Organizing and Managing a Finance-Design-Build Project in Turkey: Fourth Roebling Lecture, 1995[a]

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Abstract: It has been estimated that an expenditure of $200 billion per year must be made on the world's infrastructure for the foreseeable future. This will lead to many opportunities for U.S. contractors to work internationally. Much of the work is located in emerging countries that do not have the money available to finance the projects that they need. The subject of this lecture is the Izmir-Aydin Project in Turkey, which began as a fixed-price, finance, design-build job. The project is very interesting, and shows the many problems that may be faced during the execution of an international contract, including lack of payment, ignoring contract provisions, changes in government, and politics in general.

INTRODUCTION

First, I would like to thank the Construction Division of the American Society of Civil Engineers for selecting me as the 1995 Roebling Award recipient. It is a great honor for me to be thought of in the company of the earlier recipients, George Fox, Martin Kelly, and Joe B. McNabb.

I could not have achieved this recognition without a great deal of guidance and help from a large number of people at two fine engineering and construction companies, Guy F. Atkinson and Dillingham. I spent 30 years working for Atkinson, where I was mentored by George Atkinson, Bob Kerr, Joe McNabb, and many others. My last 14 years have been spent with Dillingham, where I received help from Joe Casey, Jim Perry, John Jacobs, Mike MacGregor, Don Sundgren, and Bill Wilson, to name a few. My thanks to these people and the many others who have worked with me over the years for making it possible for me to receive this award.

During my career with Atkinson, I had the opportunity to work on a number of major projects such as The Dalles Dam on the Columbia River; Ice Harbor and Lower Granite dams on the Snake River in Washington; Trinity and New Melones dams in California; Mica, Seven Mile, and Peace Site 1 dams in British Columbia; Mangla Dam in Pakistan; Sabana Yegua Dam in the Dominican Republic; Colbun Dam in Chile; Turimaquiri and Guri dams in Venezuela; and the Ramon Airbase project in Israel.

Some of the more notable projects I have been associated with since joining Dillingham are the Izmir Ring Road–Aydin Motorway in Turkey; Cerrillos Dam in Puerto Rico; Peace Vector IV, Military Air Base, Egypt; Masirah Island Military Air Base, Oman; 180 MW AES Cogeneration Plant, Hawaii; Tarbela Hydropower Plant, Pakistan; Balsam Meadow Underground Hydropower Plant in California; and the Route H-3, Halawa Tunnels in Hawaii.

Given my past experience, you might expect me to choose a topic associated with dam construction for my paper. However, I would like to talk about the Izmir Ring Road–Aydin Motorway Project in Turkey. Road construction, even of the magnitude of the Izmir-Aydin Project, does not present the engineering challenges faced by the Roeblings in the construction of the Brooklyn Bridge. However, I believe you may find some similarities in the political challenges encountered on both projects.

BACKGROUND

It has been estimated that an expenditure of $200 billion per year must be made on the world's infrastructure for the foreseeable future. Much of this work is located in emerging countries that do not have the money available to finance the projects that they need. The Izmir-Aydin Project is interesting in that it began as a fixed-price, finance, design-build job. I believe that we will see more of this system of project contracting as we move forward to the year 2000.

In 1984, Turkey, under Prime Minister Turget Ozal, embarked on a bold program to greatly improve its main highway systems. This program involved a number of projects, with its primary focus on providing a modern motorway built to international standards connecting Istanbul with the capital, Ankara, and a secondary focus of providing ring roads around Ankara and Izmir. Izmir is the third most populous city in Turkey. The motorways are planned to be toll roads. The ring roads, which are designed to relieve heavy traffic congestion, would be free of tolls.

The initial contracts were for a second crossing of the Bosporus and the associated access roads. These projects were open to international bidding. After the successful bidders were chosen, the contracts awarded, and construction begun, the Ministry of Public Works–General Directorate of State Highways (KGM) did an unusual thing. Rather than seek additional competitive bids, they used the unit prices they received from the initial Bosporus bids to establish fixed-unit prices for the remainder of the planned motorway system. Turkish contractors were encouraged to find foreign partners who would be able to arrange financing and would accept the previously established fixed-unit prices. These joint ventures were then awarded separate sections of the planned motorways to construct.

In 1986, Dillingham had performed a small project in Turkey for the U.S. government. In doing this, a relationship was formed with a Turkish contractor, Kutlutas Insaat VE Ticaret Sanayi Ltd. Sti. (Kutlutas). In due course, Kutlutas advised Dillingham of the potential of obtaining the Izmir-Aydin Project and asked if we would be interested in forming a joint venture. It was made clear that arranging the financing would be the responsibility of Dillingham. We were given a limited set of the plans, specifications, and anticipated quantities with their respective fixed-unit prices. With this information, Dillingham prepared an estimate of the cost of construction and determined that the work could be performed within the fixed-unit prices, with a reasonable margin for profit and contingency. After establishing that the project was feasible from a financial standpoint, Dillingham agreed to form a joint venture

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with Kutlutas (calling the joint venture KDJV) and proceeded to pursue financing.

The first step in the search for financing was to select a financial advisor. Dillingham's treasurer and chief financial officer met with several international banks and ultimately selected Chase Manhattan Bank to act as KDJV's consultant. The total value of the project, based on the quantities provided by KGM, was approximately $296,000,000. This was to complete 54 km (33.6 mi) of three-lane ring road and 94 km (57.8 mi) of two-lane motorway, both with a maximum grade of 6%. The most favorable option for obtaining financing was through the use of export credits. In order to determine the amount of export credit that could be used, it was necessary to establish an equipment and material list that could be purchased outside Turkey. It was estimated that the project could use a total of $125 million of export credits from the U.S. and Japan, including construction equipment, services of a U.S. design firm, and Dillingham's expatriate staff. Based on this, Chase was able to provide a financing proposal that included both export credits and commercial credits. The proposal was submitted to the Turkish government. The commercial credits were provided by the participating banks in amounts equal to the export credits. After several months of negotiations, KDJV was given a mandate to proceed with arranging the financing. With the assistance of the anticipated major equipment suppliers, the credit was syndicated with $100,000,000 of U.S. EXIM credit and $25,000,000 of Japanese export credit. The remainder was commercial credit. Fees paid by the KDJV associated with obtaining the credit amounted to about 2% of the total.

From the time that loan documents were executed in London until KDJV was able to make the first draw under the U.S. EXIM credit was 9 months. Stamp duty on the loan of 0.5% ($1,500,000) was payable to Turkey. Several permits had to be obtained, but six months after KDJV had been awarded the project, we finally received the 20% advance payment provided for in contract conditions and began serious mobilization.

Obviously, construction could not begin until KDJV had some final approved design drawings. As soon as the contract has been awarded, KDJV set in motion the process to select the designer for the project. Payment for design had been established as a provisional sum in the contract, and the client required that KDJV take three proposals from potential design firms. DeLeuw Cather, in joint venture with a local Turkish engineering firm, was ultimately chosen as the design engineer (referred to as DCK) at a cost of approximately 4% of the initial estimated value of the work. Shortly after the design contract had been awarded, KGM appointed a control engineer, Erer, Mayreder, Geoconsult (EMG), to oversee the construction and to review and approve the design drawings before passing them onto KGM for final approval. This complicated the progress of the design because we now had a third party who had their own ideas regarding design. This can be a problem with the design-build method of construction. Too many people with the authority to revise the design slow the approval process.

Design had hardly begun when KGM changed the scope and criteria. The motorway section was widened to three lanes each way, and the maximum grade was dropped from 6% to 4.5%. The effect of this change was to greatly increase the excavation and embankment quantities and to increase the lengths of the anticipated tunnels. KGM was not inclined to view this as a change in scope for DCK. KGM generally held the view that they had purchased a design for the entire road regardless of whether or not it was shown on the preliminary plans or indicated in the specifications. This included additional interchanges, bridges, and roads from the new motorway linking it to existing major arteries.

Change orders for the design effort were not forthcoming from KGM, which ultimately led to KDJV negotiating an additional payment to the design engineer from their own resources in order to complete the design drawings. A claim for this extra work is still pending resolution with KGM. While both KDJV and the design engineer thought they had a clear understanding of the scope of the design spelled out in their contracts, in hindsight this is an area that needed a much more detailed definition of the anticipated design effort. In this type of contract, it is absolutely necessary for all parties to fully understand what is expected from the design engineer. The design costs are now more than double the initial contracted amount.

The joint venture agreement provided that each party had 50% and that Kutlutas would be the leader. A board of representatives and an executive committee were established to manage the project, with one member from each company, plus an alternate, assigned to each committee. The board of representatives was to determine policy, and the executive committee was charged with executing the policy. Initially, board meetings were held every other month, with executive committee meetings held monthly. Meetings generally lasted two to three days. Under the terms of the joint venture agreement, the leader was to nominate the project manager and Dillingham was to nominate the deputy project manager and the field operations manager.

It was agreed that the main office of the joint venture was to be in Izmir, and this was where the project manager was to be located. However, it was decided that the joint venture must have an office in the capital, Ankara, to liaison with the client as well as with other important government offices. The project management and design teams jointly leased a building in Izmir and staffing the project began. Equipment requirements were determined and quotations were obtained from suppliers. It was necessary to select equipment to use the entire amount of the Japanese EXIM credits since they would not be available to cover U.S. expatriate costs. The cost of the equipment, shown in Appendix I, was approximately $75,000,000.

THE PROJECT

In setting up to manage the field operations, KDJV decided to divide the project into three areas because of the length of the motorway. Neither ready-mix concrete nor crushed aggregate was available, so it was necessary to locate quarry sites containing the quality of rock that would meet the specifications for asphaltic concrete. The locations of the quarries dictated the locations of the site offices, camps, repair facilities, concrete batch plants, asphalt plants, etc., because of the haul distance involved. The largest facility was established at Buca, which would service the entire ring road and a short section of the motorway. This location housed the main repair shop and warehouse. It was planned that all major repair would be handled in this shop, with only minor repairs and routine maintenance being done at satellite facilities at the other locations (see Fig. 1).

Constructing a three-lane, divided freeway does not involve any technical problems that have not been solved before, but when the project is done on a finance-design-construct basis and involved two long tunnels, a village that cannot be relocated, and very large quantities of materials, the contractor is faced with real challenges. This is particularly true because, since up until 1980, most road construction in Turkey was done by government forces. The quantities involved are much greater than all but the largest dam projects (see Table 1).

The basic design of the road specified three lanes, 3.75 m (12.3 ft) in width each way, with a 3 m (9.8 ft) wide right shoulder and a 1 m (3.3 ft) wide left shoulder. The total pavement thickness of 75 cm (30 in.) consists of 28 cm (11 in.) of

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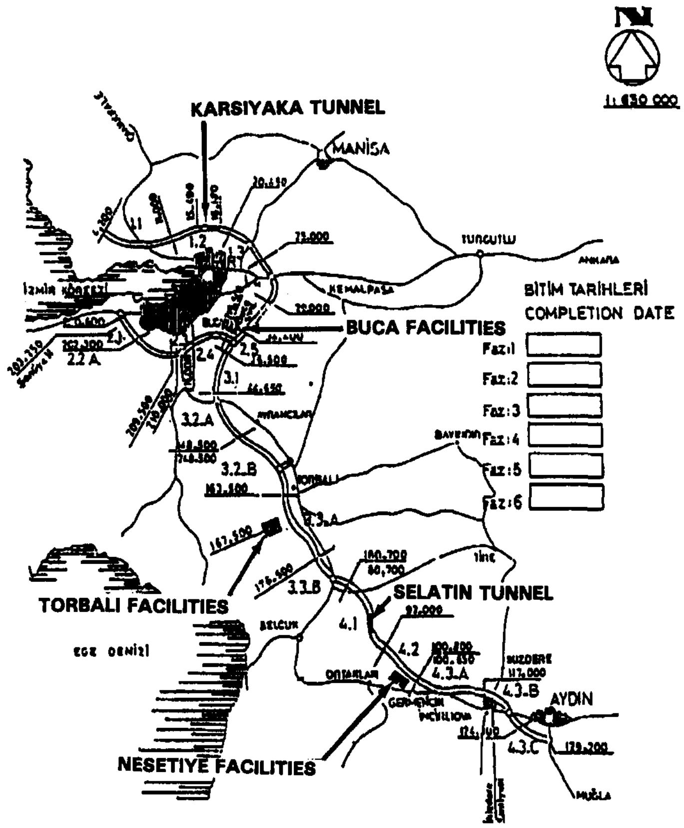

FIG. 1. Izmir-Aydin Motorway, Turkey

TABLE 1. Summary of Major Work Items

Major work item (1)	Quantity (2)	Unit of measure (3)
Excavation (excludes tunnels)	68,580,000	Cubic meters
	89,700,000	Cubic yards
Fill	56,090,000	Cubic meters
	73,366,000	Cubic yards
Piles	140,000	Vertical meters
	460,000	Linear feet
Reinforcement	90,000	Metric tonnes
	99,000	Short tons
Tieback (rock) anchors	75,000	Linear meters
	246,000	Linear feet
Concrete (all types)	1,100,000	Cubic meters
	1,439,000	Cubic yards
Culverts and drains	300,000	Linear meters
	984,300	Linear feet
Paving:		
Asphalt-Base	1,370,000	Metric tonnes
Asphalt-Binder	910,000	Metric tonnes
Asphalt-Wear	740,000	Metric tonnes
[Total asphalt]	3,020,000	Metric tonnes
[Total asphalt]	3,322,000	Short tons
Cement treated base	1,200,000	Cubic meters
Mechanical subbase	3,110,000	Cubic meters
[Total]	4,310,000	Cubic meters
[Total]	5,637,500	Cubic yards
Guardrail	580,000	Linear meters
	1,903,000	Linear feet
Tunnel excavation	2,550,000	Cubic meters
	3,335,000	Cubic yards

mechanical subbase, 22 cm (8.7 in.) of cement-treated base, 12 cm (4.7 in.) of asphalt base, 8 cm (3.2 in.) of asphalt binder and, finally 5 cm (2 in.) of asphalt wearing course.

There have been many changes in the scope of the project. The number of interchanges has grown from 10 to 24. This increase was caused by the addition of link roads to towns along the route as well as connections with existing major arteries in the city. The changes have been challenging and are still taking place as construction approaches each new area. The joint venture has had to remain very flexible throughout the project.

I will not go into the overall construction of the road in this paper, but will focus on a few areas where KDJV had the opportunity to employ some unique solutions to reduce cost or has encountered unanticipated difficulties.

CONSTRUCTION CHALLENGES

Since this was a design-build project, KDJV was in a position to propose using either cast-in-place concrete or precast, prestressed girders for bridge construction. The lowest cost option was determined to be precasting. Local facilities for casting our girders were not available. Therefore, the project had to construct its own. Considering the haul distances involved, the precast facility was located 33 km (20.5 mi) south of the ring road at the middle site, Torbali. Here two 165 m (541 ft) casting beds were built, with each capable of casting four beams at one time. KGM was concerned with the aesthetics of the bridges and, therefore, directed that box beams be used in metropolitan areas and "I" beams elsewhere. The beams vary in length from 14 m (46 ft) to 32 m (105 ft), with the majority being 30–32 m (98.4–105 ft). There are a total of 1,873 I-beams and 4,179 box beams to cast. When in production, the facility casts four beams per day.

There are an estimated 451 km (280 mi) of nonreinforced concrete pipe in the project, varying in size from 15 cm (5.9 in.) to 100 cm (39.4 in.). Given this quantity of pipe, KDJV decided to build its own pipe manufacturing facility, also located at the middle site, Torbali. It purchased a Schlusselbauer Pipe Machine, Model-Magic 1501, made in Austria. The project to date has cast approximately 40% of the pipe required and is experiencing a rather high loss of 17%, due to damage or pipe that will not pass the leak test.

Throughout the 147 km (91 mi) of roadway, there are more than 100 structures to be built. Obviously, the ground conditions vary considerably and, therefore, some structures required piling. Our joint venture partner had the equipment and experience to do cast-in-place piling, and this appeared to be the preference of KGM. Therefore, this was the pile foundation design that was used. All piles are 120 cm (approximately 4 ft) in diameter and generally are augured. KDJV has completed a little over 50% of the estimated 5,500 piles, with an average depth of pile of 21.4 m (70 ft), required.

On the project, there were two areas located at the edge of the right-of-way that could not be moved. One was a shrine and the other was a village. The soil conditions were such that a stable cut slope could not be achieved and leave these structures in place. Very high cut slopes were involved, and it was determined to steepen the slope to 0.75 to 1.0, using tiebacks/rock anchors with shotcrete and wire mesh to support the finish slope. The anchors used were Dywidag Threadbar, 36 mm (1.42 in.) in diameter, grade 835/1030. The entire length of the 26.5 m (87 ft) thread bar was pregrouted in corrugated sheathing. After the bottom 6–10 m (20–33 ft) of the anchor was grouted, the anchor was posttensioned to 60 metric tons (t) and then the remainder of the 100 mm (4 in.) drilled anchor hole was filled with grout. KDJV has completed over 2,500 of these anchors to date. The greatest challenge in this operation was drilling the anchor holes and keeping them open until the anchor could be installed and the bottom grouted. KDJV crews eventually were able to complete 10 of these anchors per day.

Large, long tunnels are always a challenge on any project, and KDJV has two on this job, the Selatin Tunnel, which is 2,930 m (9,613 ft) long, and the Karsiyaka Tunnel, which is

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2,090 m (6,857 ft) long (see Fig. 1). At the present time, KDJV is only driving the Selatin Tunnel. The new motorway alignment with this tunnel will shorten the travel distance between Izmir and Aydin by approximately 21 km (13 mi) and eliminates a steep mountain grade. The tunnel is on a constant 2.6% grade.

Selatin Tunnel's ground conditions can best be described as being in a metamorphic rock zone consisting of 2/3 schists and 1/3 marble. The first 1,000 m (3,300 ft) coming in from both sides of the tunnel are being excavated through schist, gneiss, and phyllite. There are intrusions of marble veins, breccia, and andesite within the excavation of the tunnel in these soft ground areas. The face is rarely a solid mass of one material or the other, but seems to be a conglomerate of the mixed materials. The most predominate materials are the schists.

There are a total of 17 major fault zones that are anticipated throughout the 2,950 m (9,613 ft) of tunnel, of which the contractor has encountered all but six. The middle third of the tunnel, which was anticipated to be good marble, has turned out to be more of a crystalline limestone. There are five faults anticipated in this material, of which the contractor has encountered two. The faults encountered so far were open, with large voids and blocky ground conditions on each side, and with clay filled seams. It was necessary to concrete-fill the exposed cavities in order to pass through the actual fault lines.

Initially, the tunnel was to be excavated by the standard method, with heavy steel ribs, lagging, rockbolts, and shotcrete. However, after considering the geology, the control engineer, EMG, recommended that the New Austrian Tunnel Method (NATM) be used with the anticipation that it would result in a lower cost. As is rather standard with NATM, the ground has been classified into six types, which characterize the ground conditions from being almost entirely self supporting (rock class I) to very unstable and needing significant additional supporting measures (rock class VI). Currently, 80% of the tunnel excavation has been in rock classes III, IV, and V. The rock classes also dictate how the tunnel excavation may proceed. KDJV had planned to drive the tunnel using a top heading and bench method, driving the top heading through, with heavy steel ribs providing the support, and then excavating the bench. This is not possible using NATM. In rock classes IV, V, and VI, the heading must be advanced in from five to nine separate operations rather than the two anticipated. The bench cannot remain in place because, when classes IV through VI are encountered, it is necessary to over excavate below the invert, creating a subinvert that is covered with concrete to help provide support for the walls and arch. The average advance achieved in the classes III to V ground is 1 m (3.3 ft) per day.

In using the NATM system for tunneling, the most important activity during the excavation of the tunnel is the monitoring of lining deformations. This is performed by installing measuring devices at stations along the tunnel crown and walls that must be monitored on a regular schedule to detect the amount of deformation or movement that is taking place within the tunnel. Deformations will take place and need to be anticipated in order to excavate the tunnel large enough to allow for the movements and still maintain a minimum area for the final tunnel lining (see Table 2). The deformation reading will also determine what additional support measures need to be taken to protect the integrity of the excavated tunnel. Usually, a deformation of more than 30 cm (12 in.) indicates that the shotcrete shell structure has been ruptured. Almost all of the ruptures on the Selatin Tunnel Project have occurred in the invert area where the wall and invert converge. On a number of occasions, it has been necessary to go back and remove and replace a portion of the subinvert. It has also been necessary to reexcavate the top of the arch because the amount of the deformation exceeded that anticipated.

TABLE 2. Selatin Tunnel

Rock class (1)	Anticipated Deformations: Centimeters (2)	Anticipated Deformations: Inches (3)	Actual Deformations, Normal: Centimeters (4)	Actual Deformations, Normal: Inches (5)	Actual Deformations, Exceptional: Centimeters (6)	Actual Deformations, Exceptional: Inches (7)
I	5	2	NA	NA	NA	NA
II	5	2	5	2	NA	NA
III	10	4	5	2	NA	NA
IV	15	5.9	15	5.9	25	9.8
V	20	7.9	30	11.8	60	23.6
VI	25	9.8	NA	NA	NA	NA

Note: NA = not applicable.

KGM, given the understanding that using the NATM method of tunnel excavation should result in lower cost, has unilaterally reduced the unit prices on both the tunnel excavation and the support. KDJV has found the excavation, using conventional methods, to be both slower and more expensive than anticipated and argues that the units established for the conventional method simply do not apply and that new, higher rates must be negotiated for the NATM method. This is one of the many disputes that will eventually have to be resolved.

The tunnels themselves are twin bores with a cross-sectional area of 130 m^2 (1,400 sq ft) for a regular profile, and 150 m^2 (1,614 sq ft) for a configuration with a temporary invert.

There are six crossovers designed within the tunnel length, four pedestrian crossovers, and two vehicle crossovers. The principle reasons for these crossovers are for emergency traffic control and pedestrian safety. The crossovers are located approximately 400 m (1,312 ft) apart. Each tunnel will carry three lanes of traffic in one direction, with a total traffic clearance envelope of 12 m (39.4 ft) wide by 5 m (16.4 ft) high.

The final ventilation plan at this time is for a longitudinal system utilizing roof supported, nonreversible jet fans—eight pairs in the southbound, uphill lanes, and four pairs in the northbound, downhill lanes. The fans will be distributed along the centerline of each tunnel and will create a calculated flow rate of 6–7 m/s (20–24 ft/sec) when working at full capacity.

There will be a waterproof liner installed between the final coat of shotcrete and the final concrete lining. It will include a felt-like, Geotextile drainage pad that is on the wet side of a waterproof membrane that will take any migrating ground water into a drainage system located near the bottom of each arch liner wall.

OTHER CHALLENGES

So far this paper had addressed some of the more interesting construction challenges in the project. Other aspects not involving construction have proved much more difficult to deal with. The unit of currency in Turkey is the lira (TL). At the time the project was awarded, US$1.00 was equal to 900 TL. Annual inflation was around 60%. The contract is U.S. dollar denominated, and all payments were to be in dollars within 60 days of an approved progress estimate. During the next few years, inflation remained about 60%, with the Turkish lira being devalued almost daily. However, the devaluation of the Turkish lira was significantly less than the inflation that increased all incountry costs in dollar terms. This led to negotiations between the Motorway Contractors and KGM, which in 1989 resulted in contract change order. This change order provided a series of formulas based on local indices for escalating the various contract unit prices to compensate for this problem. Today, US$1.00 is equal to 50,000 TL, and in-country inflation last year exceeded 100%.

As noted earlier, the initial contract was for $296,000,000. As the design progressed, based on flatter grades and a three-lane motorway each way, this amount was increased to $790,000,000, not including escalation, in October 1991. Generally, contractors would like to receive a change order in-

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creasing their contract amount by 267%. However, this was a very mixed blessing because KGM immediately required KDJV to increase their original 6% performance guarantee to this new amount. This was an increase of $30 million in the form of bank letter of credit, which is very different from the usual surety bond we are all familar with in the United States. This ultimately took over a year to obtain because our Turkish partner had encountered financial difficulties.

Another event that took place in October 1991 was a national election. KGM for some reason stopped paying all the Motorway Contractors several months prior to the election. The election resulted in a change of government. KDJV continued working through December of that year without any further payment and at that point was owed almost $60,000,000. This financial burden was too great for KDJV, and since KGM had no idea when the new government would make money available to pay the contractors, KDJV ceased to work. Full payment was not received until June 1992.

At this point, KDJV was informed that no further progress payments would be made until the full amount of the performance guarantee had been received by KGM. KDJV had no option but to proceed with the work without payment until May 1993, when the joint venture was finally able to provide the additional guarantee. 1993 billings were paid up to six months late in three-year, U.S. dollar-denominated bonds issued by the Turkish Treasury bearing below-market interest rates. To obtain operating cash, these bonds had to be sold at discounts of up to 25%. KGM would not even make payment with the bonds unless the contractor would execute a release waiving all rights to a claim.

The Motorway Contractors were placed on allocations for 1994 and KDJV was allocated $27,000,000 for the entire year. In 1991, KDJV's billings were over $200,000,000 with a one-month high of more than $32,000,000. KDJV again worked into January of 1994 without any payment, leading to another work stoppage. Partial payment was received in June, 70% in the form of two-year, Turkish lira-denominated bonds with the stipulation that the contractor could not sell them but must hold them until maturity.

The allocation for KDJV's work for 1995 was $18,000,000 plus escalation. The government, faced with early elections, suddenly increased this amount by $60,000,000 in the last week of September, and KGM paid all of the Motorway Contractors up-to-date in cash at that time. The key word here is flexibility.

From late in 1992 through late in 1994, the governmment refused all of Dillingham's offers to raise money for the project. Finally, late in 1994 the government accepted Dillingham's offer for $51,000,000 of U.S. EXIM credit and another $60,000,000 of Japanese credit. The first draw under the U.S. EXIM credit was expected in mid-November 1995. The Japanese loan has been executed by the Turkish Treasury, but it is anyone's guess when the first draw from this credit will be made. This is because all of the Cabinet Ministers and the Prime Minister must first approve the loan. The coalition government that was in power collapsed in 1995 just prior to the execution of the loan, and a new government with new ministers was yet to be formed at the writing of this paper. No ministers, no approval, and no loan.

CONCLUSION

During the past four years, politics and the financial misfortunes of Turkey have dictated the progress of the Izmir-Aydin Project. Expropriation of the right-of-way was a problem from the very beginning because of a lack of money. Now, almost eight years after the award of the work, 30% of the right-of-way had yet to be aquired by KGM, preventing KDJV from proceeding with construction on most of the ring road. I am now forecasting that the road will be complete in the year 2000, followed by lengthy arbitration proceedings.

In conclusion, I return to my opening observation that $200 billion should be spent throughout the world on infrastructure each year for many years to come. This will lead to many opportunities for U.S. contractors to work internationally. However, you must be aware of the many problems that may be faced during the execution of an international contract, including lack of payment, ignoring contract provisions, changes in government, and politics in general. The least challenging aspect of the Izmir Ring Road–Aydin Motorway Project has been actual construction.

APPENDIX. PROJECT EQUIPMENT LIST

EQUIPMENT	QUANTITY
Local Transportation	
Renaults	15
Suburbans	4
Minibuses	4
Coaster buses	12
GMC buses	15
Toyota landcruisers	6
GMC pickups	40
Toyota pickups	56
Trucking	
Flatracks	12
Powder trucks	7
Water trucks	18
Flatbeds	8
Lowbeds	9
End dumps—EFE (22 m^3)	50
End dumps—EFE (6 t)	18
Asphalt tankers	5
Cement tankers	8
Fuel tankers	5
Tractors, Mack	73
10-Wheelers, Mack	15
Concrete transit mixers-Rex	34
35-t dumps, Komatsu	40
Service trucks: fuel, lub, mech., tire, etc.	25
Cranes	
20-t Tadano	6
50-t Tadano	8
Manitowoc 4100	2
Manitowoc MW 80	1
Tower cranes	6
Overhead cranes	2
Loaders	
966 Cat	12
988 Cat	10
Traxcavator-Komatsu D 75	4
Dozers	
Case 850 D	2
Komatsu D 85	3
Komatsu D 155	12
Komatsu D 355	11
Scrapers	
Cat 631 E	10
Graders	
Cat 14 G	6
Dresser 870	6
Autograders	
CMI-TR 500	2
Tunnel Equipment	
Getman scaler	1

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EQUIPMENT	QUANTITY
Tamrock three-boom drill jumbo	4
Tamrock rockbolt jumbo	2
Dry shotcrete machines, Meyco	6
Wet shotcrete machines, Getman	4
Manlifts, Getman	3
Drills (Outside)	
Airtracks-I/R ECM 350	12
Airtracks-I/R CM 351	2
Shovels	
Komatsu-PC 650	2
Backhoes	
Case 580 K	3
Case 680 L	2
JCB	4
Komatsu PC 220	3
Case Cruzair	2
Komatsu-PC 400	3
Compactors	
Cat 825 C	3
I/R Vibrator, 150 D	9
I/R Vibrator, 100 D	6
Mikasa	18
Asphalt	
Pavers, Cedarapids	7
Curb machine	1

EQUIPMENT	QUANTITY
Rollers	
I/R DD 90	4
I/R DD 110	2
Dynapac CP 30	3
Compressors	
I/R 175 cfm	8
I/R 375 cfm	4
I/R 750 cfm	23
Generators	
Kohler (20 kV)	30
Cat (63 kV)	3
Cat (200 kV)	6
Cat (500 kV)	14
Magnaone (1,000 kV)	1
Concrete Pumps	
MACK/MORGAN MOBIL	6
Morgan Mustang	1
Batch Plants	
Na ce (40 m^3)	7
Erie Stayer (115 m^3)	2
CTB/MSB Plants	
Burcelix (400 t)	3
Cedarapids (900 t)	2
Asphalt Plants	
Cedarapids (400 t)	2

J. Constr. Eng. Manage. 1996.122:199-204.