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THE SAUDI ARABIAN HIGHWAY PROGRAM

AN IRF CASE HISTORY



INTERNATIONAL ROAD FEDERATION

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CENTRE FOR ARAB GULF STUDIES

UNIVERSITY OF EXETER

The development and progress of nations are directly linked with the development of their road networks. Industry, trade, and national unity depend on the quality of the road system, while international highways promote the exchange of culture and understanding between nations.

Saudi Arabia's location between the great land masses of Europe, Africa and Asia has called for access to international road traffic. The Kingdom of Saudi Arabia has created an efficient and modern highway system in just a few years, with

the help of substantial natural and financial resources. Its modern highways have been extended to all neighboring countries in order that national, international, and intercontinental traffic can move unhampered.

The evolution of the system, the foresight of the Kingdom's government officials in enlisting the best possible expertise, and the challenge of the natural and climatic barriers provide an interesting and informative document for all with an interest in road development.



The International Road Federation

March 1986

FRONT COVER:

Scha'ar Descent

OPPOSITE:

Riyadh-Makkah Expressway, view up escarpment toward Riyadh



History of the Saudi Road Program

Saudi Arabia's modern highway construction program dates from 1935, when the Public Works and Minerals Department was established. Desert tracks had existed since ancient times, but in 1951 the first asphalt road construction project in the Kingdom represented a significant technological step forward.

The Ministry of Communications was formed in 1952, and took full responsibility for the nation's roads a year later. At that time there were only 239 kilometers of paved roads in the Kingdom. By 1963, the Ministry had expanded the network of paved roads to 4,147 kilometers, despite a severe shortage of technical capabilities and specialized manpower.

At the beginning of 1964 the Ministry launched a new road development program in the Kingdom. Based on its experience over the previous few years, and as a result of preliminary studies conducted throughout the Kingdom, the Ministry was able to initiate what was called the "Main Program" for developing roads and bridges, with the object of constructing thousands of kilometers of modern roads to connect the main regions of the country. The program involved a major national commitment in manpower and resources within a limited period of time.

A brief review of the physical characteristics of the Kingdom of Saudi Arabia illustrates graphically the magnitude of any plan intended to bring transportation facilities to the entire population. Saudi Arabia is 2,253,000 square kilometers in area, or almost one-fourth the size of the United States. The European countries of Denmark, the

Netherlands, Belgium, West Germany, France, Switzerland, Austria, Albania, Yugoslavia, Italy, Spain and Portugal together take up less area than Saudi Arabia.

The distance from Dammam, the major Arabian Gulf seaport, to Jeddah, the major Red Sea port, is 1,528 km. The north-south route in western Saudi Arabia from Tabouk to Jizan covers 1,952 km. In comparison, the airline distance between Berlin and London is 931 km, and Stockholm is 1,985 kilometers by air from Rome.

The problems created by the great distances are compounded by the geological features. Saudi Arabia is a plateau sloping eastward from a mountain range extending along its western edge, usually within 15 to 25 km of the Red Sea Coast, from which it rises steeply to an average height of 1,500 meters. The coastal plain rarely exceeds 50 km in width.

The country is generally arid and barren. The only area with significant regular rainfall is the high mountainous area in the southwest. The rest of the country is desert, with areas of numerous but widely scattered oases in dry stream beds that flood on a few rare occasions each year. There are no rivers, no forests, and only a few permanent pools or small lakes.

The Arabian peninsula has three main natural divisions; (1) the Najd, which is a central core of hard desert with many valleys and oases supporting a considerable permanent population; (2) an almost complete circle of sandy waste land surrounding the central core and extending hundreds of miles outward to the north and south, known as



مركز المدينة الحديثة

the northern Nufud, the Dahna, and the Rub'-al Khali; and (3) an outer circle of steppes or mountains, in part barren and arid and in part populated and cultivated. Much of this outermost ring lies outside the borders of the Kingdom of Saudi Arabia.

In this environment, the Ministry of Communications committed itself to connect the distant parts of the Kingdom with modern roads in order to foster the creation of social, economic, agricultural and industrial conditions that would improve the lifestyles of all the citizens of Saudi Arabia.

The Main Program

The original concept of the Ministry's Main Program, begun in 1964, was to develop a major network of modern two lane highways connecting all the population centers in every geographical and political area of Saudi Arabia. The Ministry lacked a pool of trained or readily trainable manpower. It therefore sought to speed up the progress of the program by acquiring the services of international consulting firms to study, design, and supervise the construction of 5,000 km of the major highway network. This program was scheduled in addition to the existing programs already undertaken by the Ministry.

A set of *General Specifications and General Conditions for Highway Construction Contracts* and a set of *Highway Design Standards* were developed for use on all new projects. Despite the Ministry's limited experience in selecting and dealing with foreign consultants and contractors, the network of paved roads had grown to 8,027 km by mid 1970.

To supplement the Main Program, the Ministry also initiated a separate program of rural road construction in 1964. It involved the improvement and grading of existing desert and mountain tracks, while expanding the network of unpaved roads to connect as many settlements as possible with the growing primary road network. The Rural Road Construction program has continued and expanded in the intervening 17 years. Details of the program are contained on page 23.

The Ministry of Communications considered that the new road development program, or Main Program, should be implemented in four phases as follows:

Phase I: Completing the connection of main regions, and ensuring that roads would pass through the maximum number of towns and villages.

Phase II: Shortening travel distances between the main cities.

Phase III: Widening and constructing roads where anticipated future traffic indicates that they will eventually be upgraded to dual carriageways or expressways.

Phase IV: Improving the standard of services, and developing safety features for the roads.

In 1970 the Ministry of Communications prepared a comprehensive five-year road program in conjunction with the Government's overall Five-Year Plan for national development. The first phase of the Main Program continued under the five-year program, but with some modifications. The Ministry had by this time standardized its methods for selecting and dealing with foreign consultants. Technical experience that had been gained since the early days of the Main Program resulted in the 1971 revision of the *General Specifications and Design Standards*.

Phase II of the Main Program was introduced in 1970. Phase I had been concerned with connecting

Saudi Arabia's Road Network 1963



Saudi Arabia's Road Network 1970



Saudi Arabia's Road Network 1980



Saudi Arabia's Road Network 1986



the maximum number of towns and villages. This objective often resulted in circuitous routes and long travel time. Phase II was concerned with constructing direct routes between major cities to reduce distances and travel time.

Another separate road program was introduced in 1970. Saudi Arabia's Feeder Road Program provided for the study, design and construction of high standard asphalt roads between the main highway network and selected outlying villages. Thus the rural roads were connected to the Main Program. The feeder roads were located only where justified by a high agricultural, economic, administrative and social benefit.

The design and construction of the Feeder Road Program was carried out by consultants and contractors selected by the Ministry.

By 1975 most of Saudi Arabia's regions and cities were linked by paved roads, resulting in expected economic and social benefits such as increased trade, agricultural exchange among regions, and local tourism. The total length of asphalt roads in 1975 was 12,169 km, and the total length of unsurfaced rural roads was 8,077 km.

In 1975 the Ministry of Communications began its second Five-Year program, which continued the original Main Program to build a complete two-lane asphalt road network throughout the Kingdom. It accelerated the rural roads program and expanded the Feeder Roads Program. In addition, the Ministry began implementation of Phase III, widening and upgrading roads to dual carriageways or expressways.

By the mid 1970's, traffic generated by the massive highway construction program started in 1963, coupled with the increasing national development in all sectors of the economy, was exceeding the capacity of several important roads. With increasing traffic volume, the Ministry had been paying greater attention to the operational aspects

of the road system in addition to its continued concentration on construction and maintenance programs. Systematic traffic counts, traffic surveys and driver interviews had been held at various locations on the main road network in preparation for Phase III. The data obtained in these surveys and interviews were used in the study, design, and construction of 4,000 km of dual carriageways and expressways in the late 1970's.

By mid 1980 the network of primary asphalt roads had reached 17,939 km, and feeder roads had reached 3,644 km, for a total length of paved roads of 21,583 km. Major expressways were in various stages of design and construction on the following routes:

Dammam-Riyadh	Madinah-Qassim
Riyadh-Makkah	Qassim-Riyadh
Makkah-Jeddah	Madinah-Tabouk
Jeddah-Madinah	Dammam-Saudi/Kuwaiti border

Saudi Arabia's Third Five-Year Plan began in 1980. During this plan the Ministry of Communications spent US\$12.24 billions for the construction of 8,074 km of paved roads and 26,469 km of unpaved agricultural roads.

The actual pace of road construction during the Third Five-Year Plan period surpassed the targets established in 1980 for all types of roads. A total of 32,582 km of roads were constructed during the period from 1980-1985. This is equivalent to 135 percent of the target originally set in 1980.

The Fourth Five-Year Development Plan reflects the fact that Saudi Arabia's road infrastructure has largely been completed. The government's main objectives in the transport sector for the 1986-1990 period are to improve efficiency in terms of road maintenance and operations, improve safety standards, and to continue expansion of the road network to rural and sparsely populated areas.

Highway Activities of the Ministry of Communications

The planning, design, construction, operation and maintenance of all the main and intercity roads in the Kingdom of Saudi Arabia are the responsibility of the Ministry of Communications.

The Minister of Communications is His Excellency Sheik Husein Ibrahim Mansouri. H. E. Mansouri has provided much of the inspiration and planning of the road development plan since the early 1960's, first as Secretary of State, then as Deputy Minister, and now as Minister of Communications.

The Deputy Minister of Communications, Dr. Nasser Al-Salloum (University of Arizona, M.A. and Ph.D in Engineering) is directly responsible for the administration of the highway program.

A statement released by the government of Saudi Arabia in 1975 revealed the Kingdom's position regarding roads:

"Development of proper communication facilities plays an important role in the economic development of a country. Proper development of a road network not only reduces the cost of transportation both in terms of money and time, but also helps in the integration of various regions within the country and better understanding of the neighboring countries on the international level.

"Roads contribute to the development of the country by bringing in direct benefits from its role in developing other fields like agriculture, industry, commerce and mining and by bringing in indirect benefits from the enhancement in prosperity, and the change it sets in the way of life and thinking of its people.

"In the vast Kingdom of Saudi Arabia where the main population centers are not only scattered all over the country but are also separated by deserts, sand dunes, valleys and mountains, fast and reliable means of communication becomes all the more important and essential."

With this mandate from the government the new road development plan, which was started in 1964, required massive efforts exceeding the available capacities of the Ministry of Communications.

The Ministry was faced with two main alternatives: (1) to increase greatly its technical staff and its fleet of construction equipment to undertake the design and construction of the total road program, or (2) to enlist the services of consulting and contracting firms to assist in the prompt and timely completion of the program.

The first alternative would have required expansion of Ministry technical personnel and construction equipment beyond its capacity at that time. Funds for the equipment were available, but technical manpower was one of the Kingdom's scarcest resources. The recruitment of such massive increases in either capability would have resulted in intolerable delays in completing the road programs. The second alternative, the enlisting of the services of consulting and contracting firms, obviously presented a more practical and logical choice.

The Kingdom's ambitious road programs have aroused world wide interest, causing large numbers of consulting and contracting firms to offer their professional services. Due to the large volume of

roads to be designed and constructed to the highest available standards, it was apparent that sound selection criteria should be developed to choose the right firms to undertake the work. For the first few years, the selection was achieved by ad-hoc committees on a job-by-job basis. However, as the program continued to develop, the Ministry began to standardize its selection criteria. The Ministry drew on the experience of the United Nations, the World Bank, and the American, European and Middle East Governments.

This effort has resulted in the development of what is considered to be a unified and inclusive system for acquiring, collecting and evaluating the pertinent information needed to prequalify consulting and contracting firms. To prequalify, an outside firm must now complete a lengthy questionnaire describing its organizational structure, experience and capabilities. The Ministry works with more than 20 consultant firms, 14 of which are Saudi and 2 joint ventures, as well as nearly 100 contractors. Most of the prime contractors are now Saudi, while many foreign contractors are specialty subcontractors. A great proportion of all of the contractor's workers are foreign nationals.

The Ministry is concurrently developing its own capability as an integral part of the new road development plan. The Saudi engineering capability has expanded with time, and is responsible for the design of an increasing portion of the recent highway plans. Saudi contractors are bidding and winning more construction projects.

Since the mid-1970's the Ministry of Communications has made significant efforts to develop its internal staff capabilities and to share resources, technology and expertise with other nations by inviting teams of experts to work within the Ministry.

In 1977, as part of a Technical Cooperation Agreement which provides for the operation of a

United States - Saudi Arabian Joint Commission on Economic Cooperation, the Ministry signed a highway development technical assistance agreement with the U.S. Department of Transportation. The United States since has furnished a team of experts to provide technical advisory services in the fields of highway planning, design, construction, maintenance, traffic and safety, administration and other specialized disciplines as needed.

The Ministry of Communications also has entered into technical cooperation agreements with China and Sweden.

In January 1978 a team of Chinese experts arrived on loan from the Chinese Highway Mission. Currently numbering approximately 20, the team assists the Ministry of Communications in a variety of fields including design, construction, maintenance, materials testing, traffic and computers.

The latest technical cooperation agreement was signed with Sweden in 1984. Shortly thereafter, a team of 10 experts from SweRoad, a subsidiary of the Swedish Road Administration, were assigned to share information with the Ministry relating primarily to traffic counting and safety programs and road mapping.

By assigning Saudi counterparts to work closely with visiting experts, the Ministry is constantly improving and expanding the skills and abilities of its staff.

Highway Operations: The Structure

The highway section of the Ministry of Communications is subdivided into a series of Departments, each headed by a Director responsible to Deputy Minister Dr. Nasser Al-Salloom. Several of these departments are further subdivided into sections headed by Chiefs.

The country is divided into thirteen Road

GOODSYLAR

مخرج 8B اب

الرياض (غرب)
المدينة المنورة مكة المكرمة
Riyadh (West) Al Madinah Makkah

الرياض (شرق)
الخرج
Riyadh (East) Al Kharj

مخرج 8000 م

مخرج 8A ا

الطاب
Airport



Districts. The District Directors are also responsible for the construction and maintenance of the rural roads in their district and the supervision of the contractors who maintain all of the paved roads within their districts.

The Follow-Up Division, which is situated within the Planning, Follow-Up and Budget Department, plays a prominent role in the Ministry's advance planning. It administers the prequalification of contractors and consultants, both domestic and foreign, and prepares, monitors, and reports on the current Five-Year Plan. The Budget Division and the Statistics Division also fall within the same Department.

The Department for the Follow-Up of Studies for Technical Projects administers design consultant contracts, reviews and responds to citizen requests for new road links and design changes, secures aerial photographs and rights-of-way, and handles routine administrative matters on design contracts.

The Construction Department is divided into two sections. The Consultant Section provides MOC direction to contractors and supervising consultant engineers, provides technical supervision of contractors, resolves citizen petitions, and handles payment enquiries. The Checking Section processes monthly certificates, invoices, bills of quantities and claims, checks tender documents and prepares comparative statements, and prepares rate analyses where needed.

The Materials Laboratory conducts routine tests on highway construction and pavement marking materials, verifies project reports submitted by consultants, contractors, and Ministry personnel, troubleshoots construction problems, and assists in the Engineering Training Program.

The Design Department is subdivided into four sections, covering Bridges, Roads, Specifications and Quantities, and Surveys. It also includes a

Design Publication Group which prepares design manuals, standard construction drawings, and guidelines for the review of consultant design.

The Maintenance and Rural Department is subdivided into three sections. The Maintenance Section controls the contract maintenance of the network of paved roads; the Rural Roads Section controls construction of unsurfaced roads with department personnel and equipment; and the Mechanical Section deals with purchase, maintenance, service, and safety aspects of all equipment owned by the MOC.

The organizational structure described above is perhaps unique in its heavy orientation towards controlling and checking large volumes of design and construction contracts. The exclusive use of contractors for maintenance is also quite unusual. The insight and skilled administrative capabilities of the originators of the new road development plan are obvious when one considers that the organization was developed in less than twenty years. The purpose of the road plan, i.e. to serve all of the people, is also apparent on examination of the duties of each department. Citizens have an opportunity at each stage to request action from or to have complaints investigated by the various Directors and section chiefs.

In addition to the technical units that are responsible for transforming plans into actual construction projects which expand the Kingdom's network, there are a host of other Departments within the Ministry of Communications that help to carry out the Ministry's mandate.

Personnel, Training and Staff Development, Public Relations and Information, and the Computer Departments all work closely with the other technical units to ensure that the Ministry is operating efficiently and responding to the needs of the Kingdom's citizens.





Highway Design Features in Saudi Arabia

The Ministry of Communications adopted the highest internationally accepted design and construction criteria when it inaugurated its new road construction program in 1963. Most of the Kingdom's roads were still to be built, so the decision has given the Saudis one of the most modern road systems in the world. The choice of high design criteria was dictated by the difficulty of the terrain in many areas. Furthermore, high initial design standards were established to permit upgrading in conjunction with the country's overall national development plan, and with increasing travel volume.

The highways in the Kingdom are functionally classified as primary, secondary, feeder and agricultural roads. Each class is built to the standards required by the anticipated future traffic needs, but with provisions for upgrading as demand changes. The Ministry uses a lane width of 3.65 meters with a 0.20 meter border strip and a 2.50 or 3.0 meter shoulder.

The crown cross-slope is 1.5 percent to lessen the effect of moving sand dunes crossing the roads and because of the low rainfall and absence of snow. Since user safety has been a prime consideration since the beginning of the highway construction program, 4:1 or flatter side slopes are used for embankments of three meters or less. In sand dune areas 6:1 side slopes are used for safety and to avoid sand dune accumulation on the roadway.

Most primary and secondary highways are multi-

lane expressway facilities, divided by a median separating two-way traffic. In the interests of safety, medians are generally 20 meters wide except in mountainous and extremely difficult areas where they are reduced in width. In sand dune areas the only way to avoid or minimize accidents is to have a wide median. Any obstruction in the median area, such as guard rail or New Jersey barrier or even light reflectors, will trap moving particles and will result in accumulation of sand on the roadway.

Expressways crossing other roads are provided with grade separations or interchanges. Interchange configurations vary from simple diamonds to very complex multi-level directional interchanges with two-lane wide ramps. Single-lane ramps are about 5.5 meters wide (depending on curvature) which allows for the safe passing of a disabled vehicle on the ramp. Two-lane ramps are 7.30 meters in width. The minimum clearance under overpasses is 5.5 meters, based on the requirements of pilgrim buses. In built-up areas, and in areas where there is a potential build-up, viaducts are substituted for embankments greater than 5.0 meters high for aesthetic and economical reasons.

The Ministry of Communications generally establishes preliminary alignment using photogrammetric techniques. Long straight distances of road are avoided in desert and uninhabited areas as a safety measure to reduce monotony and boredom. Two-lane highways normally have a design

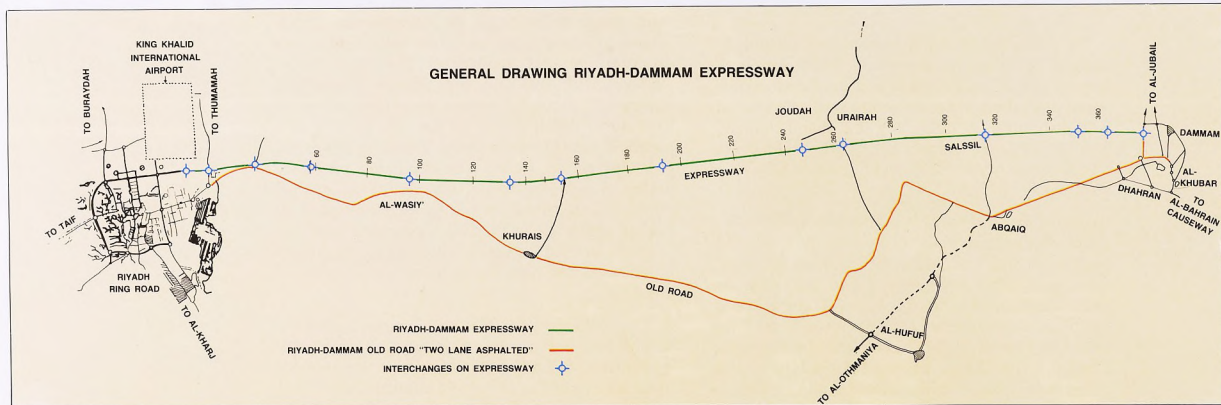
speed of 110 km/hr. (68 mph) while expressways are usually designed for 120 km/hr. (75 mph). The minimum preferable horizontal radius for two-lane highways is 1,200 meters, and 1,650 meters is the preferred horizontal radius for expressways. The vertical curves are designed for the same design speed as the horizontal curves. The minimum stopping sight distance determines the minimum preferable radius of the vertical curves, which are 14,300 meters for 110 km/hr. two-lane highways and 19,400 meters for 120 km/hr. expressways. The design speed must occasionally be reduced in mountainous and other extremely difficult areas.

Sand dune areas prove especially difficult to negotiate. Design engineers must evaluate the direction of the prevailing wind and location of the

highest dune within the corridor under study. The best current solution is to go around sand dunes on the windward side. Dunes can also be passed on the downwind side if the dune height is lowered to 1/20 of the distance to the road and the upwind side of the dune is stabilized. If it is impossible to bypass the dune, the next best solution is to go over the top.

It is not always possible to go around or over every sand dune. Current experience indicates that if the roadway must go through a dune, a four meter level area should separate the outside edge of the shoulder from the toe of the slope. The cut slopes themselves should be 1:20 on the windward side but in no case should they be steeper than 1:10.

The Riyadh-Dammam Freeway



The slope faces must be stabilized by spraying on a stabilizing solution. In some cases cutback asphalt (MC-1) has worked, while in other cases chemical stabilizing solutions have been more successful. A series of bituminized rubber strips laid parallel to the road is also under test.

The design thickness of the road structure is of course a function of axle weight and the number of loadings anticipated during the expected life of the road. Saudi roads are designed for a twenty-year life, using maximum single axle loads of 13 metric tons and maximum tandem axle loads of 20 metric tons. The most commonly used paving material is asphalt. However, as asphalt has increased in cost, even in Saudi Arabia, the Ministry has begun to experiment with the use of sulfur as a partial substitute for asphalt in hot-mix pavements. Sulfur is a by-product of the oil refining process, and is accumulating in large stockpiles near most refineries.

The first three phases of the new road development plan and the overall development plan were mentioned on pages 5-10. Phase IV is devoted to improving the standard of services and developing road safety features, and is now being implemented in the form of additional design standards and criteria. To reduce driver boredom, the Ministry encourages the installation of commercial signs, promotes agricultural land use, and supports the planting of desert trees and shrubs that do not require periodic watering along the highway rights-of-way.

A program is underway to provide rest areas on long sections of roadways. The rest areas vary from lay-by and parking areas at scenic spots to complete facilities including service stations, restaurants, motel units and truck stops.

Other safety items in the highway design specifications include increased use of information, regulatory and warning signs, painted stripes and

other road markings, and guard rails and concrete median barriers in mountainous areas where highway widths are below recommended limits.

A highway patrol system has been introduced, and emergency communication facilities installed along the highways. Sophisticated lighting, easy to read signing in both Arabic and English, and lane markings are required at all interchanges.

Divided Road in East Area

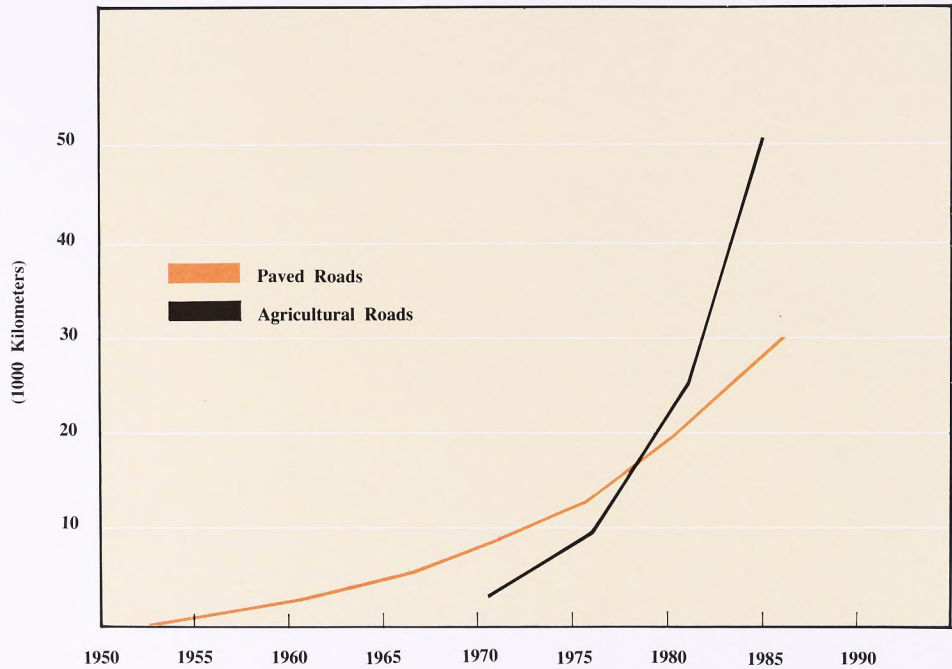




Night view of Gulf Street Viaduct



CUMULATIVE ROAD LENGTH OPEN TO TRAFFIC



Rural Road Program

The rural road (agricultural road) program of the Ministry of Communications has been designed to provide essential transportation services to many isolated areas. Particularly important is the need to provide routes for transportation of agricultural products to market, and to link isolated villages with health and other social services located in larger population centers.

The rural road program began in 1964, immediately following the implementation of the Ministry's new road development program. It involved the improvement and grading of existing desert and mountain tracks and the design, construction and maintenance of additional unpaved graded roads connecting as many settlements as possible with each other and with the primary road network.

By 1968 fourteen teams had been formed throughout the Kingdom. These teams, consisting entirely of Ministry personnel and equipment, had opened and were maintaining 2,316 km of rural roads.

Between 1968 and 1970 four additional teams were established. These 18 teams added 701 km, or approximately 38 km per team, during the year to bring the total length of the rural road system up to 3,487 km.

During the first four years of the first Five-Year program, four more rural road teams were placed in the field. The additional length of roads put into service in each of those four years was 660 km, 821 km, 780 km, and 998 km respectively. In the fifth

year, four more teams were added, mainly in the western areas, bringing the total to 26. In 1975, 1,695 km were added to the rural road network which then totaled 8,441 km.

During the second Five-Year plan, 15 new teams were added, and the total length of roads in the program increased to 24,186 km.

From 1964 through the mid 1980's, there was no correlation between the numbers of crews in the field and the lengths of road completed. This is due to several factors:

1. All crews were not of the same structure.
2. The maintenance activities varied yearly according to the weather; one heavy rain-storm can add months of maintenance.
3. All crews were not working in the same terrain.

The Ministry is now considering the use of contractors to continue the rural road construction program.

Taif-Abha-Jizan Road



Taif-Abha-Jizan Road

The history of roadbuilding in Saudi Arabia has been reviewed, and the organization which is undertaking the massive task of tying the Kingdom together has been described. Exactly how difficult and costly is Saudi road building? One of the most spectacular roads built in the kingdom is the "Road to Prosperity", which serves more than 400 villages in the southern, southwestern, and western regions of the Kingdom. Its history parallels the development of the Saudi road program and illustrates the continuing process of planning to achieve predetermined goals which has been followed throughout. Without such an overall plan with fixed objectives, carefully programmed and rigorously followed, coupled with a generous financial budget, this road would never have been completed.

The road is located in southwestern Saudi Arabia. It connects the Red Sea port of Jizan in the southwestern corner of the Kingdom with the city of Taif which lies in the mountains 8 km east of Makkah on the Jeddah-Riyadh-Dammam highway, the major east-west route across the kingdom. The completed road is a 753 km long, two-lane asphalted highway which travels along the Red Sea coast in a southeasterly direction. It runs 556 km to Abha, and from there goes down the escarpment, dropping some 1,500 meters in sixteen km at the Dila' Descent between Abha and Adi Ad Dilah. The road then traverses the coastal plain for 168 km to Jizan.

Preparations for the road began in 1963. The

first efforts were undertaken by a team of Ministry engineers and workers who began by constructing unpaved roads in the suburbs of Taif. In 1964 Ministry workers began grading operations near Al-Jibub and continued until the final design of a 75 km section of roadway was laid out for the first contract in 1968. Ten years later, in 1978, the road was completed and opened to traffic.

The Taif-Abha-Jizan road, which cost US\$528 million to build, was completed in eleven years from the time the first construction contract was let, twelve years from the time the first design contract was let, and fifteen years after the Ministry of Communications' construction team began the original work.

What did the road accomplish? It opened up one of the most important and densely populated areas of the Kingdom by land for the first time. It directly serves more than 400,000 people in a mountainous area that was previously accessible only by air or foot. It further links 30,000 people in 37 villages on the coastal plain who previously could be reached only by plane or ship. It opened up the southern coastal plain to further road building, settlement and important agricultural development. It has strengthened national unity and allows the flow of raw materials, intermediate and finished products, and the passage of manpower according to the density of the population and the labor requirements in various regions. The road itself created a need for trade centers, auto service stations and tourist facilities which have brought



OPPOSITE:
Thaqeef-Biladzahran Road South-Western Area

Taif-Abha-Jizan Road.

added prosperity to the village inhabitants.

The construction of the road has created considerable social impact by facilitating contact, not only between the inhabitants of the villages it serves, but also between the inhabitants and the work force building the road and now the tourists using the road. It makes education, health, and information services available to many of the area inhabitants for the first time, and also provides increased services to each village in addition to the central services available in the neighboring towns.

Construction of the road provided work for thousands of laborers, and represented an ideal training opportunity for several roadbuilding trades and professions. Since the entire road was built by a Saudi contractor employing Saudi engineers, new local skills and experience have been established. The Taif-Abha-Jizan road was at the time of completion the most expensive of all the Kingdom's roads as well as the most difficult to



build, due to the mountainous terrain, the great change in altitude in the escarpment area, and the large quantity of rock encountered (14.72 million cubic meters).

All of the quantities involved in this project are impressive and all contribute to the modern technical experience of Saudi road builders. For example, the first two highway tunnels in the Kingdom, totaling 553 meters in length were built at the Dila' Descent. The first high thin reinforced concrete piers with box girder cross sections were constructed. The first stainless steel superstructures with reinforced concrete deck slabs were built.

The 753 km of the Taif-Abha-Jizan road has 354 bridges with a total length of 19,066 meters.

In addition, 2,140 culverts, 153 retaining walls totaling 17,676 meters in length, and 1,320,000 square meters of riprap were constructed.

Wadi Hanifah Bridge on Riyadh-Makkah Expressway



Representative Current Projects

Riyadh City Road Network

The Kingdom has experienced a tremendous upsurge of growth in the past few years, including changes in social, cultural and economic life. As a result the Kingdom's cities expanded at a rapid pace with a corresponding increase in both intracity and intercity traffic. The growth in traffic has been far beyond all predictions and has resulted in traffic congestion on city streets and on roads leading into major cities.

The primary road system in Riyadh is now undergoing a period of rapid growth aimed at constructing an integrated road system capable of keeping pace with the capital's development. This plan will allow Riyadh to maintain its position as a key national, Arab, Islamic, and international center.

The MOC has therefore taken care to design its road system to the highest international standards. All designs include provision for the future expansion of public utilities such as electricity, telephone, water and sewage services coordinated with local government authorities. The road system will include interchanges, bridges, tunnels, lighting, landscaping and all safety features. The primary highway system in Riyadh has been subdivided into the following:

- The Riyadh Ring Road
- Main Arterial Streets of the City
- Main entrances to Riyadh

Riyadh Ring Road

The total length of the Ring Road and its links is 94 kilometers. It comprises a dual carriage, primary highway with 4 lanes on each carriageway and an 8-meter wide median. Service roads are provided on each side with entry to and exit from the expressway limited to interchanges. The interchanges also serve residential and commercial areas surrounding Riyadh.

The Ring Road has all necessary facilities such as lighting, landscaping, directional signs, storm water drainage systems, etc. The Ring Road has 4 legs. The northern leg is 17 km long, the eastern leg is 26 km, the southern leg is 16 km and the western leg is 35 km long. There are 8 free interchanges on the Riyadh outer ring road located at the main intersections leading into the city. They are:

1. The intersection of the northern leg with Salbukh Road, new Dariyah Road and the western leg. Located north of King Saud University.
2. Intersection of the northern leg with the Riyadh-Sudair-Qassim expressway. Located in northern Olaya.
3. Intersection of the northern leg with the new King Khalid International Airport access road and the Riyadh-Dammam expressway.
4. Intersection of the eastern leg with the Khurais expressway. Located in the Rawdah quarter of the city.
5. Intersection of the eastern leg with Al-Kharj



Building the Outer Ring Road, Riyadh

road link and the southern leg. Located north east of the cement factory.

6. Intersection of the southern leg with the Al-Kharj road. Located north of Aziziya.

7. The Hijaz intersection which links the southern leg with the existing Hijaz road, the western leg and Makkah Al-Mukarramah road. This intersection is considered to be the Kingdom's largest.

8. Intersection of the western leg with the Riyadh-Hijaz expressway. Located west of Zahrat-laban north of the low-income residential areas.

The cost of completed sections of the Ring Road has thus far totaled 2200 million Riyals (US\$600 million).

Makkah Al-Mukarramah Road

This is a 29 km dual carriage road with 3 lanes in each direction, service roads with 3 lanes and side parking areas. The two carriageways are separated by New Jersey barriers in the median.

The road project was divided into many sections to speed construction and avoid traffic congestion. The road crosses the center of Riyadh and intersects several primary roads in the city. Construction work includes all necessary features including curbing, lighting, landscaping and the full utilization of the right-of-way to ensure the best possible services.

Makkah Road Sections

Section (1): From the Hijaz intersection to Asir Street with a length of 2 km. This section is complete.

Section (2): 5 km from Asir Street to Al-Washem Street. The main roadways in this section will be constructed as a 4 km long tunnel to provide minimum disruption to surrounding areas.

Section (3): 3 km from Al-Washem Street to King Fahad Road. The road is well underway and has one underpass at the intersection with Al-Ma'zar Road and a main free interchange at the intersection with King Fahad Road.

Section (4): 4 km from King Fahad Road to Al-Aruba Road. This section was constructed by the Municipality of Riyadh and will be improved to match the final design of the completed road.

Section (5): 6 km from Al-Aruba Road to the Riyadh Ring Road (Northern Leg). This includes one underpass and two bridges. Work will start shortly.

Section (6): 6 km from the Riyadh Ring Road to Riyadh-Sudair-Qassim Expressway.

This project is crucial to easing traffic congestion in an important area of the city of Riyadh. It constitutes a major component in the modernization of the capital.

The Inner Ring Road of Makkah Al-Mukarramah

This 9 km semi-circular road is located in the city's central area. It is a dual carriageway with 3 lanes in each direction. There are 4 two-way tunnels each 5 km long. Construction of the tunnels began in 1980 with a total cost of 400 million riyals (US\$110 million). The project will greatly help to ease traffic congestion around the Grand

Mosque by redirecting through traffic away from the crowded areas around the Grand Mosque, particularly during the high season.

Makkah Al-Mukarramah Middle Ring Road

This project consists of an outer ring road around Makkah Al-Mukarramah approximately 28 km long. It is a dual carriageway with 3 lanes in each direction with several interchanges linking it to all primary access roads to Makkah Al-Mukarramah. Work is underway on the important southwestern leg which carries pilgrims coming from Jeddah directly to the Holy Areas without having to cross central Makkah. This 8 km section has 4 interchanges linking it to other primary roads and 2 others leading to a housing project. The project is being constructed at a cost of 310 million riyals (US\$85 million). The other sections are scheduled for future construction.

Al-Baha Descent Road

This is a 47 km road project with a total cost of approximately 520 million riyals (US\$143 million). The Al-Baha descent constitutes an important road project in the region and includes 69 bridges with an overall length of 5,747 meters and 34 tunnels with an overall length of 2,011 meters. Total construction time is 36 months. When completed the project will greatly shorten the time and distance between Al-Baha and Tihama regions and will facilitate the marketing of agricultural products in the two regions. Better access to King Fahad Central Hospital in Al-Baha will also be provided. The hospital is one of the most modern and best equipped in the Kingdom.

Madinah Road Interchange near King Abdul-Aziz Airport, Jeddah





Tri-level interchange: Gulf Street viaduct at King Abdul-Aziz Rd., Riyadh

Buraydah Ring Road

This project includes the construction of a 6 lane expressway (3 lanes in each direction), with service roads and side parking in inhabited areas. The ring road has the following components:

Section (1): A 6 km section beginning at the northeastern corner of the ring road and proceeding in a southerly direction to an intersection on the Al-Hadiya Road.

Section (2): 7.85 km from the end of Section (1) proceeding in a southerly direction to Wadi Al-Rummah Bridge. It also includes a relocation of the existing Zulfi Road for a distance of 5 km.

Section (3): 4.15 km beginning at the end of Section (2) and proceeding in a southerly direction. It coincides with the 4.8 km university access link.

Section (4): 7.19 km beginning at the end of Section (3) and proceeding in a southerly direction to an intersection with Riyadh-Qassim Expressway which coincides with the Ring Road for a distance of 4 km.

Section (5): 8.5 km from an intersection with Television Street proceeding in a northerly direction to the intersection with the Buraydah Airport Road.

Section (6): 13 km section which begins at the end of Section (5) and continues in an easterly direction to the beginning of Section (1).

Section (7): The first part of this section is 5.5 km long, the second 11.3 km and the third 1.6 km.

Section (8): A 19 km section involving the construction of a multiple level interchange.

Section (9): Consists of the following:

A. An underpass at the intersection between the existing Buraydah-Unayzah Road and section four of the Ring Road.

B. An underpass in front of the industrial city entrance on the existing Buraydah-Unayzah Road.

C. An underpass in front of the royal palaces.

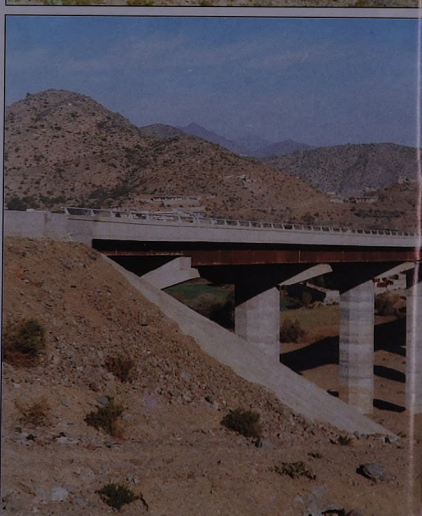
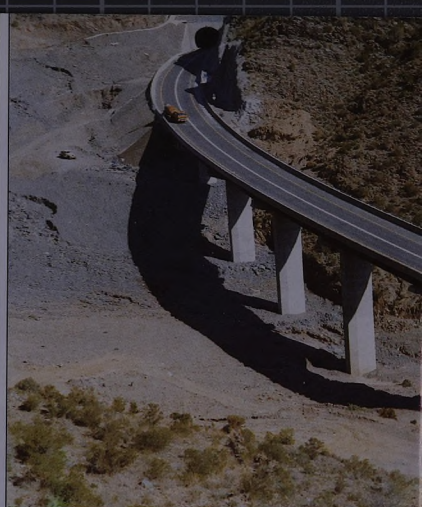
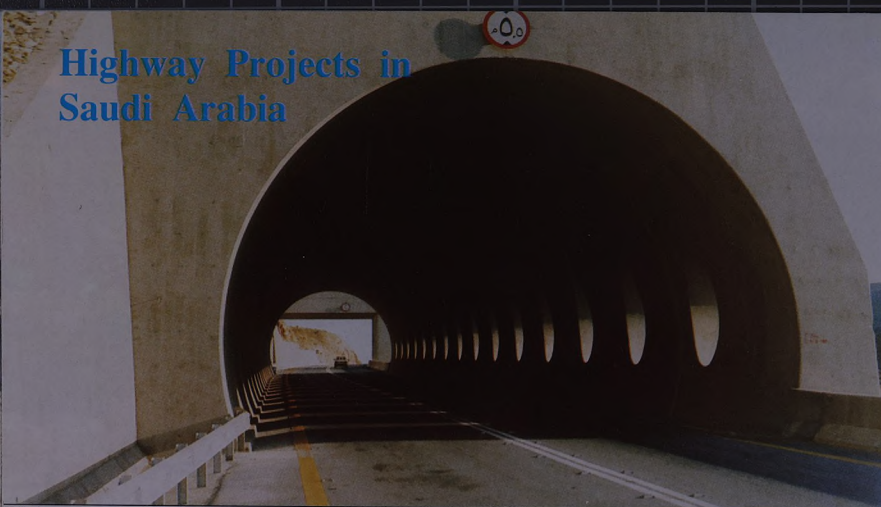
D. An intersection of the southern section of the Ring Road with the existing Buraydah-Unayzah Road.

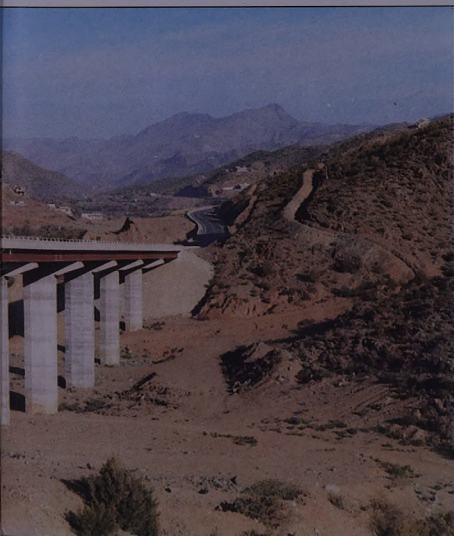
E. 3 intersections on the road from west Unayzah.

Al-Baha Descent (Current Project)



Highway Projects in Saudi Arabia





Highway Projects in
Saudi Arabia



Plans for the Future

Between the period from 1970 to 1985, Saudi Arabia made significant advances in the material and institutional conditions affecting individual and social welfare. A large-scale modern infrastructure was substantially completed for the benefit of all the Kingdom's citizens.

During this time, the Kingdom's paved road network expanded from 8,440 km to nearly 33,000 km (including 3,000 km of asphalted agricultural roads). In 1970, 3,487 km of unpaved roads were part of the Ministry's system; by the end of 1985 there were 50,655 km of such roads.

During the Third Five-Year Plan alone (1981-1985), targets in terms of the number of constructed kilometers were exceeded in all road categories:

Road Type	Target	% Achieved
Primary	6,260	121
Secondary/Feeder	2,144	150
Rural	24,178	138

As might be expected, the number of vehicles has also increased dramatically during the past decade, creating the need for the roads which have been built. At the end of the Third Five-Year Plan period, there were 2,163,000 vehicles officially registered – an increase of 200 percent since 1978.

The Fourth Five-Year Development Plan period, from approximately 1986 to 1990, recognizes that the Kingdom's basic infrastructure has been completed. The new Plan emphasizes improvements in efficiency and productivity.

Now that the basic road infrastructure is nearly complete, Saudi Arabia's road construction program will focus on secondary and feeder roads, as

well as on links to new and expanding agricultural areas. In addition, improvements in road maintenance and safety will play an important role in the near future.

The Fourth Five-Year Plan target for secondary and feeder road construction is 3,350 km. Another 32,800 of rural (agricultural) roads are targeted for addition to the existing unpaved network.

Primary road construction will also continue during the Fourth Five-Year Plan period, but at a pace which responds to the fact that the primary road system in the Kingdom is essentially complete. Construction which started prior to the start of the Fourth Plan will be continued to its completion, resulting in the addition of more than 2,000 km of primary roads to the existing paved network by the end of 1990.

Some of the major road projects which are targeted for completion during 1986-1990 are:

- Riyadh Ring Road
- Madinah Outer Ring Road
- Riyadh - Taif Expressway
- Makkah Inner Ring Road
- Makkah Road in Riyadh
- Qassim Expressway Network
- Dhal'a Descent in Asir Area
- Hail - Al-Ula Road
- Abu Hadriyah - An Nuayriyah Road
- New Al-Hasa Airport Road



Conclusion

The evolution of Saudi Arabia's highway system from desert tracks to an extensive system of superhighways in little more than a generation is a record of outstanding success in engineering and in perseverance. The long distances, the physical conditions, and the lack of experience and trained personnel make the achievement all the more remarkable. Of course it was all possible economically because the Kingdom was blessed with a vast quantity of oil, but that does not diminish the importance of the accomplishments.

The most important achievement, however, seems to have been the manner in which the whole effort was perceived from the beginning. Saudi roads were seen and planned as a means or tool of Saudi development. As the Kingdom began to recognize its potential as a nation, its leaders also recognized the vital role roads would play in the realization of that potential. Perhaps more than anywhere else in the world, we see here a national case study, compressed in time, of road systems being planned and built not as show pieces beyond the needs, and not as desperate efforts to catch up

with neglected needs, but as a necessary basic part of an ambitious program of rapid national development.

The Government of the Kingdom of Saudi Arabia, and in particular the leadership of the Ministry of Communications, had the foresight to understand in the earliest days of national development the importance of a well planned and executed highway network. It recognized that without roads reaching into the remote corners, social development and national unity would not be possible.

The Ministry also showed equal foresight and skill in enlisting the assistance of the world's industrialized nations, and then in assimilating much of the expertise for the further stages of development.

The network of highways, planned and constructed to stimulate and facilitate economic and social progress, may well be seen one day as the single most important use of resources in the accelerated effort to bring the Kingdom of Saudi Arabia to its full potential.

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OPPOSITE:

Night view of Prince Fahd Viaduct, Jeddah

BACK COVER:

Tri-level Interchange: Gulf Street Viaduct at King Abdul Aziz Rd., Riyadh.



