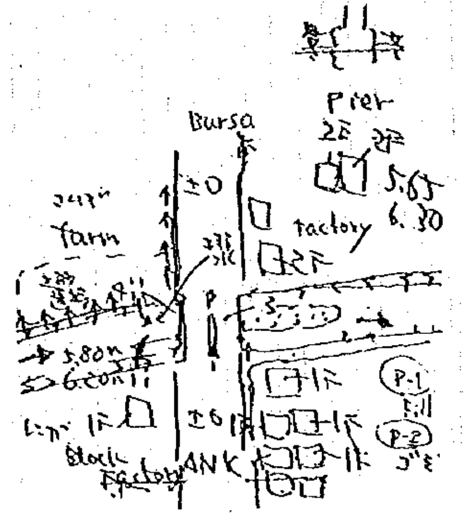
River and Ground Conditions

Water Clearness: Clear, opaque, muddy, brown, [✓ mix-sewage], no water.

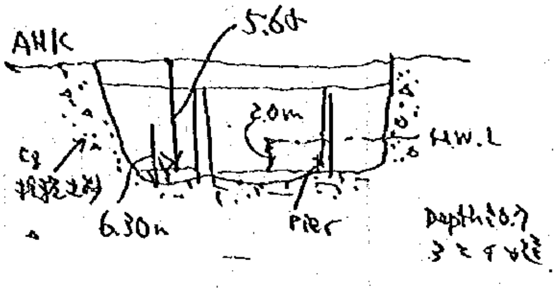
Riverbed Material: Silt and clay, [✓ sandy], gravel, rock, [✓ solid waste]

Current Velocity: 2. m/sec | Scouring: on Column foots

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 5

Date: Sept. 29	Time: 1:25 p.m	Weather: Fine ~ Cloudy	
Bridge Name: Babadat		Bridge No: AA-200-10-1	
KGM Division No.: 4		Area: Afyon	
Traffic Volume	Heavy, Medium, [✓ Light] Scarce	Approach Gradient: Plain	
Land Use	Urban, Suburban, Rural, [✓ Farming] Others		
Topography	[✓ Plain], Hilly, Mountainous, Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	Wheat	Wheat
		Up Stream	"	"

River and Ground Conditions

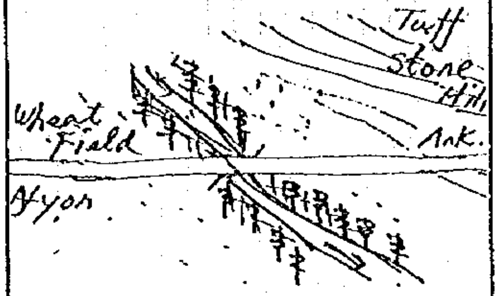
Water Clearness: Clear, opaque, muddy, brown, mix-sewage, [✓ no water.]

Riverbed Material: [✓ Silt and clay,] sandy, gravel, rock, solid waste.

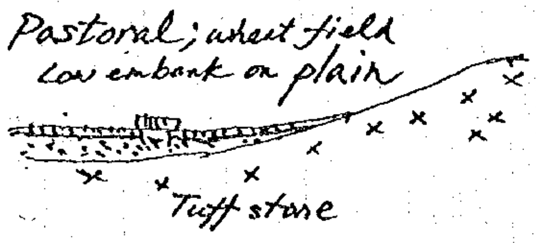
Current Velocity: m/sec

Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks: Trees along stream.

INSPECTION SHEET
Environmental and Natural Conditions

No. 6

Date: Sept.24 | Time: 9 AM | Weather: Cloudy ~ Fine
Bridge Name: Selyeri | Bridge No: AR-010-16-4
KGM Division No.: 7 | Area: Samsun
Traffic Volume: Heavy, [✓ Medium] Light, Scarce
Land Use: Urban, [✓ Suburban] Rural, Farming, Others
Topography: [✓ Plain,] Hilly, Mountainous, Valley, Coastal
Approach Gradient:

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	–	–
		Up Stream	–	–
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	Houses	DSI office
		Up Stream	–	–
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	–	–
		Up Stream	Trees	–
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	–	–
		Up Stream	–	–
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	–	–
		Up Stream	–	Firming

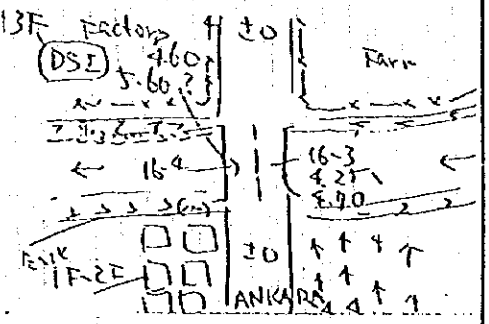
River and Ground Conditions

Water Clearness: Clear, opaque, [✓ muddy,] brown, mix-sewage, no water.

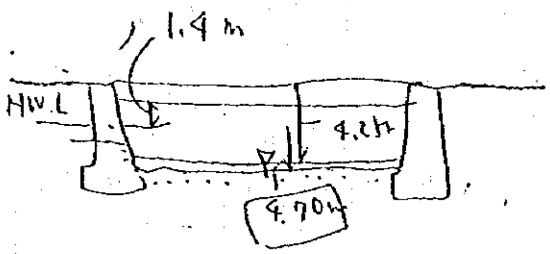
Riverbed Material: Silt and clay, [✓ sandy,] gravel, rock, solid waste.

Current Velocity: / m/sec | Scouring: –

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 7

Date: Sept. 22, 95	Time: 5pm	Weather: Cloudy ~ fine	
Bridge Name: Akcay		Bridge No: AR-010-16-12	
KGM Division No.: 7		Area: Samsun	
Traffic Volume	Heavy, [✓ Medium] Light, Scarce	Approach Gradient:	
Land Use	Urban, Suburban, [✓ Rural] Farming, Others		
Topography	[✓ Plain], Hilly, Mountainous, Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	Trees	Trees
		Up Stream	"	"
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	—

River and Ground Conditions

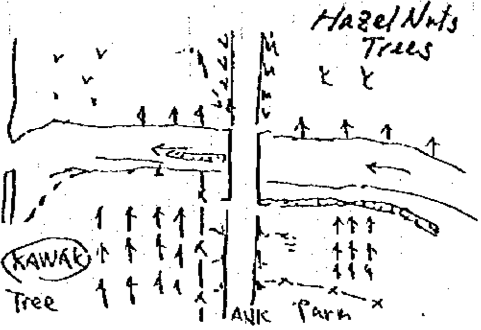
Water Clearness: Clear, opaque, [✓ muddy], brown, mix-sewage, no water.

Riverbed Material: Silt and clay, [✓ sandy], gravel, rock, solid waste.

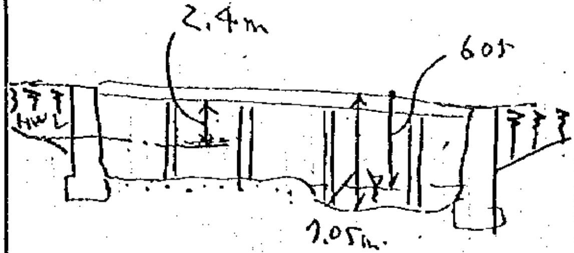
Current Velocity: 0.1 ~ 0.2 m/sec

Scouring: —

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 8

Date: Sept. 25 | Time: 11:30AM | Weather: Fine

Bridge Name: Merzifon | Bridge No: AR-100-17-1

KGM Division No.: 7 | Area: Samsun

Traffic Volume: Heavy, Medium, [✓ Light], Scarce

Land Use: Urban, [✓ Suburban], Rural, Farming, Others

Topography: [✓ Plain], Hilly, Mountainous, Valley, Coastal

Approach Gradient:

			Left Bank To Town	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	houses	Ware Houses
		Up Stream	—	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	Farming

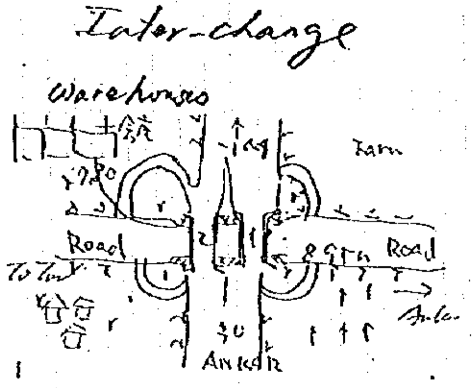
River and Ground Conditions

Water Clearness: Clear, opaque, muddy, brown, mix-sewage, no water.

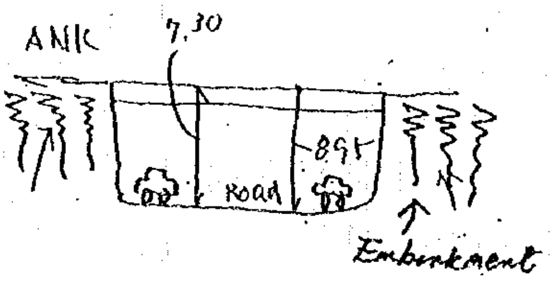
Riverbed Material: Silt and clay, sandy, gravel, rock, solid waste.

Current Velocity: m/sec | Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 9

Date: Sept. 25	Time: 11:50 AM	Weather: Fine
Bridge Name: Ust Gecit II		Bridge No: AR-100-17-4
KGM Division No.: 7		Area: Samsun

Traffic Volume	Heavy, Medium, [✓ Light], Scarce	Approach Gradient:
Land Use	Urban, Suburban, [✓ Rural], [✓ Farming], Others	
Topography	[✓ Plain], Hilly, Mountainous, Valley, Coastal	

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	-	
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	Cereals	Cereals
		Up Stream	〃	〃

River and Ground Conditions

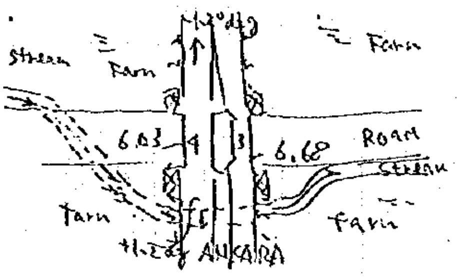
Water Clearness: Clear, opaque, muddy, brown, mix-sewage, no water. —

Riverbed Material: Silt and clay, sandy, gravel, rock, solid waste. —

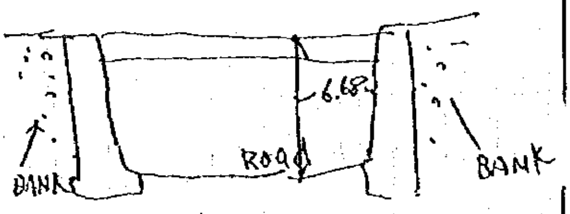
Current Velocity: m/sec | Scouring: —

Plan & Outcrops

Fly-Over



Section of Topography, River & Geology

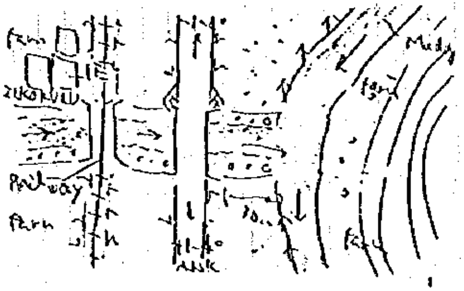


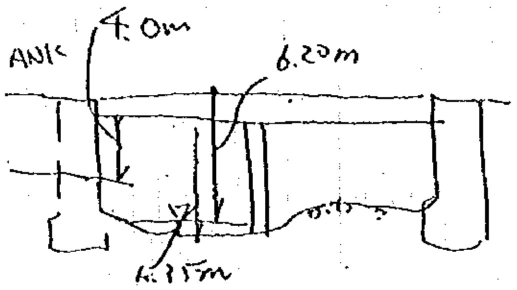
Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 10

Date: Sept. 25	Time: 12:45	Weather: Very Fine		
Bridge Name: Pasa Pinar		Bridge No: AR-100-17-5		
KGM Division No.: 7		Area: Samsun		
Traffic Volume	Heavy, [✓ Medium], Light, Scarce	Approach Gradient:		
Land Use	Urban, Suburban, [✓ Rural], Farming, Others			
Topography	Plain, [✓ Hilly], Mountainous, Valley, Coastal			
			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	–	–
		Up Stream	–	–
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	–	–
		Up Stream	–	–
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	–	–
		Up Stream	–	–
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	–	–
		Up Stream	–	–
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	river side	river side
		Up Stream	Wheat	wheat
River and Ground Conditions	Water Clearness: Clear, opaque, muddy, brown, mix-sewage, [✓ no water.]			
	Riverbed Material: Silt and clay, sandy, [✓ gravel], rock, solid waste.			
	Current Velocity: – m/sec		Scouring: –	
	Plan & Outcrops		Section of Topography, River & Geology	





Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 11

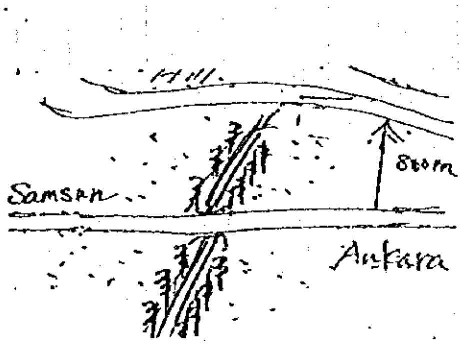
Date: Sept. 26
Time: 1.30 pm
Weather: Very Fine
Bridge Name: Koparan II
Bridge No: AR-785-05-2
KGM Division No.: 7
Area: Corum
Traffic Volume: Heavy, [✓ Medium, Light], Scarce
Land Use: Urban, Suburban, [✓ Rural], Farming, Others
Topography: [✓ Plain], Hilly, Mountainous, Valley, Coastal
Approach Gradient:

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	Cereals	Cereals
		Up Stream	〃	〃

River and Ground Conditions

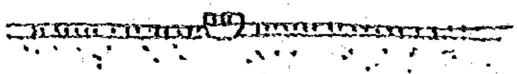
Water Clearness: Clear, opaque, muddy, brown, mix-sewage, [✓ no water.]
Riverbed Material: Silt and clay, sandy, [✓ gravel], rock, solid waste.
Current Velocity: — m/sec
Scouring:

Plan & Outcrops



Section of Topography, River & Geology

Rolling hills to Mts.



Small River in wide plain

Remarks:

Trees along stream

INSPECTION SHEET
Environmental and Natural Conditions

No. 12

Date: Sept. 26	Time: 1.55p.m	Weather: Very Fine	
Bridge Name: Hasimusa		Bridge No: AR 285-05-4	
KGM Division No.: 7		Area: Corum	
Traffic Volume	Heavy, [✓ Medium, Light] Scarce		Approach Gradient:
Land Use	Urban, Suburban, [✓ Rural] Farming, Others		
Topography	[✓ Plain] Hilly, Mountainous, Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	–	–
		Up Stream	–	–
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	–	–
		Up Stream	–	–
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	–	–
		Up Stream	–	–
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	–	–
		Up Stream	–	–
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	b	b
		Up Stream	b	b

River and Ground Conditions

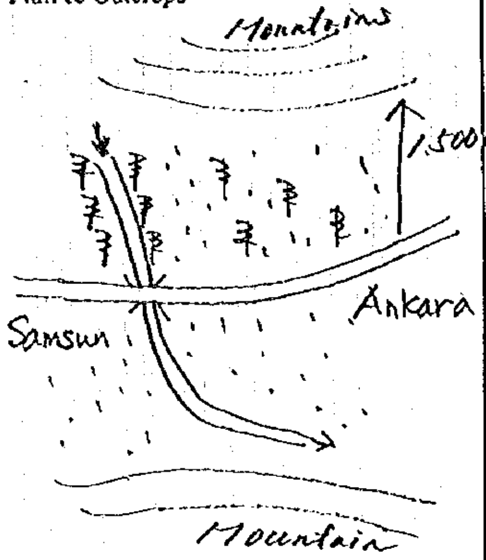
Water Clearness: Clear, opaque, muddy, brown, mix-sewage, [✓ no water.]

Riverbed Material: [✓ Silt and clay], [✓ sandy] gravel, rock, solid waste.

Current Velocity: m/sec

Scouring:

Plan & Outcrops



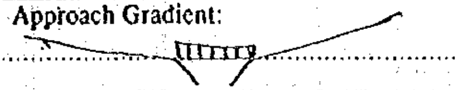
Section of Topography, River & Geology

Road runs through a plain between mountains on low embankment.
LWL width 3m (0m)
HWL width 18m

Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No./3

Date: Sept. 25	Time: 9:45AM	Weather: Very Fine	
Bridge Name: Askgi Cakalli		Bridge No: AR-795-01-5	
KGM Division No.: 7		Area: Corum	
Traffic Volume	Heavy, [✓ Medium], Light, Scarce	Approach Gradient: 	
Land Use	Urban, Suburban, [✓ Rural], Farming, Others		
Topography	Plain, Hilly, [✓ Mountainous], Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	Mosque	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	—	houses
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	Tre
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	Wheat	—

River and Ground Conditions

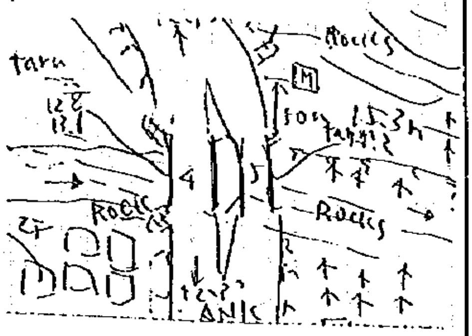
Water Clearness: Clear, [✓ opaque], muddy, brown, mix-sewage, no water.

Riverbed Material: [✓ Silt and clay], [✓ sandy], [✓ gravel], rock, solid waste.

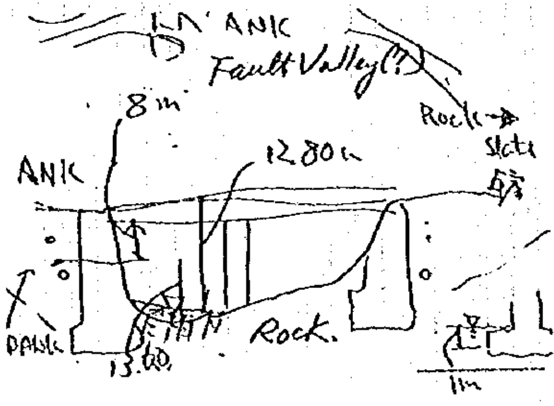
Current Velocity: 1~2 m/sec

Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 14

Date: Sept. 21
Time: 10:10 AM
Weather: Very Fine
Bridge Name: Harsit
Bridge No: AR-010-19-19
KGM Division No.: 10
Area: Trabzon

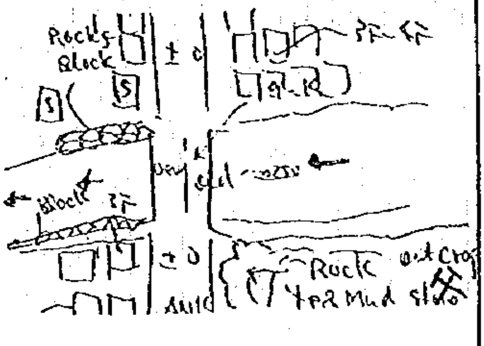
Traffic Volume: Heavy, [✓ Medium], Light, Scarce
Land Use: Urban, [✓ Suburban], Rural, Farming, Others
Topography: [✓ Plain], Hilly, Mountainous, Valley, Coastal
Approach Gradient:

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	houses	Factory
		Up Stream	Zinc Mine	houses
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	—

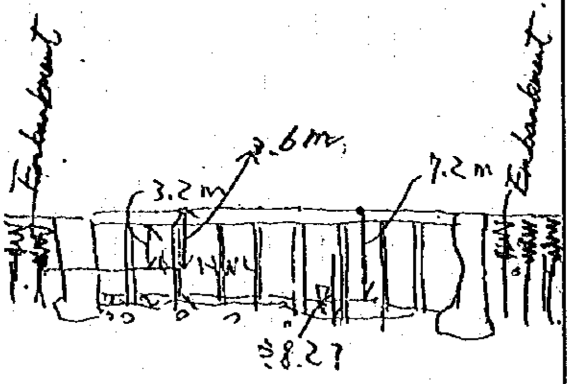
River and Ground Conditions

Water Clearness: Clear, opaque, muddy, [✓ brown], mix-sewage, no water.
Riverbed Material: Silt and clay, [✓ sandy], [✓ gravel], rock, solid waste.
Current Velocity: 2~3m m/sec
Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 15

Date: Sept. 21	Time: 2:15 pm	Weather: Very Fine
Bridge Name: Topallı		Bridge No: AR-610-20-10
KGM Division No.: 10		Area: Trabzon

Traffic Volume	Heavy, [✓ Medium], Light, Scarce	Approach Gradient:
Land Use	Urban, Suburban, [✓ Rural], Farming, Others	
Topography	Plain, Hilly, Mountainous, Valley, [✓ Coastal]	

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	house	house
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	—

River and Ground Conditions

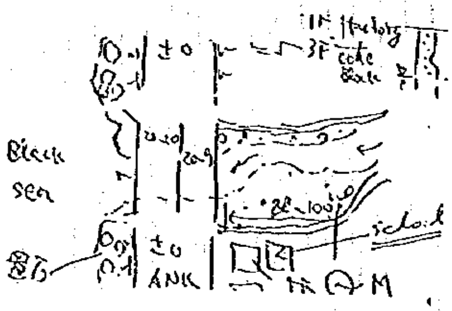
Water Clearness: [✓ Clear], opaque, muddy, brown, mix-sewage, no water.

Riverbed Material: Silt and clay, [✓ sandy], [✓ gravel], rock, solid waste.

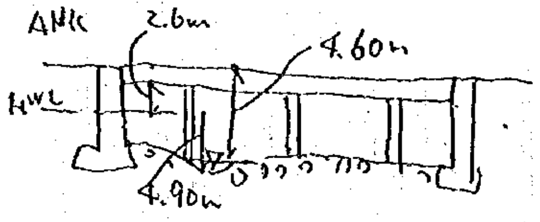
Current Velocity: 0.8 m/sec

Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No./6

Date: Sept. 21	Time: 5:30pm	Weather: Very Fine	
Bridge Name: Degirmendere		Bridge No: AR-010-22-1	
KGM Division No.: 10		Area: Trabzon	
Traffic Volume	[✓ Heavy], Medium, Light, Scarce	Approach Gradient: 1~2°	
Land Use	[✓ Urban], Suburban, Rural, Farming, Others	Ankara	
Topography	Plain, [✓ Hilly], Mountainous, Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	c and d	—
		Up Stream	d	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	Trees
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	—

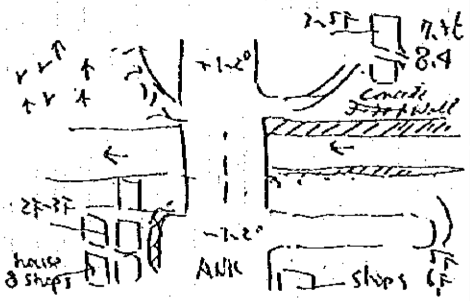
River and Ground Conditions

Water Clearness: Clear, opaque, [✓ muddy], brown, mix-sewage, no water.

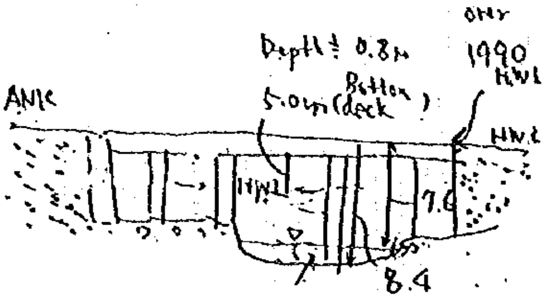
Riverbed Material: Silt and clay, [✓ sandy], [✓ gravel], rock, solid waste.

Current Velocity: 1.0 m/sec | Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 17

Date: Sept. 20	Time: 5.05 p.m	Weather: Cloudy	
Bridge Name: Zuyan Soğukpinar		Bridge No: AR-010-22-15	
KGM Division No.: 10		Area: Trabzon	
Traffic Volume	Heavy, [✓ Medium], Light, Scarce	Approach Gradient:	
Land Use	Urban, Suburban, [✓ Rural], Farming, Others		
Topography	Plain, Hilly, [✓ Mountainous], Valley, [✓ Coastal]		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	house	house
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	—

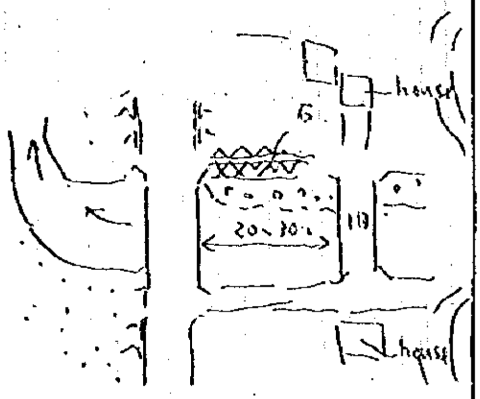
River and Ground Conditions

Water Clearness: Clear, opaque, muddy, [✓ brown], mix-sewage, no water.

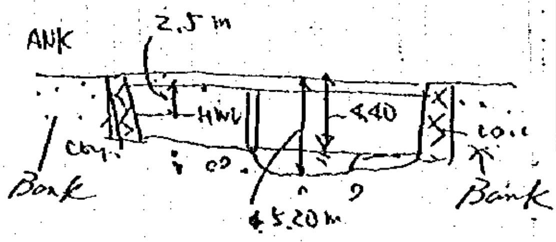
Riverbed Material: Silt and clay, [✓ sandy], gravel, rock, solid waste.

Current Velocity: 0.4 m/sec | Scouring:

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 18

Date: Sept. 20	Time: 4:20 pm	Weather: Fine w/ clouds	
Bridge Name: Solakli		Bridge No: AK-010-22-16	
KGM Division No.: 10		Area: Trabzon	
Traffic Volume	Heavy, [✓ Medium], Light, Scarce	Approach Gradient:	
Land Use	Urban, Suburban, [✓ Rural], Farming, Others		
Topography	Plain, Hilly, Mountainous, Valley, [✓ Coastal]		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	Mosque
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	Gravel Crusher	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	—	—
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	—	—

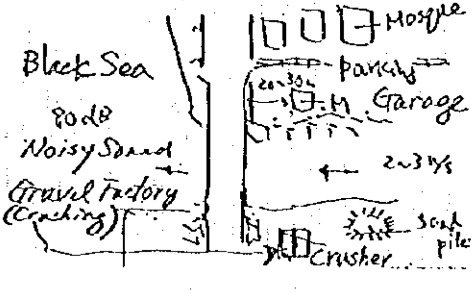
River and Ground Conditions

Water Clearness: Clear, opaque, [✓ muddy], brown, mix-sewage, no water.

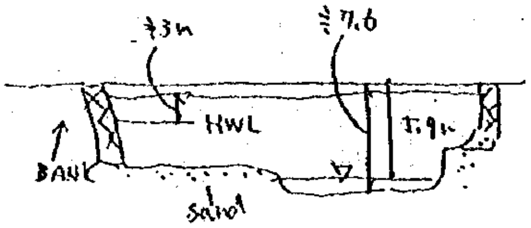
Riverbed Material: Silt and clay, [✓ sandy], gravel, rock, solid waste.

Current Velocity: / m/sec | Scouring: Piers

Plan & Outcrops



Section of Topography, River & Geology



Remarks:

INSPECTION SHEET
Environmental and Natural Conditions

No. 19

Date: Sept.29	Time: 8:30 AM	Weather: Cloudy	
Bridge Name: Sardere		Bridge No: AA-650-11-3	
KGM Division No.: 13		Area: Antalya	
Traffic Volume	Heavy, Medium, [✓ Light], Scarce	Approach Gradient:	
Land Use	Urban, Suburban, [✓ Rural], Farming, Others		
Topography	Plain, [✓ Hilly], Mountainous, Valley, Coastal		

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	Barren	Barren
		Up Stream	—	—
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	—
		Up Stream	Wheat	Wheat

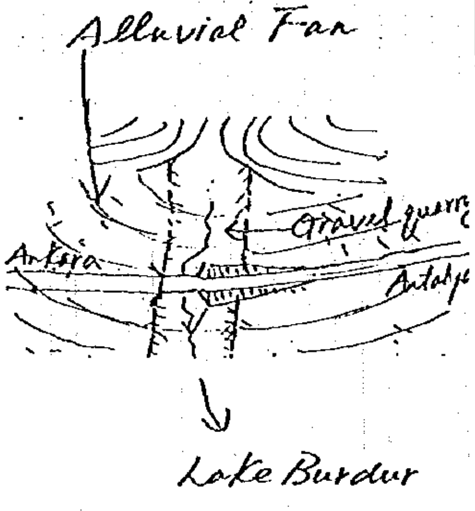
River and Ground Conditions

Water Clearness: Clear, opaque, muddy, brown, mix-sewage, [✓ no water]

Riverbed Material: Silt and clay, sandy, [✓ gravel], rock, solid waste.

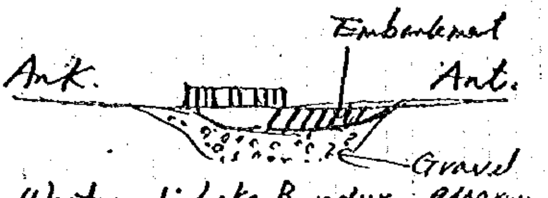
Current Velocity: m/sec | Scouring:

Plan & Outcrops



Section of Topography, River & Geology

Road crossing on fan topography on gentle hill.



Westward: Lake Burdur

Remarks:

Fig 9-2-2 INSPECTION SHEET
Environmental and Natural Conditions

No. 20

Date: October 10, '95 | Time: 13:40 | Weather: Fine
Bridge Name: Candir Hosunpasa | Bridge No: SB-201-06-12
KGM Division No.: Div. 14 | Area: Bursa

Traffic Volume	Heavy, [✓ Medium], Light, Scarce	Approach Gradient: Ankara Flat
Land Use	Urban, Suburban, [✓ Rural], Farming, Others	
Topography	[✓ Plain], Hilly, Mountainous, Valley, Coastal	

			Left Bank	Right Bank
Environmental Conditions	a)School, b)Hospital, c)Mosque, d)Cemetery, e)Historical relics, f)Others	Down Stream	—	—
		Up Stream	—	—
	a)Office Building, b)Apartment Building, c)Houses, d)Shops, e)Factories, f)Others	Down Stream	—	e) Sand..
		Up Stream	e) [illegible]	—
	a)Forest, b)Trees, c)Barren, d)Desert, e)Wild animals, f)Birds, g)Others	Down Stream	b...	b
		Up Stream	b	b
	a)Swampy, b)Grass, c)Fish, d)Birds, e)Insects, f)Others	Down Stream	—	—
		Up Stream	—	—
	Farming: a)Fruit Trees, b)Cereals, c)Vegetables, d)Live Stocks, e)Others	Down Stream	—	d
		Up Stream	d	—

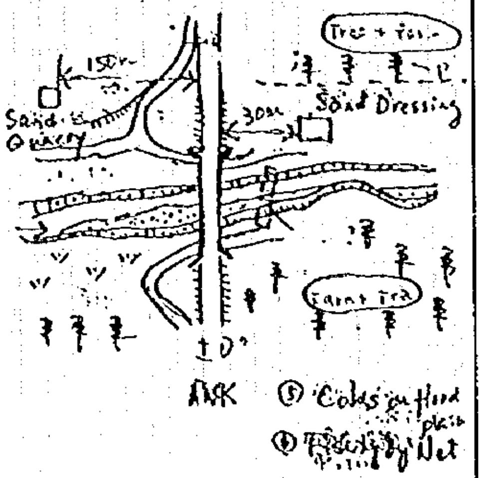
River and Ground Conditions

Water ~~Clearness~~ cleanliness: Clear, opaque, [✓ muddy], brown, mix-sewage, no water. ~~By quarry~~

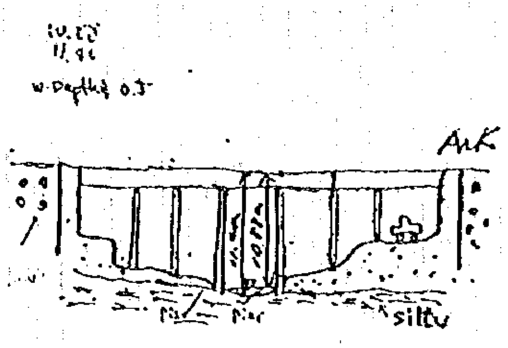
Riverbed Material: [✓ Silt and clay], [✓ sandy], [✓ gravel], rock, solid waste.

Current Velocity: Fast 1~1.5 m/sec | Scouring: piers

Plan & Outcrops



Section of Topography, River & Geology



Remarks:
1 Some quarrying at up-stream ~~left~~
2 Fast current by broken wier
3 Pier Scoured badly
4 River bed scouring

Appendix 8

Planning Operation

Bridge name: **Babadat - Div 4** *Repair Cost*: $ 52,000	*Bridge Ref*: **AA 200-10-1** *Repair duration*: 100 days

Crossing: River *Av. ht (m)*: 4.0	*Lane:* 2 lanes *Width (m):* 10.0	*Function*: Main road *Length (m)*: 25.2

Proposed repair to be carried out in 1996

Repairs required:

- Concrete peel off
- Exposed rebar
- strengthening of foundation due to scour
- widening of bridge for safety

Materials required:

- 1.0m diameter concrete pipes
- rock and selected fill materials
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout

Traffic management:

Advance work to divert traffic will be necessary

Specialist equipment & machinery required:

- excavator, spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments

Logistic:

Work to be carried out after the winter and Bayram, preferably in May 1996.

Bridge name: **Asagi Cakali - Div 7** Repair Cost: $ 153,000	Bridge Ref: **AR 795-01-5** Repair duration: 200 days

Crossing: Valley Av. ht (m): 12.0	Lane: dual 2 lane Width (m): 10.10	Function: Main road Length (m): 71.55

Proposed repair to be carried out in 1996

Repairs required:

- Concrete peel off
- Exposed rebar
- expansion joint
- cracks
- voids and honey combing
- water leakage

Materials required:

- selected fill for crossing at central reservation
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout
- expoxy resin grout for injection
- deck waterproofing membrane

Traffic management:

Advance work to divert traffic. Diversion across central reserve to other deck.

Specialist equipment & machinery required:

- excavator, spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators
- underbridge platform

Logistic:
Work to be carried out after winter and Bayram in May 1996

Bridge name: **Sardere - Div 13** Repair Cost: $124,000	Bridge Ref: **AA 650-11-3** Repair duration: 80 days

Crossing: River Av. ht (m): 5.6	Lane: 2 lane Width (m): 12.7	Function: Main road Length (m): 43.15

Proposed repair to be carried out in 1996

Repairs required:

- Concrete peel off
- Exposed rebar
- Voids and honey combing
- expansion joint

Materials required:

- 1.0m diameter concrete pipes
- rock and selected fill material
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout

Traffic management:

Advance work to divert traffic will be necessary

Specialist equipment & machinery required:

- traffic diversion signs and signal control
- launching gantry for lifting deck
- formwork and timber
- scaffolding
- concrete breaking, placing and compacting equipments eg compressors,vibrators

Logistic:

Work to be carried out in September 1996.

Bridge name: **Candir Hasanpasa-Div 14** Repair Cost: $ 117,000	Bridge Ref: **SR 200-06-12** Repair duration: 120 days
Crossing: River Av. ht (m): 4.5	Lane: 2 lane Width (m): 10.4

Proposed repair to be carried out in 1996

Repairs required:
- Concrete peel off
- Exposed rebar
- Scour of foundation
- cracks
- water leakage
- strengthening of columns

Materials required:
- 1.0m diameter concrete pipes
- rock and selected fill materials
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout
- deck waterproofing membrane
- gabion
- epoxy resin grout for injection

Traffic management:
Advance work to divert traffic will be necessary

Specialist equipment & machinery required:
- excavator, spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators
- underbridge platform

Logistic:
Work to be carried out after the winter and Bayram, preferably in May 1996.

Bridge name: **Hilal II - Div 2**

Bridge Ref: **AI 300-02-8**

Repair Cost: $ 340,000

Repair duration: 100 days

Crossing: River & railway
Av. ht (m):4.0

Lane: dual 3 lanes
Width (m): 13.5

Function: Urban flyover
Length (m): 347.8

Proposed repair to be carried out in 1997

Repairs required:

- Concrete peel off
- cracks
- expansion joints
- widening of bridge for safety

Materials required:

- selected fill materials for temporary cross over in the central reserve
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout
- epoxy resin grout for injection

Traffic management:

Partial traffic management and traffic control work to divert traffic will be necessary

Specialist equipment & machinery required:

- excavator, spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators

Logistic:

Work to be carried out in August 1997.

<table>
<tr><td colspan="3">Bridge name: Akcay - Div 7
Repair Cost: $ 78,000</td><td colspan="3">Bridge Ref: AR 010-16-4
Repair duration: 80 days</td></tr>
<tr><td colspan="2">Crossing: River
Av. ht (m): 4.1</td><td colspan="2">Lane: 2 lane
Width (m): 10.0</td><td colspan="2">Function: Coastal road
Length (m): 106.9</td></tr>
</table>

Proposed repair to be carried out in 1997

Repairs required:

- Concrete peel off
- Exposed rebar
- expansion joints
- widening of bridge for safety

Materials required:

- 1.0m diameter concrete pipes
- rock and selected fill materials
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout
- steel cyclindrical bearings

Traffic management:

Advance work to divert traffic will be necessary

Specialist equipment & machinery required:

- excavator, spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators
- temporary beam launching equipments for lifting deck

Logistic:

Work to be carried out after the winter, prefearbly end of April 1997.

Bridge name: **Buca Ustgecit - Div 2** Repair Cost: $ 7,000		Bridge Ref: **AI 300-02-2** Repair duration: 15 days
Crossing: Road Av. ht (m): 4.2	Lane: Slip road Width (m): 18.2	Function: Urban flyover Length (m): 33

Proposed repair to be carried out in 1998

Repairs required:

- Concrete peel off
- Exposed rebar
- burried joint
- widening of bridge for safety

Materials required:

- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout

Traffic management:

Partial traffic management work to divert traffic will be necessary

Specialist equipment & machinery required:

- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators

Logistic:

Work to be carried out after the winter, preferably in the middle of August 1998..

Bridge name: **Selyeri - Div 7**
Repair Cost: $ 37,000

Bridge Ref: **AR 010-16-4**
Repair duration: 35 days

Crossing: River
Av. ht (m): 3.1

Lane: 2 lane
Width (m): 9.6

Function: Coastal road
Length (m): 21.7

Proposed repair to be carried out in 1998

Repairs required:

- Concrete peel off
- Exposed rebar
- water leakage
- expansion joint
- widening of bridge for safety

Materials required:

- selected fill materials
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout
- deck waterproofing membrane

Traffic management:

Partial traffic management and control work to divert traffic will be necessary

Specialist equipment & machinery required:

- excavator, spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators

Logistic:

Work to be carried out in September 1998.

Bridge name: **Koparan II - Div 7** Repair Cost: $ 32,000	Bridge Ref: **AR 785-05-2** Repair duration: 100 days

Crossing: brook Av. ht (m): 3.1	Lane: 2 lane Width (m): 9.8	Function: Main road Length (m): 27.45

Proposed repair to be carried out in 1998

Repairs required:

- voids and honeycombing
- Exposed rebar
- widening of bridge for safety

Materials required:

- 1.0m diameter concrete pipes
- rock and selected fill materials
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout

Traffic management:

Advance work to divert traffic will be necessary

Specialist equipment & machinery required:

- excavator, spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- scaffolding
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators

Bridge name: **Gelincik - Div 7** Repair Cost: $57,000	Bridge Ref: **AR 010-22-15** Repair duration: 250 days

Crossing: River	Lane: 2 lane	Function: Coastal road

Proposed repair to be carried out in 1998

Repairs required:

- Concrete peel off
- Exposed rebar
- voids and honeycombing
- widening of bridge for safety

Materials required:

- selected fill materials
- asphalt
- concrete
- rebars and steel mesh
- self levelling, non-shrink and rapid hardening cementitious grout

Traffic management:

Partial traffic management work to divert traffic will be necessary

Specialist equipment & machinery required:

- spreader, roller,wagons and pavers for construction of temporary diversion
- traffic diversion signs and signal control
- underbridge platform
- formwork and timber
- concrete breaking, placing and compacting equipments eg compressors,vibrators

Logistic:

Work to be carried out at the end of March 1998

Appendix 9

Explanation of AAR Testing

Appendix 9.1 Result of AAR

Petrographic examinations were made of concrete core samples taken from two deteriorated bridges near Izumir (Hilal 2 & Halkapinar), to check the occurrence of alkali-aggregate reaction in these concretes. Standard aggregate tests were also conducted for local aggregates currently used in this area to evaluate their potential alkali reactivity. The following interim results were obtained.

1) Microscopic observations of thin sections of the concrete cores revealed that the two structures are undergoing typical alkali-silica reaction, due to reactive sand grains of glassy rhyolite, glassy rhyolitic tuff and calcareous chert, contained in small amounts in the sand used for these structures (Table - 9.1.1). These sand grains have reacted to form numerous radially to randomly to randomly arranged cracks filled with colorless gel products (alkali-silica gels) in these concretes.

2) There is no petrographic evidence that limestone coarse aggregates used in the structures have reacted deleteriously. However, veins of alkali-silica gels are occasionally seen filling cracks in the limestone aggregate, but these gels have migrated along the crack from the reacted sand grains in the cement paste, and do not represent the evidence of a chemical reaction within the limestone aggregate.

3) The lithology of the hill sand currently used in this area is generally similar to that of the sand contained in the deteriorated concrete structures. These sands largely consist of metamorphic quartz schist and phyllite grains, with minor amounts of potentially reactive volcanic rock, such as glassy rhyolite and glassy rhyolitic tuff. Possibly, reactive glassy rhyolite is contained more commonly in the deteriorated structures than in the sand currently used (Table - 9.1.2).

4) The hill sand currently produced and used in this area was found deleterious according to the CSA accelerated mortar bar test, while the conventional ASTM chemical test failed to detect its reactivity (Table - 9.1.3).

5) The crushed limestones tested as innocuous in the standard aggregate tests for the potential alkali-reactivity (Table - 9.1.3).

Table - 9.1.1 Petrographic examinations of concrete cores from deteriorated bridge

Bridge	Crushed Stone	Hill sand (causing deterioration)	
		Gravel (>10mm)	Sand (<5mm)
Hilal 2	Limestone	Calcareous chert (rare)	Glassy rhyolite (minor) Glassy rhyolitic tuff (rare)
	Sound	Alkali-silica reaction Crack, gel, reaction rim	Alkali-silica reaction Crack, gel reaction rim
Halkalpinar	Limestone	Glassy rhyolite (rare)	Glassy rhyolite (minor)
	Sound	Alkali-silica reaction Crack, gel	Alkali-silica reaction Reaction rim

Table - 9.1.2 Petrographic examinations of currently produced aggregates for identifying potentially deleterious rock types and minerals

Aggregate	Rock type	Potentially alkali-reactive rock
Crushed stone		
Coarse	Limeston	None
Medium	Limeston	None
Medium (white)	Limeston	None
Sand	Limeston	None
Hill sand		
Bulk	Quartz schist, phyllite, sandstone metarhyolite, psammitic schist glassy rhyolitic tuff, glassy rhyolite	Glassy rhyolitic tuff Glassy rhyolite
White	Glassy rhyolitic tuff, glassy rhyolite silicified rhyolitic tuff, limestone	All except for limestone

Table - 9.1.3 Results of the standard aggregate tests for evaluating potential alkali-reactivity of currently used aggregates

Test method	Crushed stone (limestone)			Hill sand
	Coarse	Medium	Sand	
1) Alkali-silica reactivity				
Chemical test (ASTM 289)	Innocuous	Innocuous	Innocuous	Innocuous
Accelerated mortar bar test (CSA A23.2-25A)	Innocuous	Innocuous	Innocuous	Deleterious*
2) Alkali-carbonate reactivity				
Chemical screening test (CSA A23.2-26A)	Non-expansive	Non-expansive	Non-expansive	

* Expnasion after 14days was 0.26%, beyond the limit (0.15%) of innocuousness

Result of the chemical test (ASTM C289)

Type	No.	Re: Reductions in alkalinity (mmol/l)		Se: Dissolved silica (mmol/l)	
		Result	Average	Result	Average
Crushed limestone (coarse)	1	9.5	7.7	1.4	1.2
	2	4.0		0.9	
	3	9.5		1.2	
Crushed limestone (medium)	1	14	11	1.4	1.1
	2	6.0		0.9	
	3	12		0.9	
Crushed limestone (sand)	1	8.0	10	1.4	1.3
	2	14		1.1	
	3	6.5		1.3	
Hill sand	1	69	64	44	44
	2	64		43	
	3	59		44	

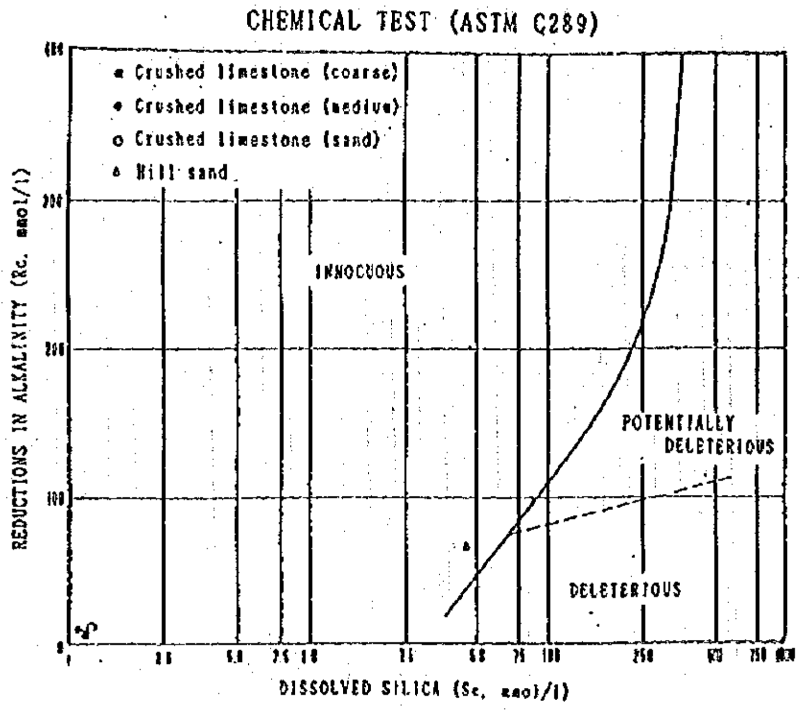


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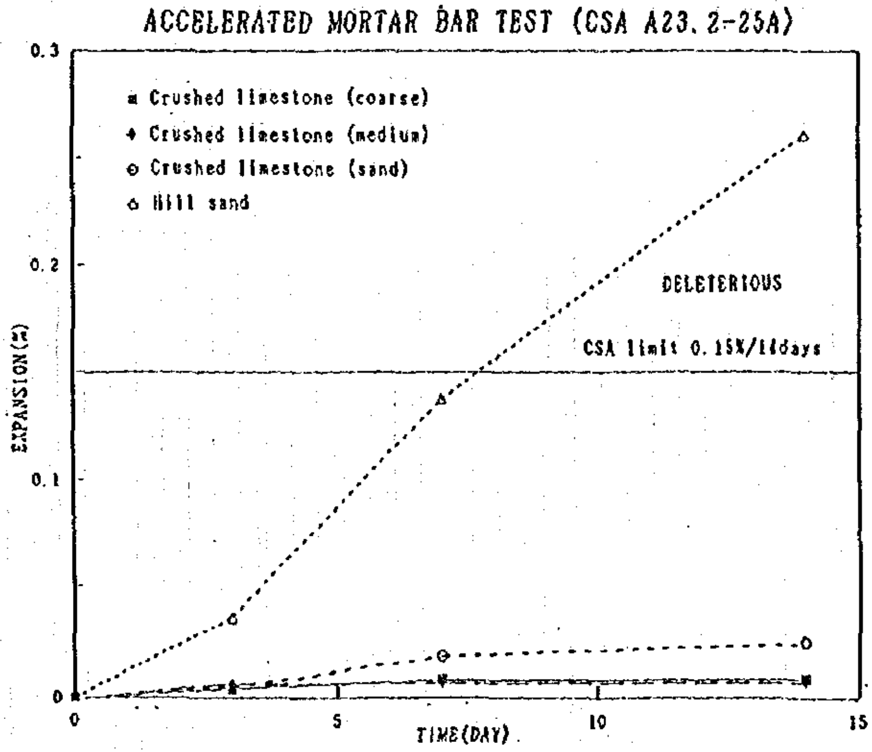
Figure - 9.1.1

Result of Chemical (ASTM C289)

Result of the accelerated mortar bar test (CSA A23.2-25A)

Type	No.	Expnasion (%)		
		3d	7d	14d
Crushed limestone (coarse)	1	0.004	0.008	0.008
	2	0.004	0.008	0.009
	Av.	0.004	0.008	0.008
Crushed limestone (medium)	1	0.008	0.008	0.008
	2	0.004	0.004	0.005
	Av.	0.006	0.006	0.006
Cr. 1s. (sand)		0.005	0.019	0.024
Hill sand	1	0.037	0.141	0.254
	2	0.034	0.135	0.268
	Av.	0.036	0.138	0.261



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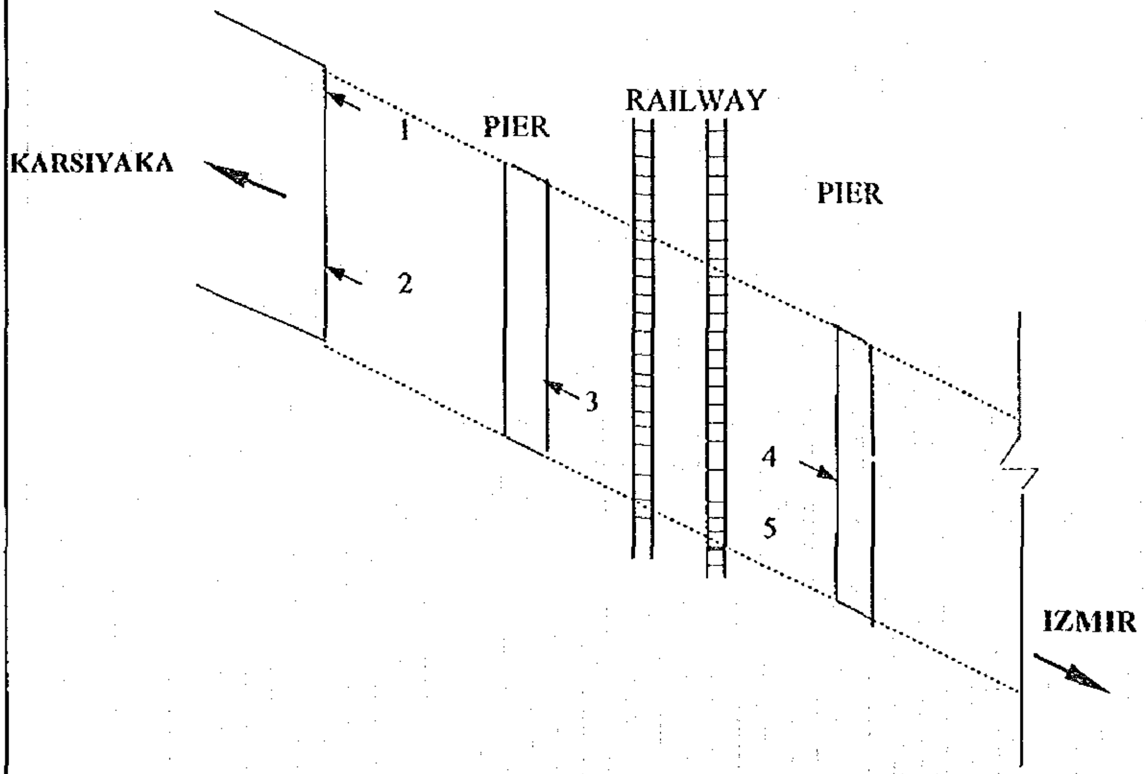

Key
(No) Concrete Core Location

THE STUDY ON THE MAINTENANCE AND REHABILITATION of HIGHWAY BRIDGES in THE REPUBLIC of TURKEY AUGUST, 1996 ORIENTAL CONSULTANTS COMPANY LIMITED in association with JAPAN OVERSEAS CONSULTANTS CONPANY LINTED	Figure - 9.1.4 Concrete Core Location at Naldoken Bridge (IZMIR)

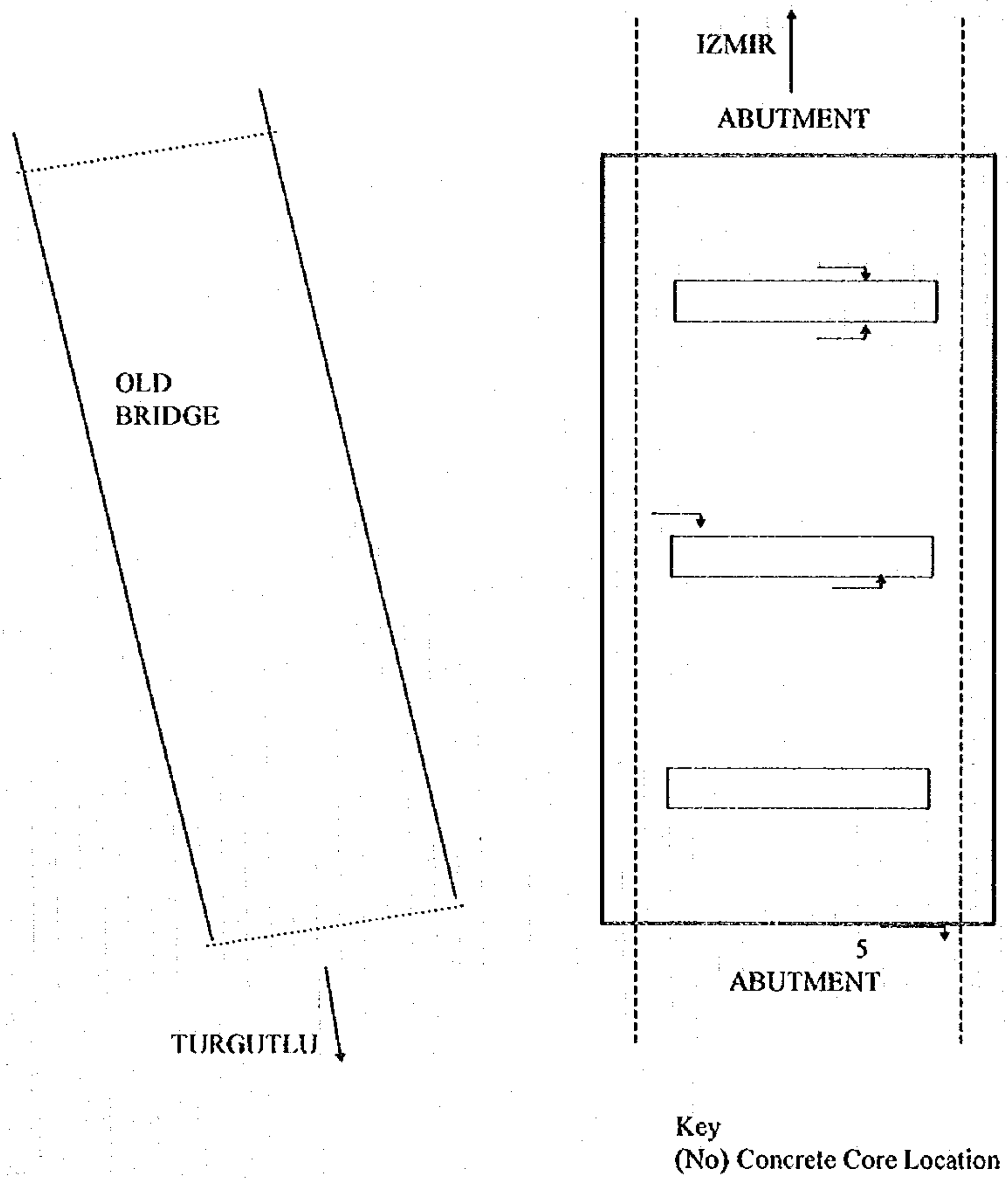

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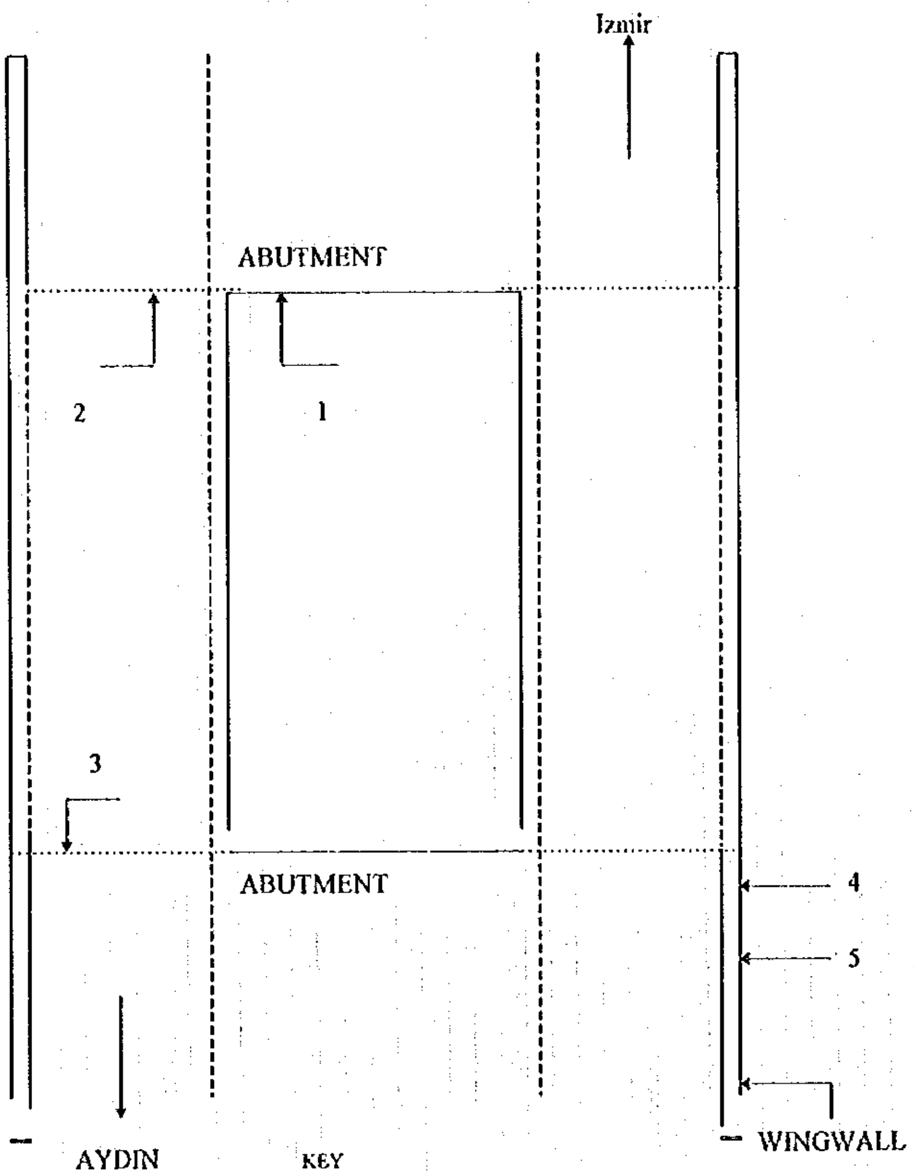
Figure - 9.1.5

Concrete Core Location at Turgutlu
(IRLAMAZ) Bridge

BUCA MOTORWAY BRIDGE



KEY

(NO)	CORE LOCATION
CORE 1	IZMIR ABUTMENT FACE
CORE 2	IZMIR ABUTMENT
CORE 3	AYDIN ABUTMENT
CORE 4	AYDIN WINGWALL
CORE 5	AYDIN WINGWALL

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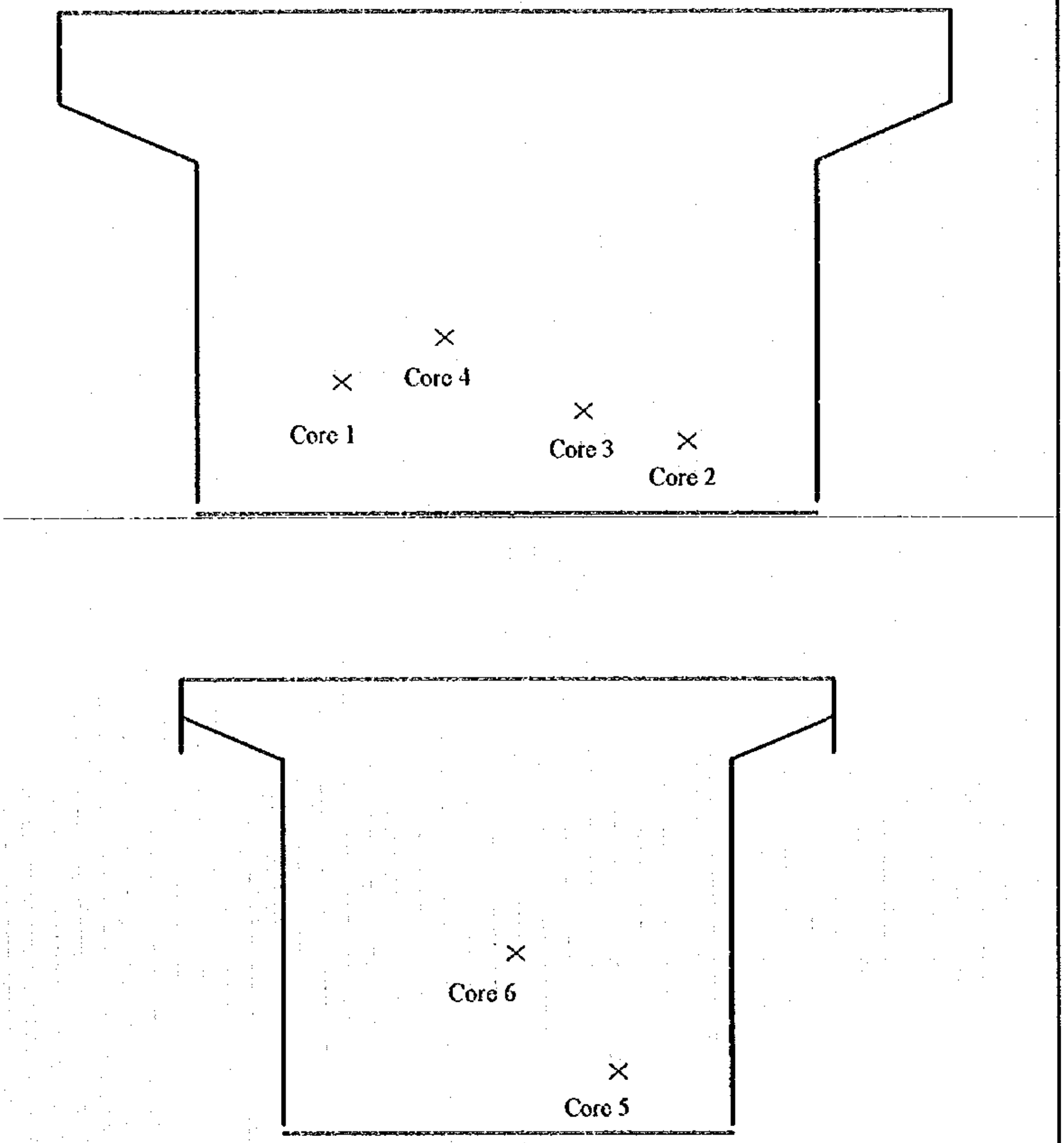
Figure - 9.1.6

Concrete Core Location at Buca Motorway Bridge

HILAL2 VIADUCT (IZMIR)



Pier 7 (Right) A way From Izmir Face

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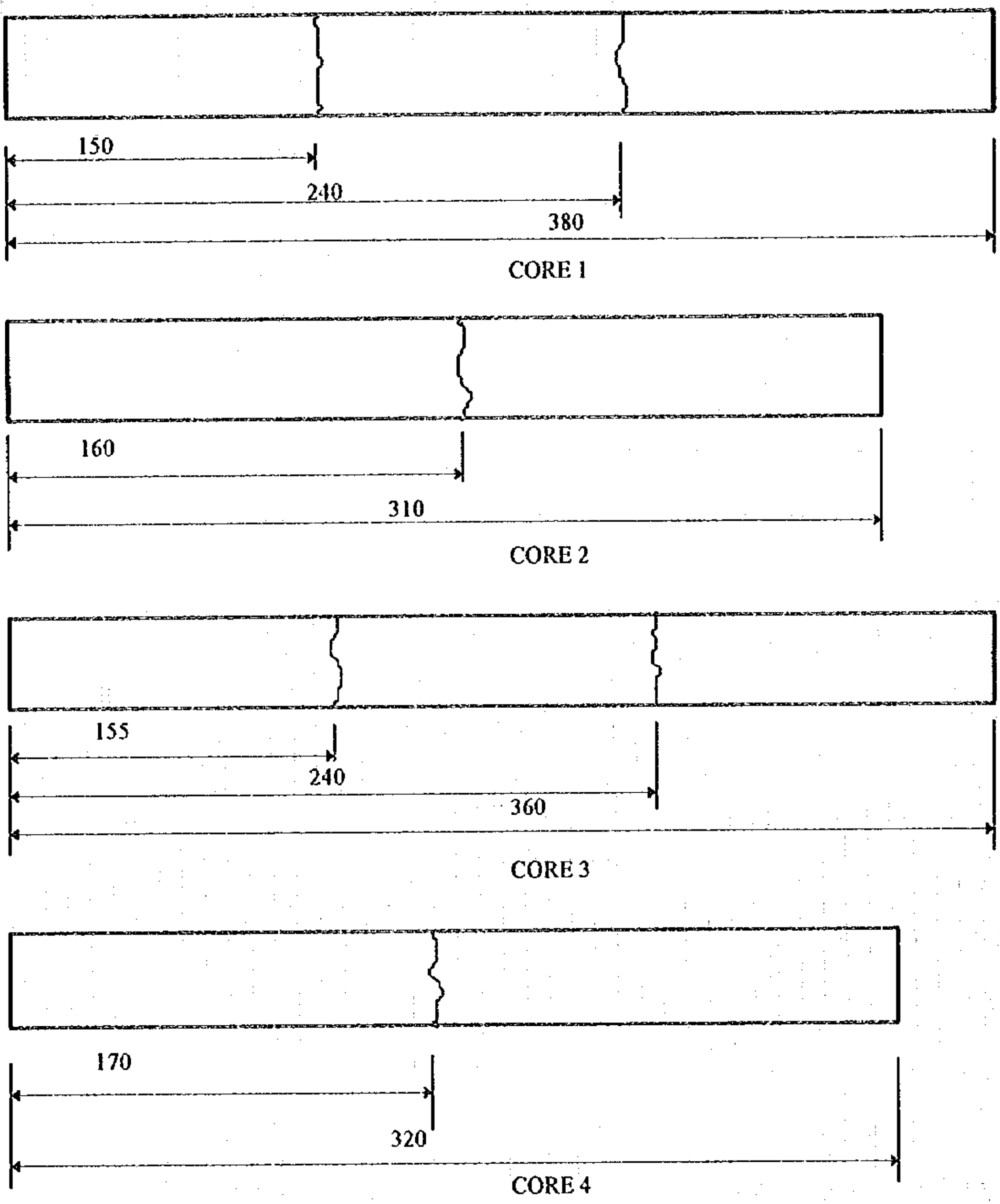

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Figure - 9.1.8 (a)

Concrete Cores from Naldoken Bridge

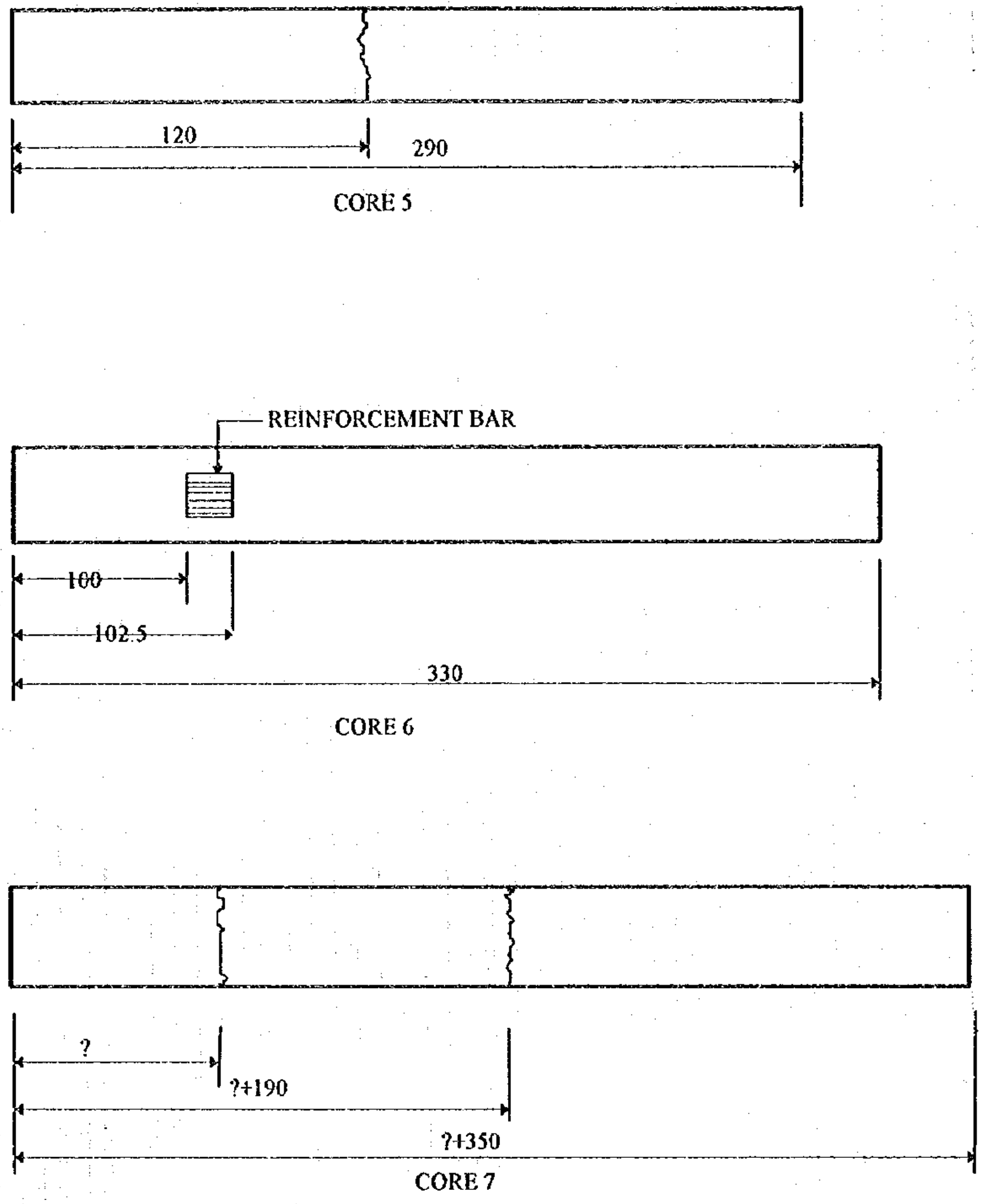

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Figure - 9.1.8 (b)

Concrete Cores from Naldoken Bridg

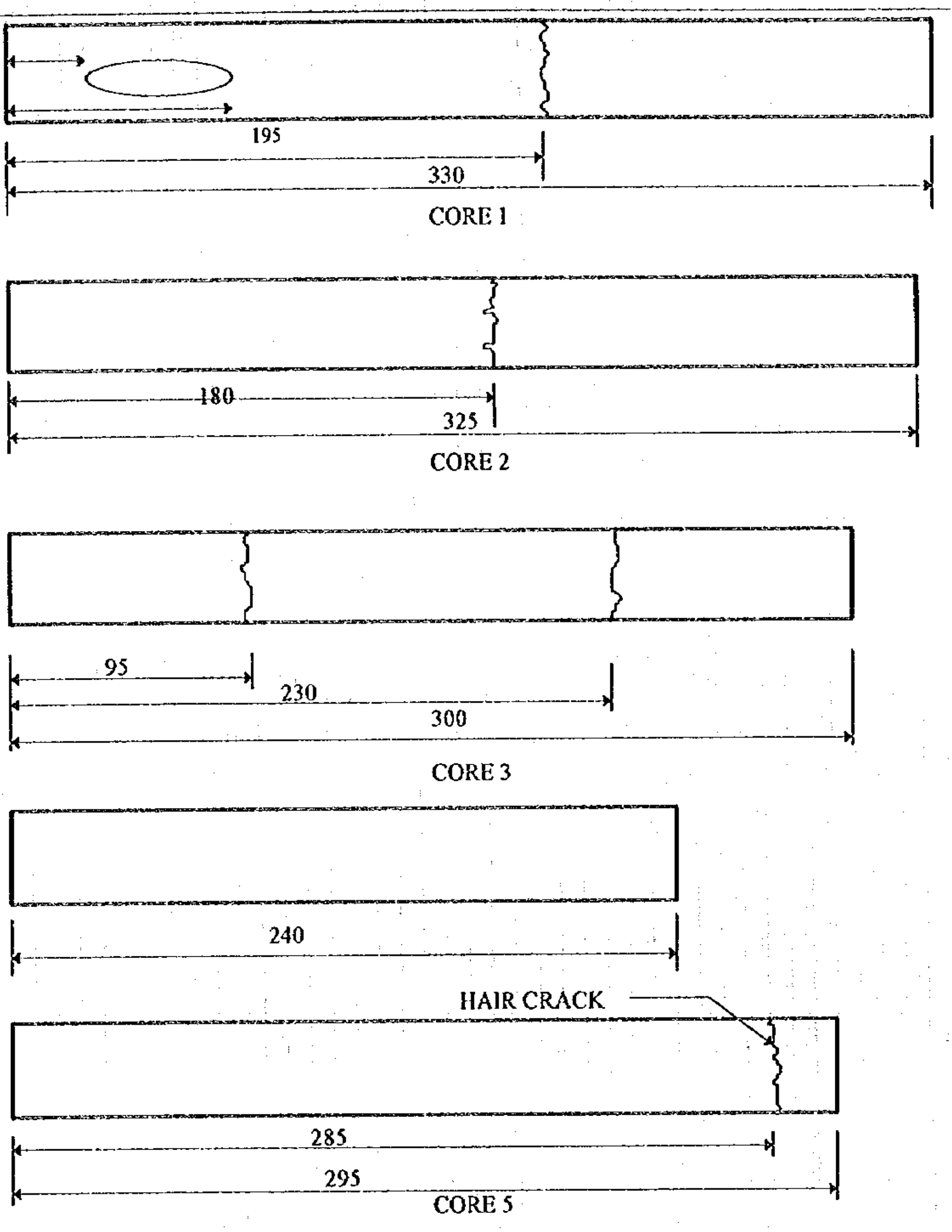

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Figure - 9.1.9

Concrete Cores From Turgutlu Bridge

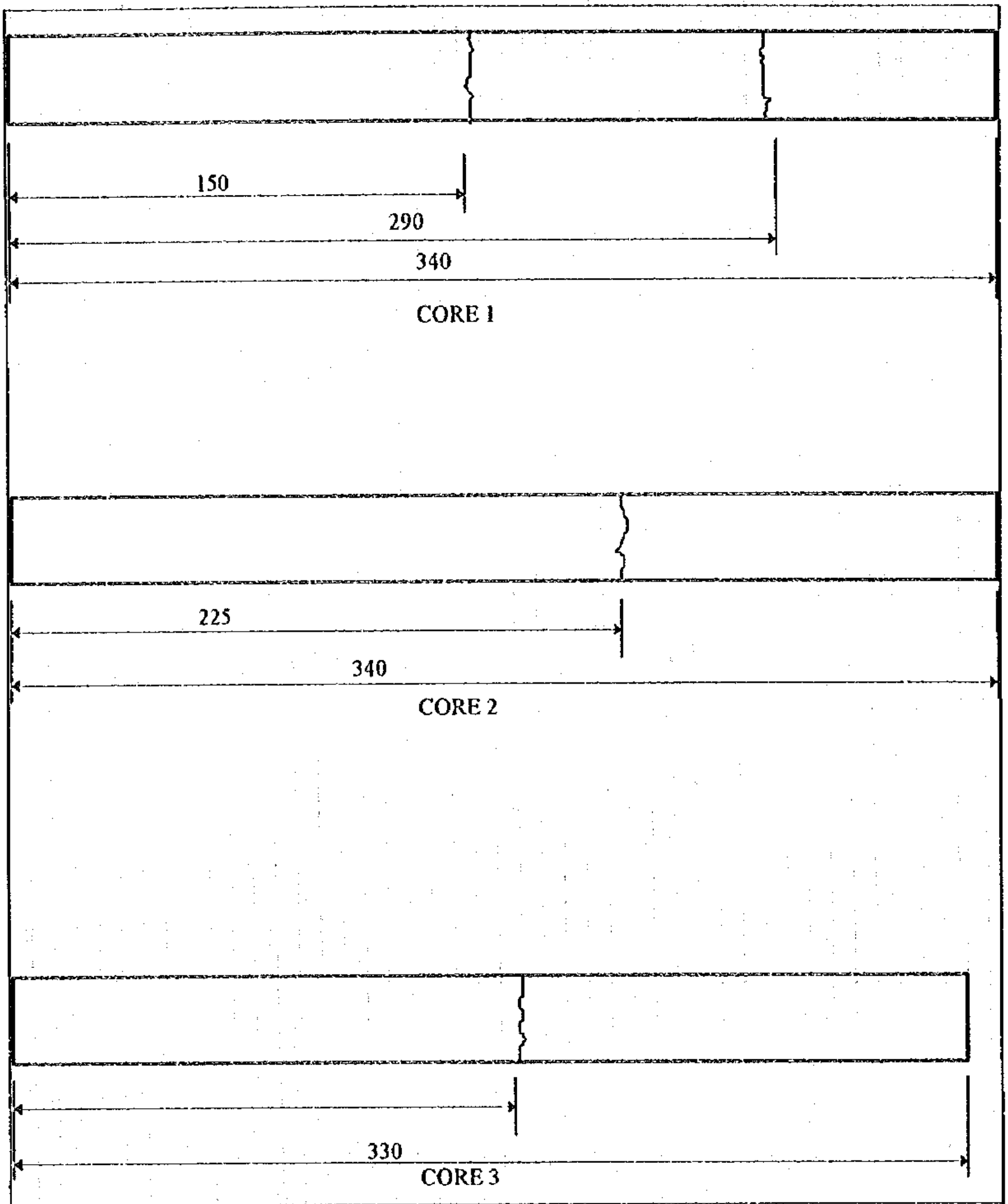

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Figure - 9.1.10 (a)

Concrete Cores from Buca Motorway Bridge

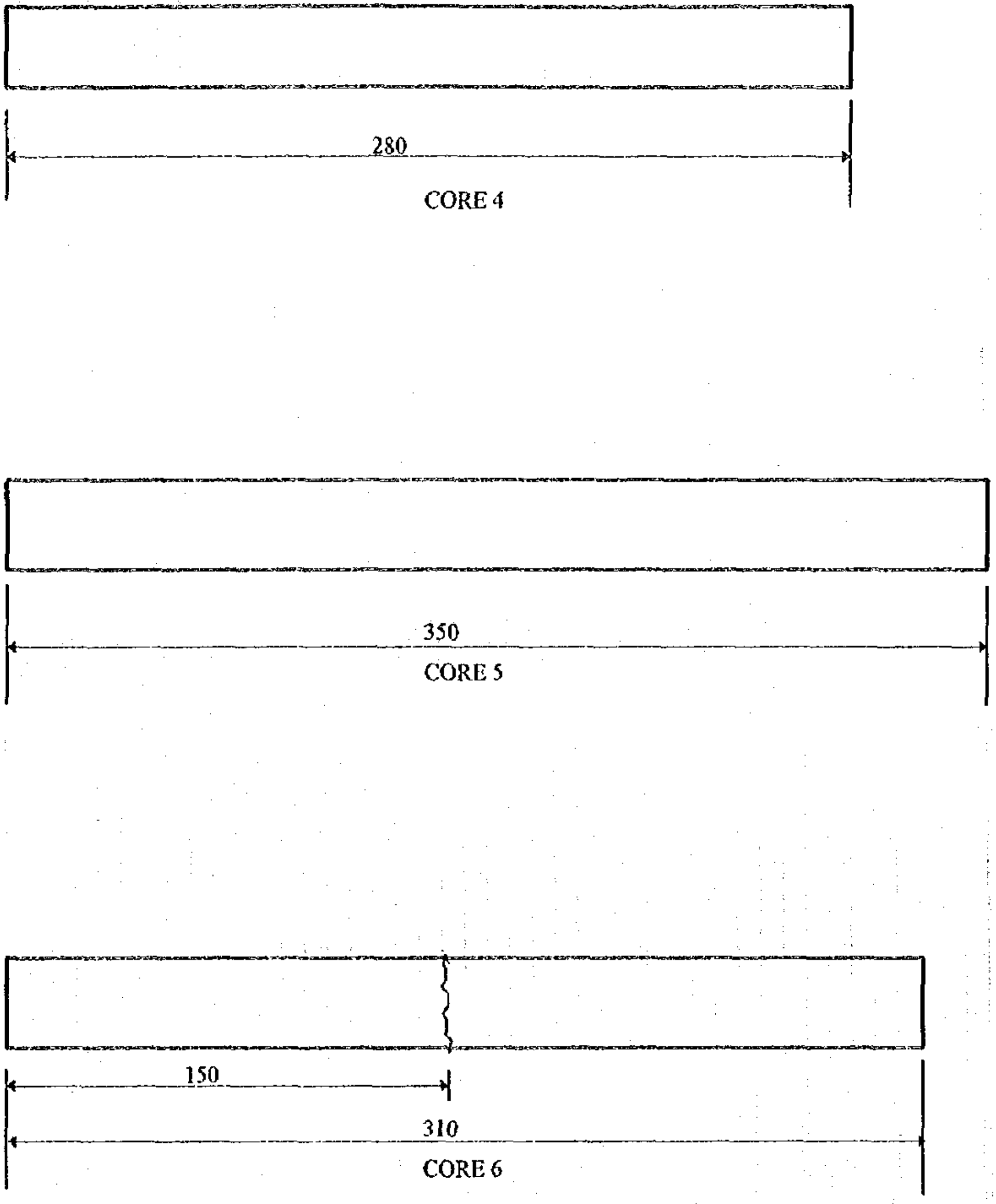

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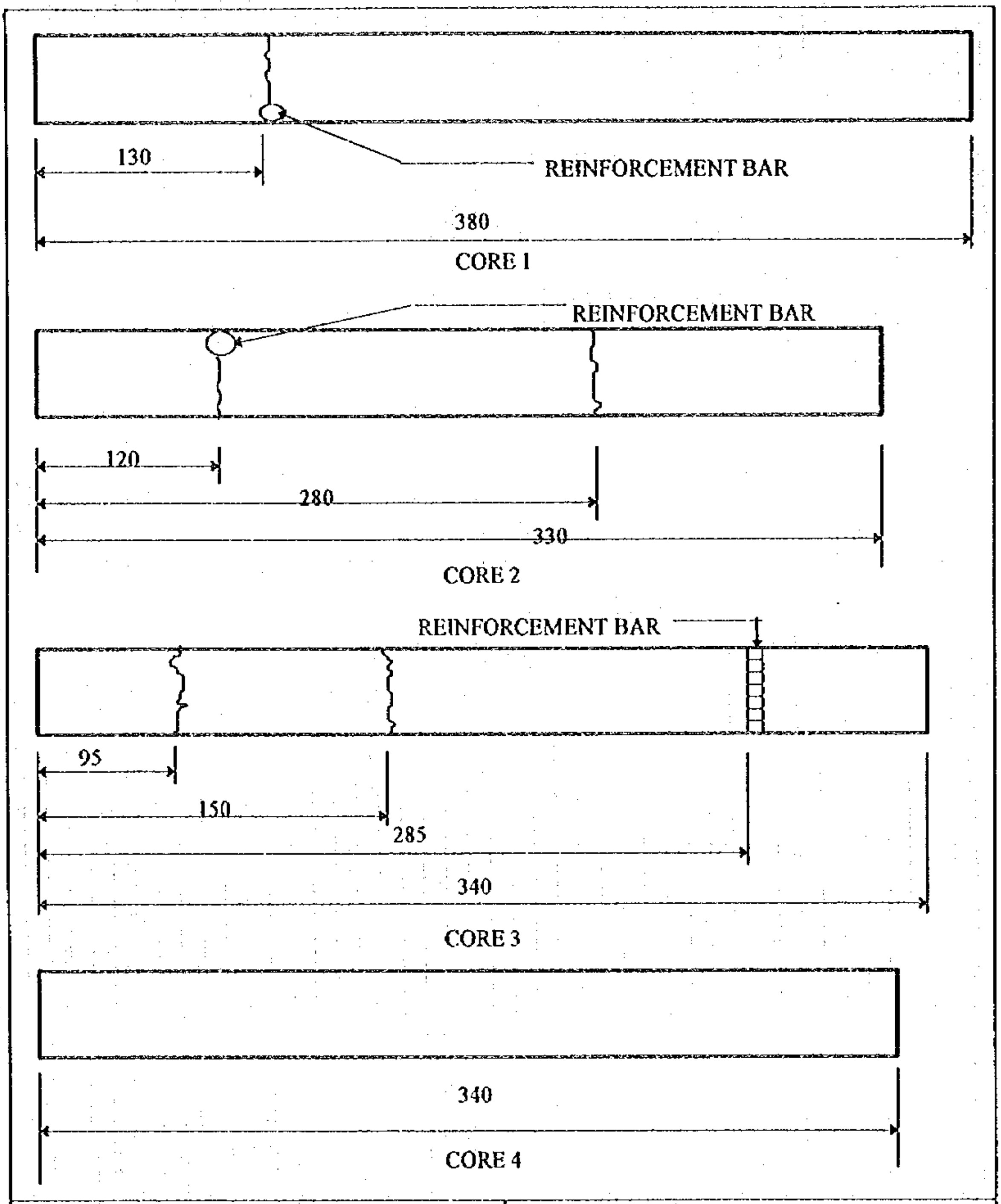
Figure - 9.1.10 (b)

Concrete Cores from Buca Motorway Bridge



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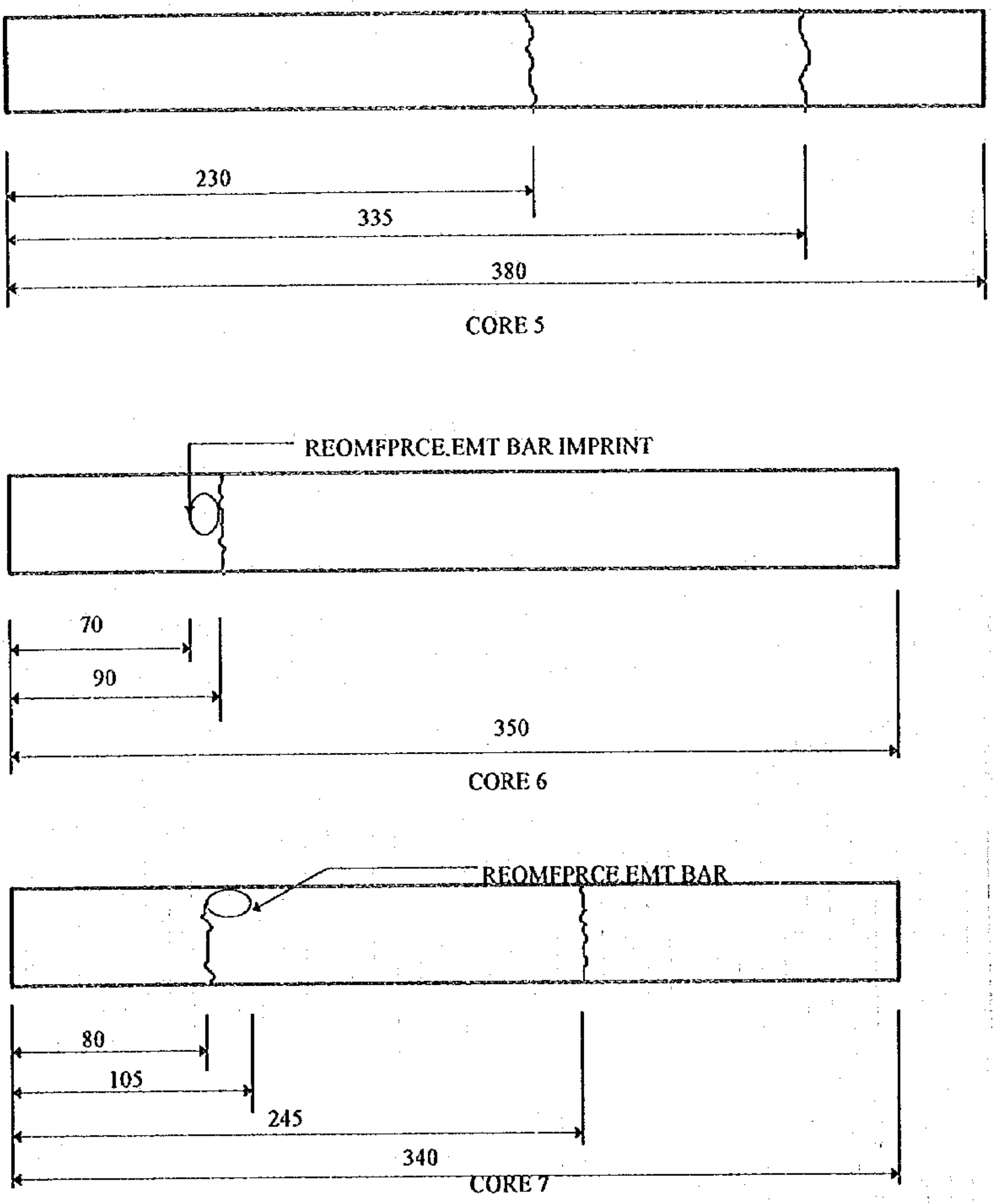

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Figure – 9.1.11 (b)

Concrete Cores from Hilal2 Bridge

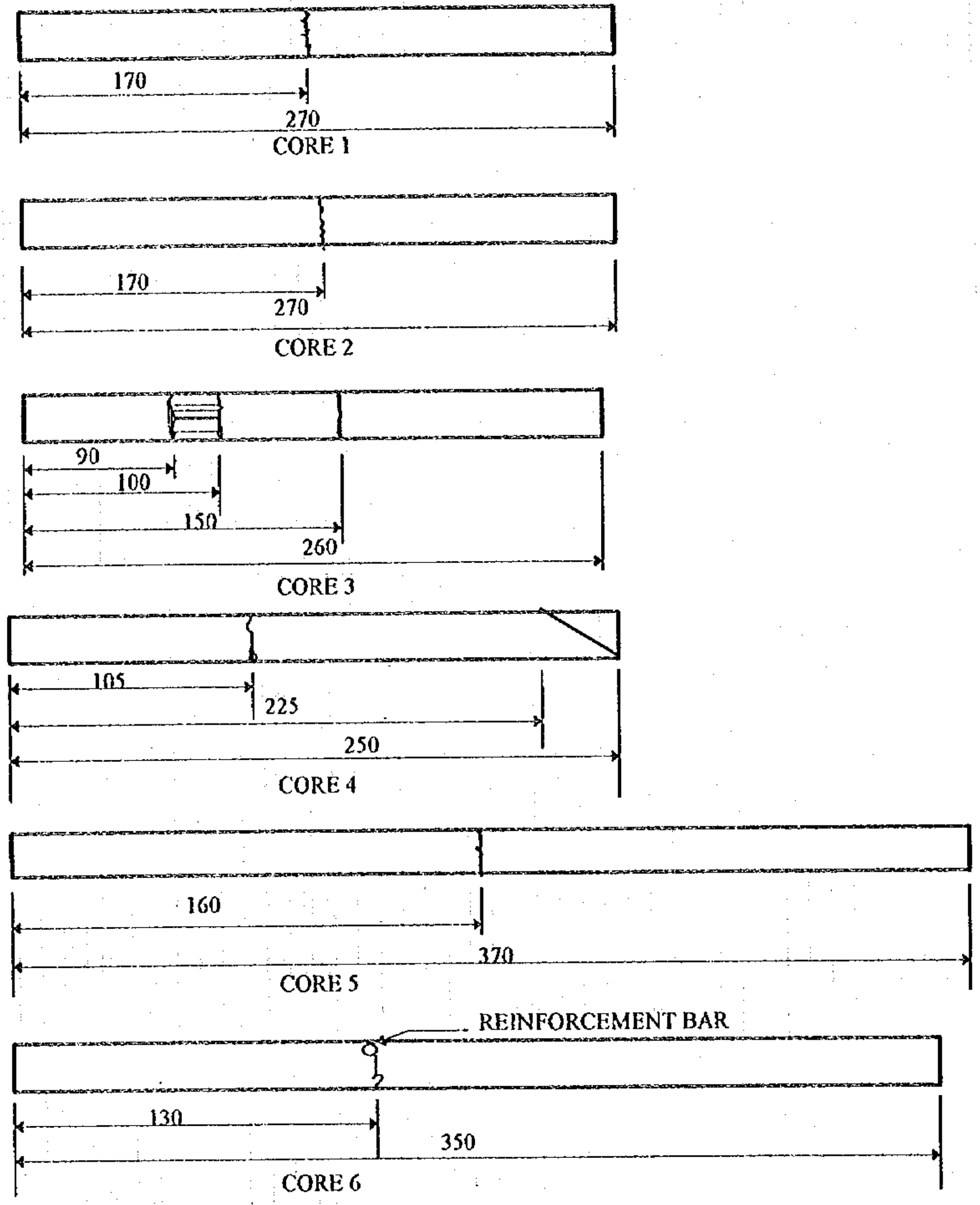

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Figure - 9.1.12

Concrete Cores from Turan Bridge

NALDOKEN BRIDGE IZMIR

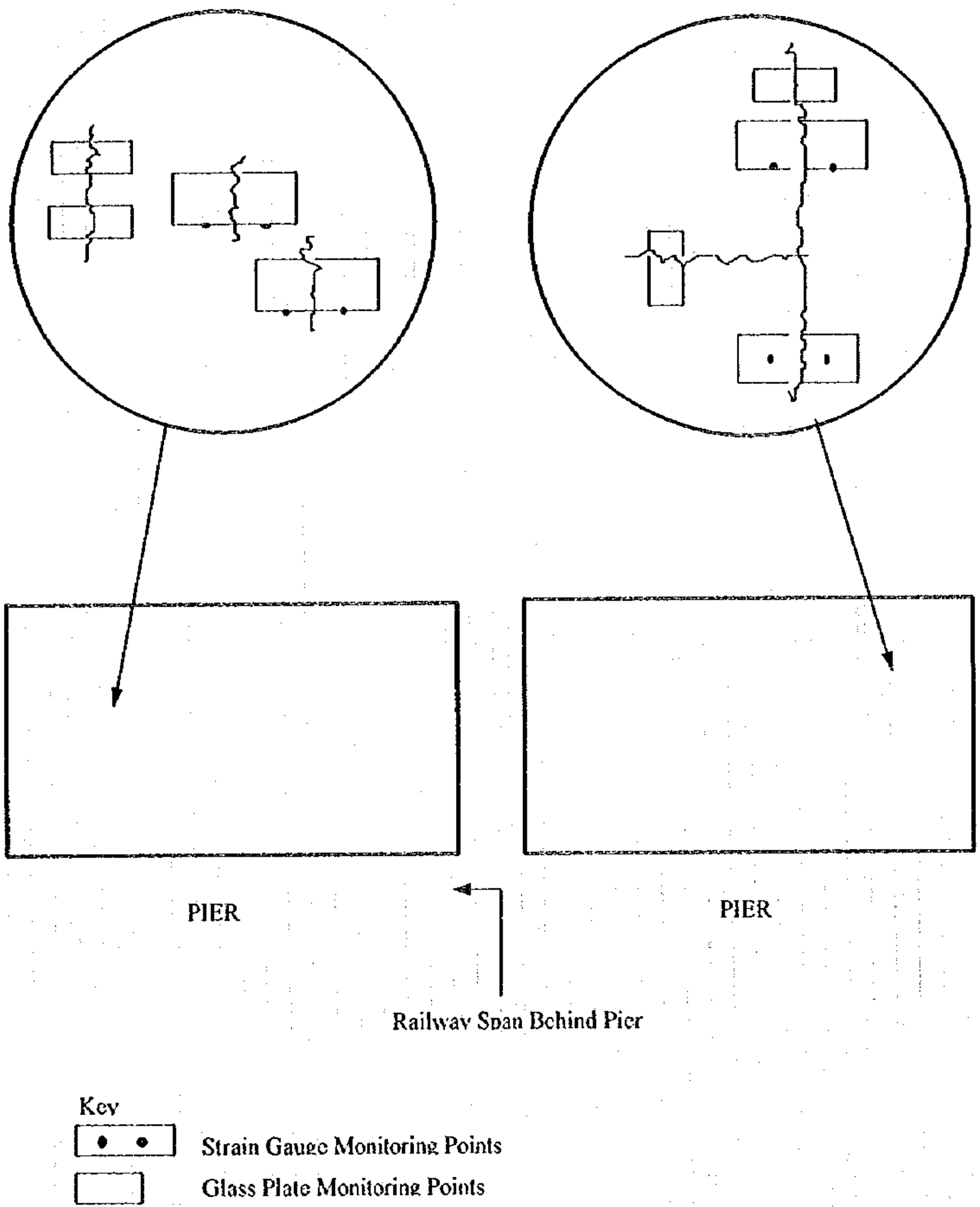

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Figure - 9.1.13

Location of Strain Gauge and Glass Plate Monitoring Points

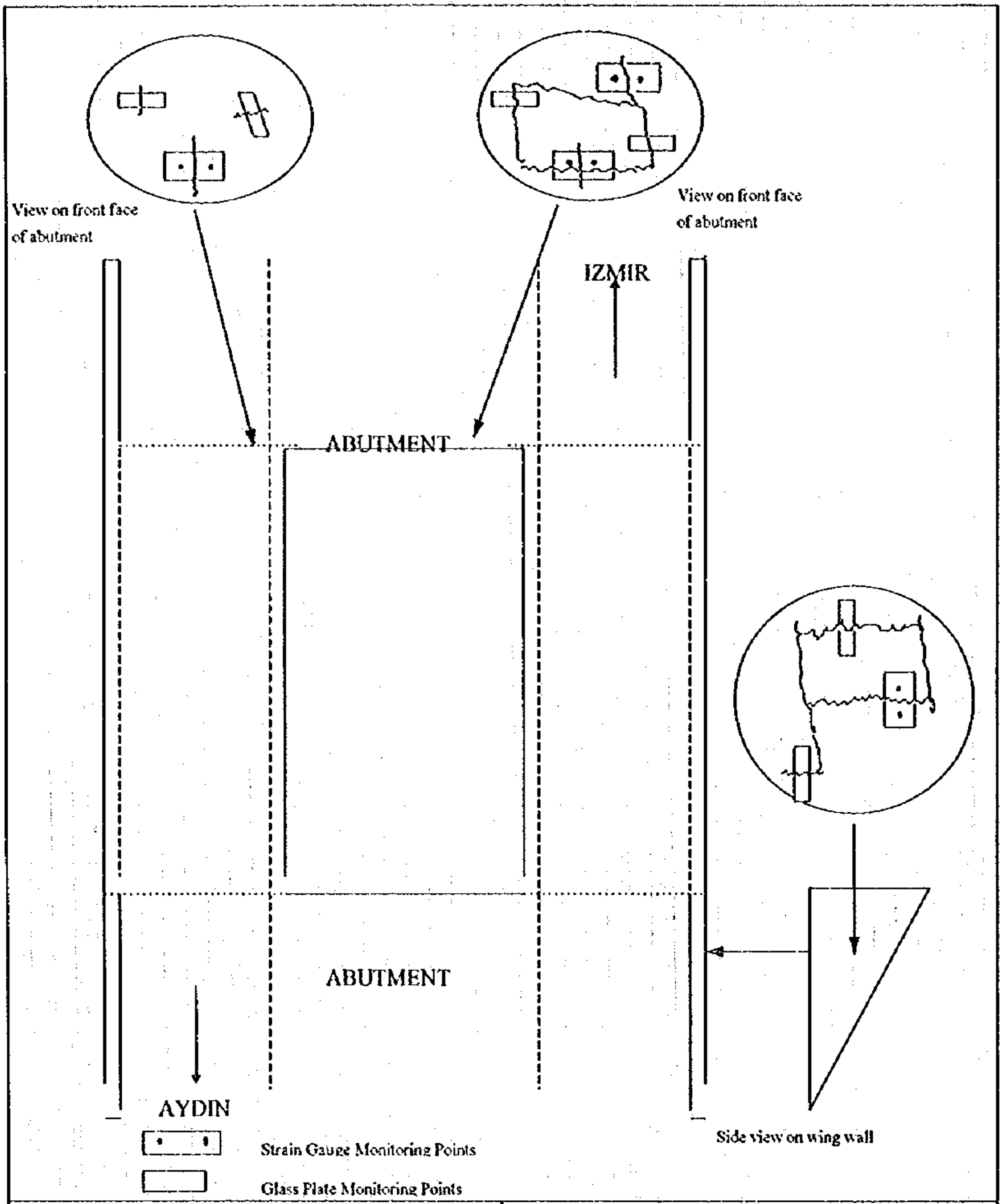

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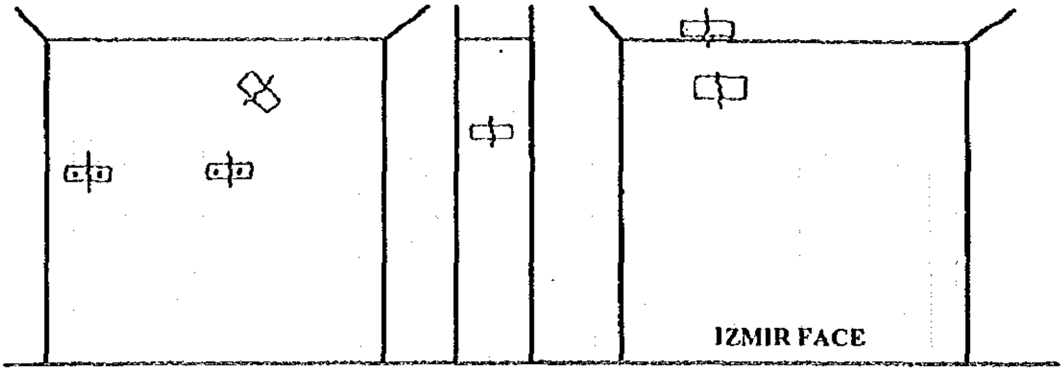
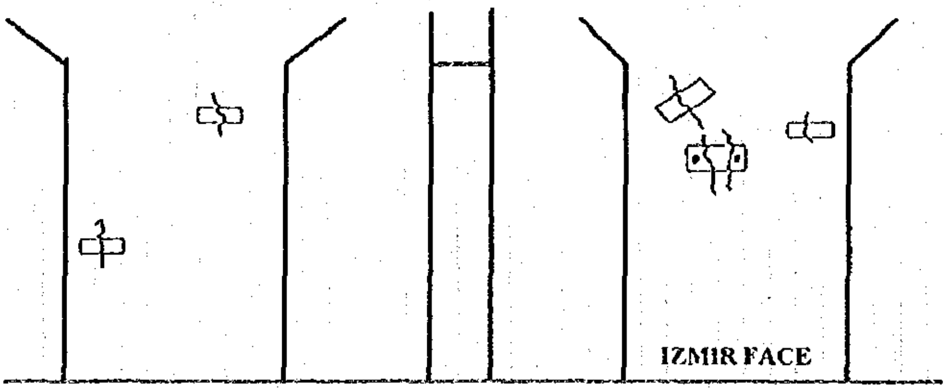
Figure - 9.1.14

Location of Strain Gauge and Glass Plate Monitoring Points



PIER 8 LEFT CARRIAGEWAY



PIER 7 RIGHT CARRIAGEWAY

Key
⊡ Strain Gauge Monitoring Points
▭ Glass Plate Monitoring Points

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Figure - 9.1.15

Location of Strain Gauge and Glass Plate
Monitoring Points

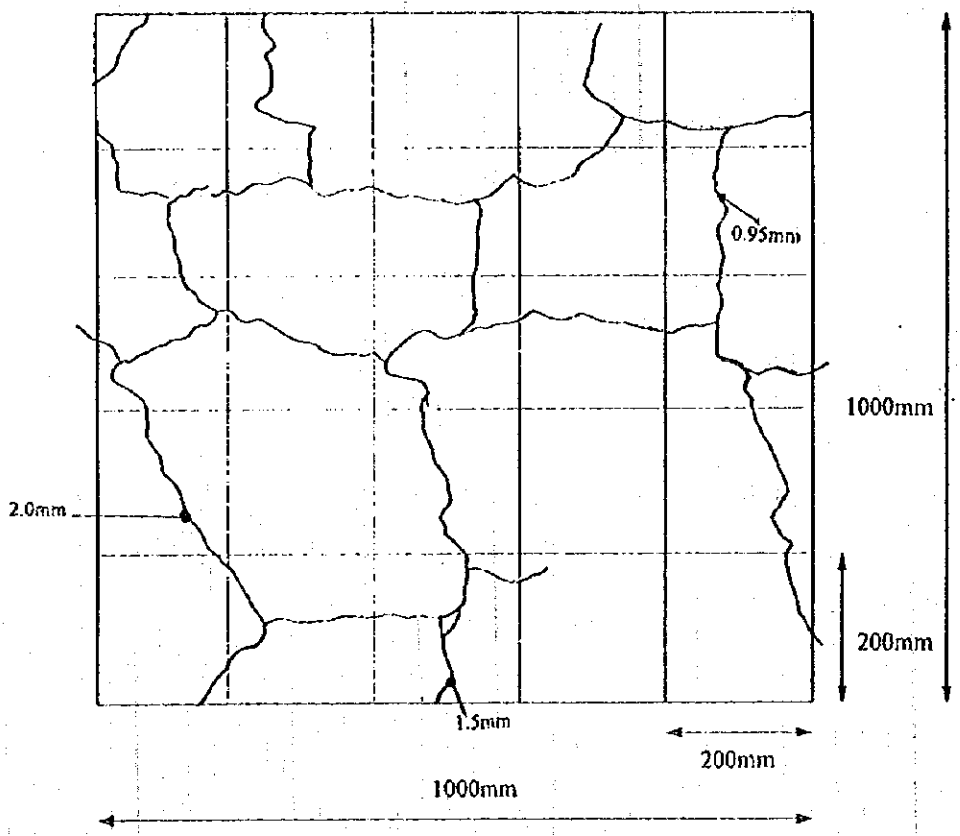

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Figure - 9.1.16

Existing Cracks on Abutment 1/
Kahramanlar Side

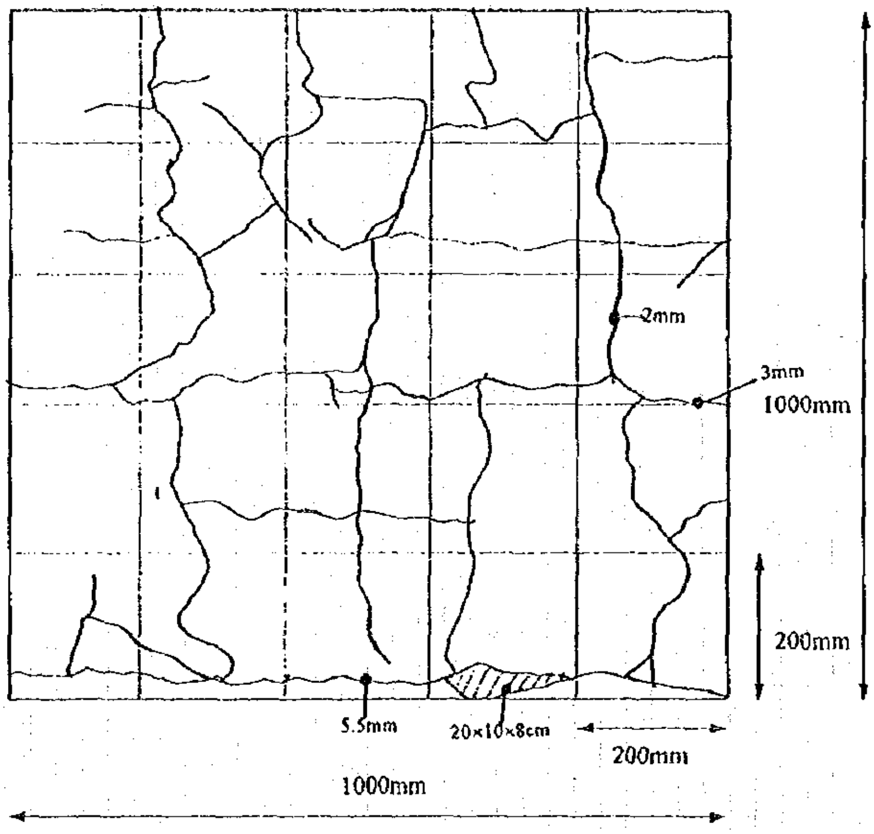

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Figure - 9.1.17

Existing Cracks on Pier I Crossbeam/
Yesildere Side

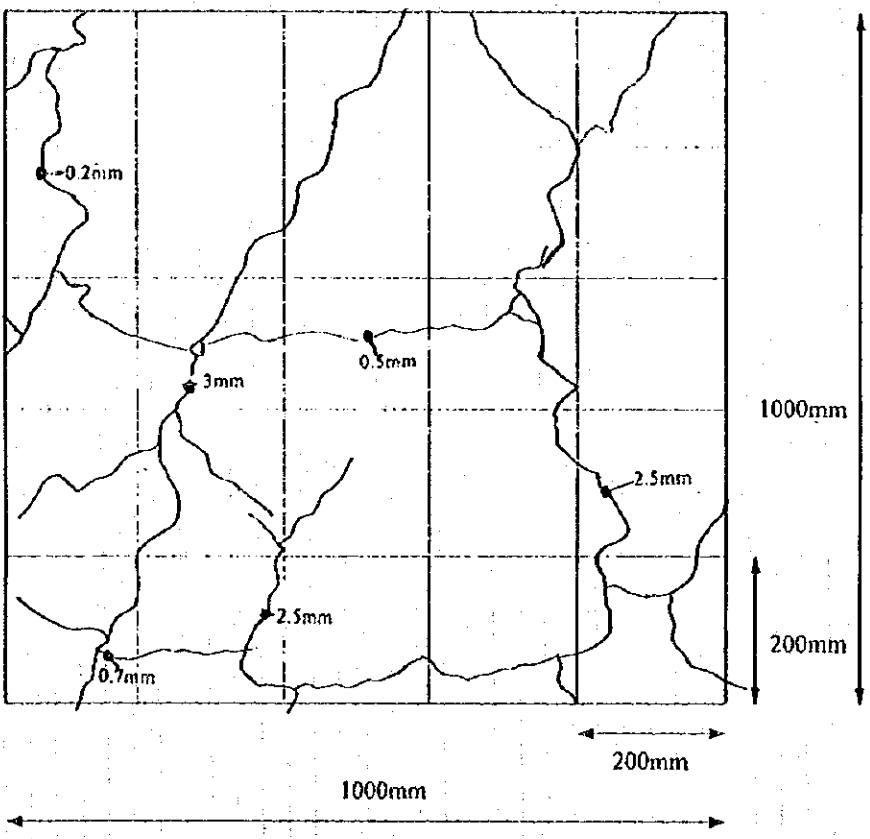

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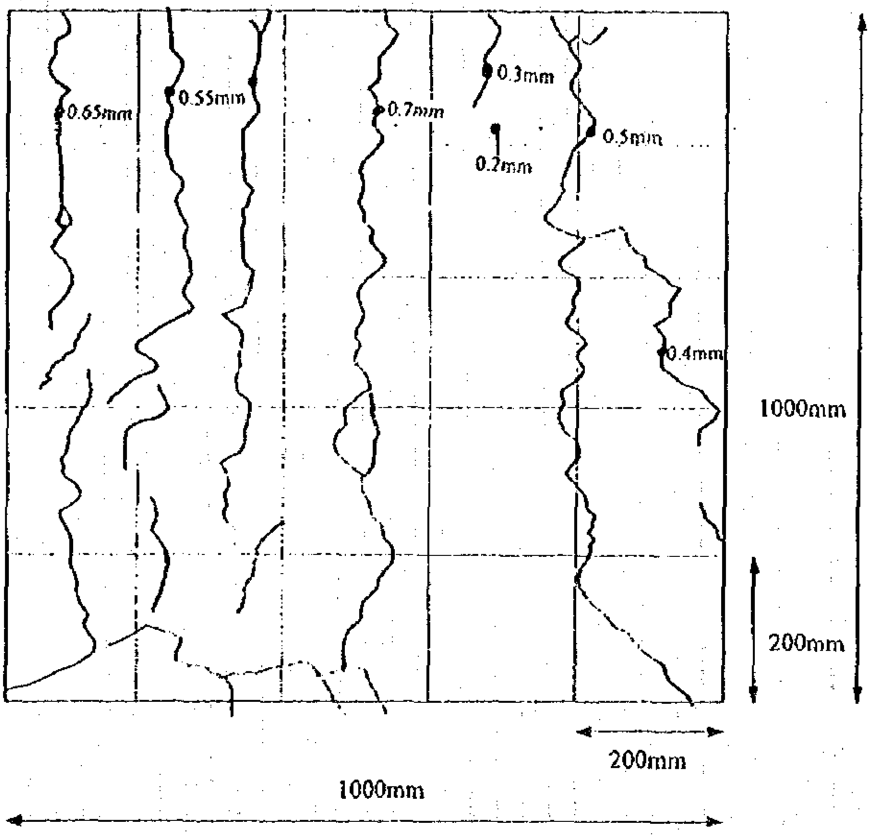
Figure - 9.1.18

Existing Cracks on Pier 6/Ankara Face



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