Saudi Arabia-Bahrain causeway management aspects

Autor(en): **Nije, Frans / Svensson, Kjell**

Objekttyp: **Article**

Zeitschrift: **IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht**

Band (Jahr): **12 (1984)**

PDF erstellt am: **15.09.2024**

Persistenter Link: https://doi.org/10.5169/seals-12113

Saudi Arabia-Bahrain Causeway Management Aspects

Gestion de la construction de la liaison routière Bahrain-Arabie Saoudite

Aspekte des Managements des Saudi Arabia-Bahrain Dammprojektes

Frans NIJE
Consult. Eng.
Ballast Nedam
Amstelveen, Netherlands

Frans Nije, born 1937 M.Sc., Delft University of Technology, the Netherlands, worked since 1965 for consulting engineers and joined in 1972 Ballast Nedam Construction International. After various management assignments on international projects he was appointed head of Technical Services Department. Presently responsible for development of Project and Construction Management Services.

Kjell SVENSSON
Consult. Eng.
Ballast Nedam
Amstelveen, Netherlands

Kjell Svensson, born 1943, graduated as M.Sc. 1967 at the Royal University of Technology, Stockholm, Sweden, specialized in Project Management of a projects different stages from design to construction-commissioning and has been responsible for several major commissions in his field i.e. university-hospitals, factories, airports, accommodation-service centers, hydro- and nuclear power plants and bridges.

SUMMARY
The Saudi Arabia-Bahrain Causeway which is to be completed by early 1986, will provide a 25 km long road link between the Arabian Peninsula and the island of Bahrain. This causeway built up of bridge and embankment sections carries a four lane dual carriageway. The construction contract, was awarded to the Contractor on basis of their alternative bridge design in prestressed concrete and featuring a highly industrialized construction approach. This article outlines management features of this international mega-type project together with some aspects of the Middle East construction environment.

RESUME
La liaison routière Bahrain-Arabie Saoudite sera complétée au début de 1986 et permettra de relier la péninsule arabique à l'île de Bahrain, distante de 25 km. Cette liaison comprend des tronçons de ponts et de digues permettant le passage de 4 voies dans chaque sens. Le contrat a été confié à l'Entreprise sur la base d'une variante de ponts en béton précontraint, et faisant appel à des techniques de construction très industrialisées. L'article présente certains aspects particuliers de la gestion de la construction de cet énorme projet, dans l'environnement du Moyen-Orient.

ZUSAMMENFASSUNG
Der Saudi Arabia-Bahrain Damm, dessen Fertigstellung für Anfang 1986 vorgesehen ist, schafft eine 25 km lange Strassenverbindung zwischen der Arabischen Halbinsel und der Insel Bahrain. Dieser Damm, bestehend aus Brückenabschnitten abwechselnd mit Dammbauten, wird vier Fahrspuren in beide Richtungen aufweisen. Der Auftrag wurde dem Unternehmer aufgrund seiner herausstechenden Konstruktionsvarianten für die Brücken zugesprochen. Die vorgesehene Ausführung in Spannbeton verlangt einen hochtechnisierten Ausführungsstandard. Dieser Artikel streicht Merkmale des Managements dieses internationalen Jahrhundertprojekts, unter dem besonderen Aspekt des Standorts im mittleren Osten, heraus.

1. INTRODUCTION

1.1 History. The first plans for this major and prestigeous civil engineering project date back some twenty years. In 1974 Saudi Danish Consultants were appointed as the consultants, after which six and a half years elapsed for feasibility studies, design and pre-tender preparations. Tender documents were issued early in 1980 and sixteen prequalified international construction consortia and companies submitted their tenders in July of that year. After severe competition and extensive negotiations the contract was awarded to the Ballast Nedam Groep in July 1981, based on an offer comprising an alternative bridge design proposed by Ballast Nedam. The contract sum of US\$ 564 x 10^6 was about 15% less than the lowest bid also made by Ballast Nedam but based on the tender design.

1.2 Scope of Work. The Causeway with a total length of 25 km comprises five bridge sections varying in length from 930 to 5190 m at a maximum water depth of 13,0 m and seven embankment sections with lengths ranging from 620 to 3130 m in a water depth up to approximately 5,0 m. Two navigation channels are included in bridges 3 and 4, with ship clearance heights of 28,5 m and 18,5 m respectively, relative to the mean sea level. Standard bridge spans are 50,0 m except for bridge 3 which has a main span of 150,0 m and two side spans of 80.0 m. The bridge design consists of prestressed concrete structures for both sub- and super-structures comprising a high degree (90%) of prefabrication with elements weighing up to 1300 tonnes, and with an advanced material specification to prolong the durability.

1.3 Construction Environment. Construction projects in the Middle East are mostly organized along traditional lines, that is a sequential scheduling of project phases from inception through design, construction and commissioning. Most construction contracts are of the FIDIC type, but sometimes considerably modified to suit local traditions, regulations and business attitudes. Ballast Nedam, together with other West European, American and Far East companies has successfully been executing, individually or in joint venture, a number of other large and complex projects in the oil producing countries of the Middle East, however not without a learning period for adapting to the scale enlargement effects and the local business and construction environment. The enormous development and construction booms over a relatively short period of time, together with a restricted local construction experience on the one hand, and the strong position of a demanding Client with his Arabic cultural and social background on the other hand, has made the positions and roles of the contractual parties develop somewhat differently from the West European pattern. The Clients, for instance, act much more directly towards the Contractor in both contractual and technical matters, sometimes assisted by additional advisors, such as quantity surveyors and and other specialists from international agencies. In these circumstances we see the consulting engineers forced to act as the technical supervisor only, rather than the traditional contractual and technical representative of the Client.
The contractor is thus directly confronted by a Client and an environment in which the socio-cultural features are quite different from his own. This may lead to unusual demands and complicated lengthy procedures for the processing of approvals for materials, variation orders, payments and permits. It is therefore necessary that both the contractor and engineer show the flexibility and the will to build up the necessary trust levels and informal working relations between themselves and the Client, as otherwise the project which in general is faced with considerable imports of labour, material and plant, will be subject to large procurement and logistical problems and thus delays and financial losses.

LAY-OUT SAUDI ARABIA-BAHRAIN CAUSEWAY

AUGUST 1984

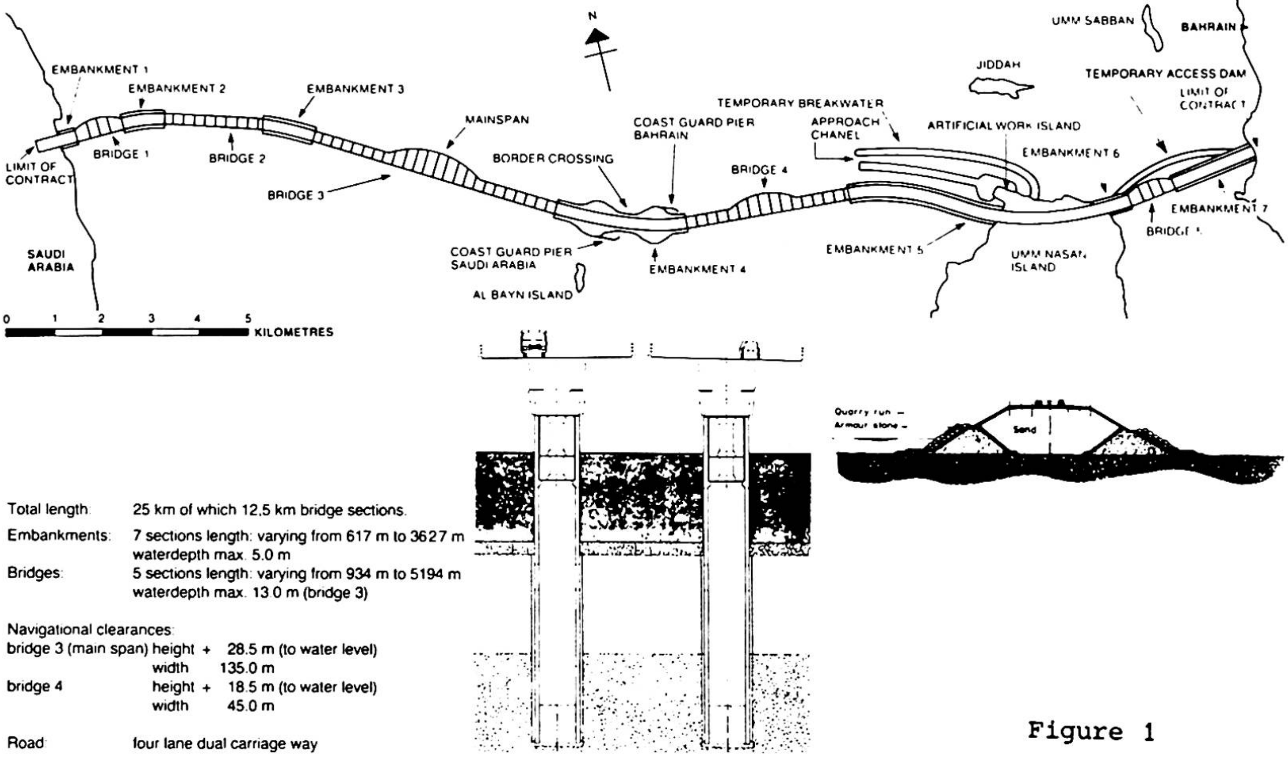
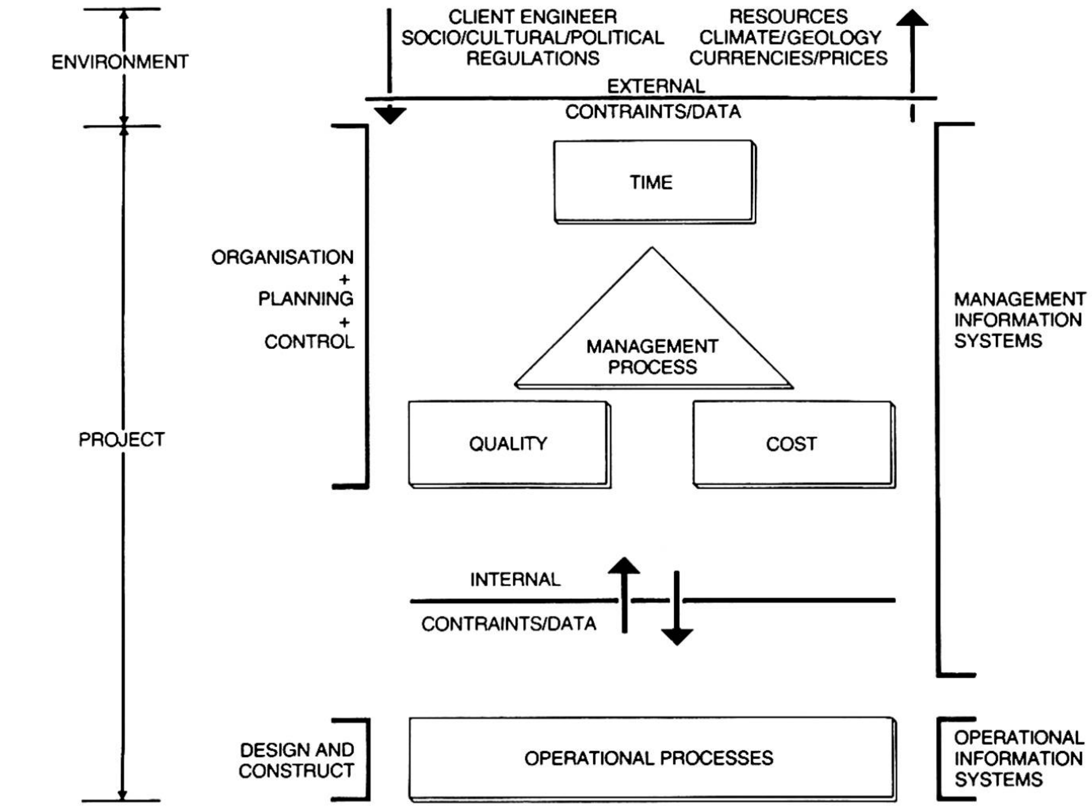


Figure 1

MANAGEMENT PROCESS - SBC

Figure 2



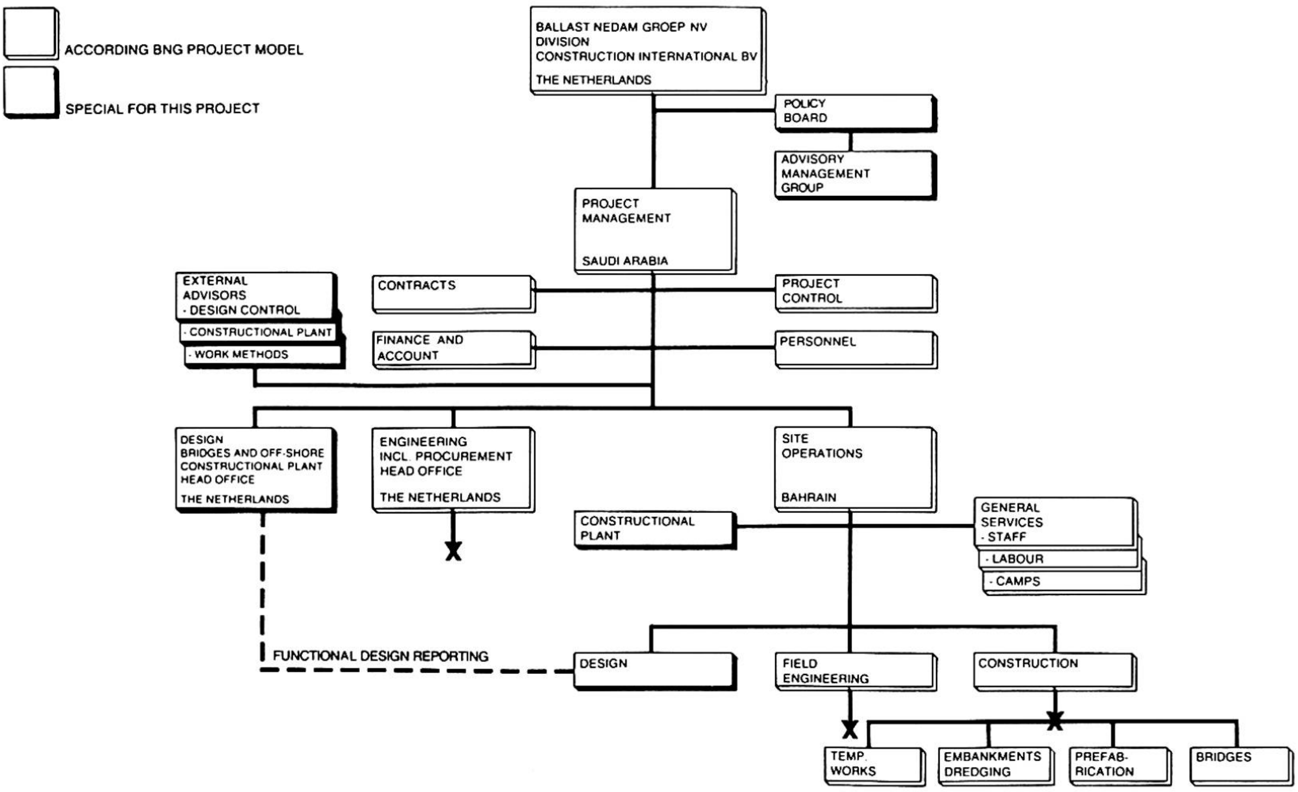
The project processes are presently subject to further contraints caused by the understandable policy on the part of the government to impose on foreign contractors the use of local materials, local agents for imports and local sub-contractors. To these impediments we have to add the more general aspects of international contracting, like the unknowns inherent in the one-time relationship between the contract parties, currency and price fluctuations, and political risks.
It will be evident that the combination of these external local constraints together with the organisational and financial demands and risks resulting from project scale enlargement render the execution of a contract in the Middle East a complex and vulnerable enterprise with regard to time, cost and quality, consequently a project approach by means of a clear management concept based on local experience is essential. This concept should recognize the influence of internal and external constraints and the necessity and ability to control them, which can be summarized by the simplified process model (figure 2). This model separates the management functions from production and furthermore distinguishes the well-known project parameters of quality time and costs with the required information systems to control them.

2. PROJECT MANAGEMENT

The experiences of the last 10 years with large scale projects within Ballast Nedam has led to the implementation within our company of a model organisation structure (figure 3) with master procedures and systems for such projects. The project managers have to use this model as a framework for organizing their projects. With this model an effective utilisation of available know-how and systemized project information and reporting is achieved for not only the various projects levels but also the higher divisional levels.

BALLAST NEDAM PROJECT ORGANIZATION - SBC

Figure 3



2.1 Organisational Structure. The project model can be clearly recognized within the organisation of the SBC-project, see figure 3. Engineering and construction have been split up into four managerable and technically independent operations being:

- temporary works, including the reclamation by hydraulic fill of the work-island (1.6 x 10^6 m^3), access dams (3.3 km), dredging of the access channel (5 km), erections of prefabrication facilities on a 300.000 m^2 area, workshops, camps, offices etc.
- on-shore fabrication of concrete bridge elements
- off-shore erection of standard bridges and main span bridges
- embankments, including the quarrying of stone and dredging.

Essential to the site operations of Middle East projects is the Department of General Services, which is responsible for all staff and labour recruiting, board and lodging and the human relations within the multinational community which is created for these projects. The Contract Department plays a vital role in managing the external constraints apart from administrering the contract and sub-contracts. Another model feature is the project control department, which although directly serving the project management has also a functional responsibility towards the divisional control section to safeguard the quality of management information.

The special features of each project have always to be laid-out and compared with the basic features of the standard project model and the available staff resources to establish whether any changes or additions to the standard model are necessary to arrive at an effective organisation.

For instance the SBC-project, without a time-extension for the required design, was faced with severe time restrictions for establishing final project policies and decisions on key aspects such as:

- detailed consequences of acceptance of the alternative design,
- choice of work methods in combination with company investments for constructional plant.
- final specifications for the reinforced concrete, yet to be decided by the client,
- all items or decisions which either would have great impact on programming, cost and quality or would have a direct bearing on the overall investment programmes and liability of Ballast Nedam as a company.

The above mentioned aspects can be directly projected and summarized and will then give the following list of items of which some are general for large international projects and some are unique to SBC-project, but still have an influence on the risks and the ultimate result:

PROJECT INFLUENCE ASPECTS	TEMP.W.	BRIDGES	EMBKS
Off site (home office or elsewhere)			
*1) Contractor's design/durability responsibilities	x	x	-
*2) Work methods/plant section	x	x	0
3) Interrelations technique/time	x	x	-
4) Logistics: non-local material and plant	x	x	0
5) Engineers approvals	x	x	0
On-site (Bahrain/Saudi Arabia)			
*6) Quality assurance (climate, soils)	0	x	0
*7) Interrelations technique/time	x	0	-
*8) Logistics: local and non-local material/plant-spares/labour	x	x	0
9) Maintenance/Repair of Plant/Services	x	x	0
10) Sub-Contracting	0	-	x
11) Engineer's/Client's approvals	0	x	0
12) Government approvals/permits	x	x	x
13) Cultural/Social/Political constraints	x	x	x

x/0/- = large/normal/limited influence on cost and/or risk
* = typical SBC features

The normal course of action, reporting and decision making via our normal project model and company hierarchical lines were not considered feasible in terms of the required speed and quality of these decisions. To be able to cope with this situation an ad hoc policy group was formed on divisional level headed by the head of the international division, which was responsible for the project, supported by an advisory group consisting of the project manager, the heads of design, engineering and site-operation departments, technical and financial specialists (figure 3).

Within the framework of the milestone planning of the project the advisory group managed to prepare reports to an extent and quality that allowed fast and timely decisions by the policy group. Also special recommendations were prepared such as postponement by 30 weeks of the start of pile production and off-shore installation to allow ample time for optimum design- and equipment-engineering. Both decisions, for which firstly the Client's approval had to be obtained, contributed greatly to the quality and smooth progress of the works on site.

2.2 Design Guarantee. As well as the design for the bridges the contractual design guarantee was also transferred to Ballast Nedam. To assure the necessary internal design quality standards and controls, within our project model a separate engineering department was created with its own responsibilities towards the project management. The latter was charged with the proper coordination between design and engineering departments to optimize the project results (figure 3). To further limit the risk connected with the design guarantee, Ballast Nedam appointed an independent civil engineering consultant to make a check on all vital structural systems and elements. This check, together with the contractually required approval by Saudi-Danish Consultants was considered to be prudent to safeguard both Client and contractor from any calamities due to design errors.

2.3 Planning & Control. The vulnerability of the project due to the scale effects and constraints as described required great emphasis on coordination of planning and control of time, costs and quality throughout all stages of the project (figure 4).

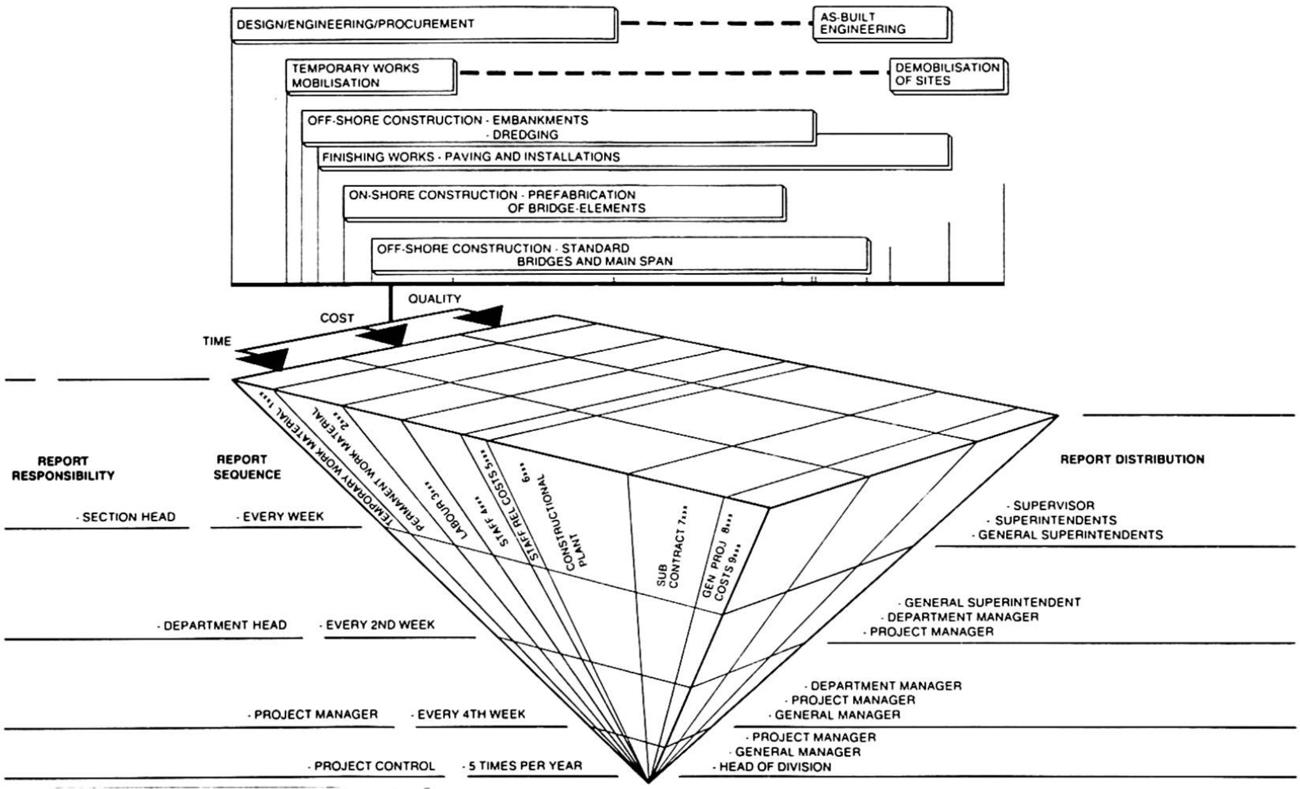
The time planning and monitoring systems are built up in two sections, the contract system in accordance with the Client's approved programme, and Ballast Nedam's own target system (figure 5). Within these there are three different levels; from detailed day-to-day programs up to overall summary schedules. Resources are allocated and linked together by milestones and built up from work method manuals and logical networks for the different operations.
The cost model with a planned sequence of detailing the tender estimate, parallel with the design development up to a fixed status called the work estimate, formed the allowed budget and reference basis for all periodical follow-up. The model included a coding system which facilitated a detailed split up per operational job item, as well as aggregated summaries per discipline, resource and responsible organisational unit.

The quality control is based on programs linked to the design, engineering, and construction stages of the project and to the specifications and test procedures for permanent and temporary materials, equipment and work methods, as well as the final product. The quality control program is controlled overall by a Quality Assurance Group for local as well as non-local tests executed by Ballast Nedam, suppliers or independent laboratories.

The above mentioned models (figure 5) and systems mentioned above are first coordinated overall, then detailed to operational units and finally rechecked against the original milestones allowing the possibility to adjust the milestones at an early stage. To process and generate the information flows a computerized information system is required (figure 6) complemented by manual summaries for the trend and deviation reports, selected for the various levels within the organisation (figure 4 and 5).

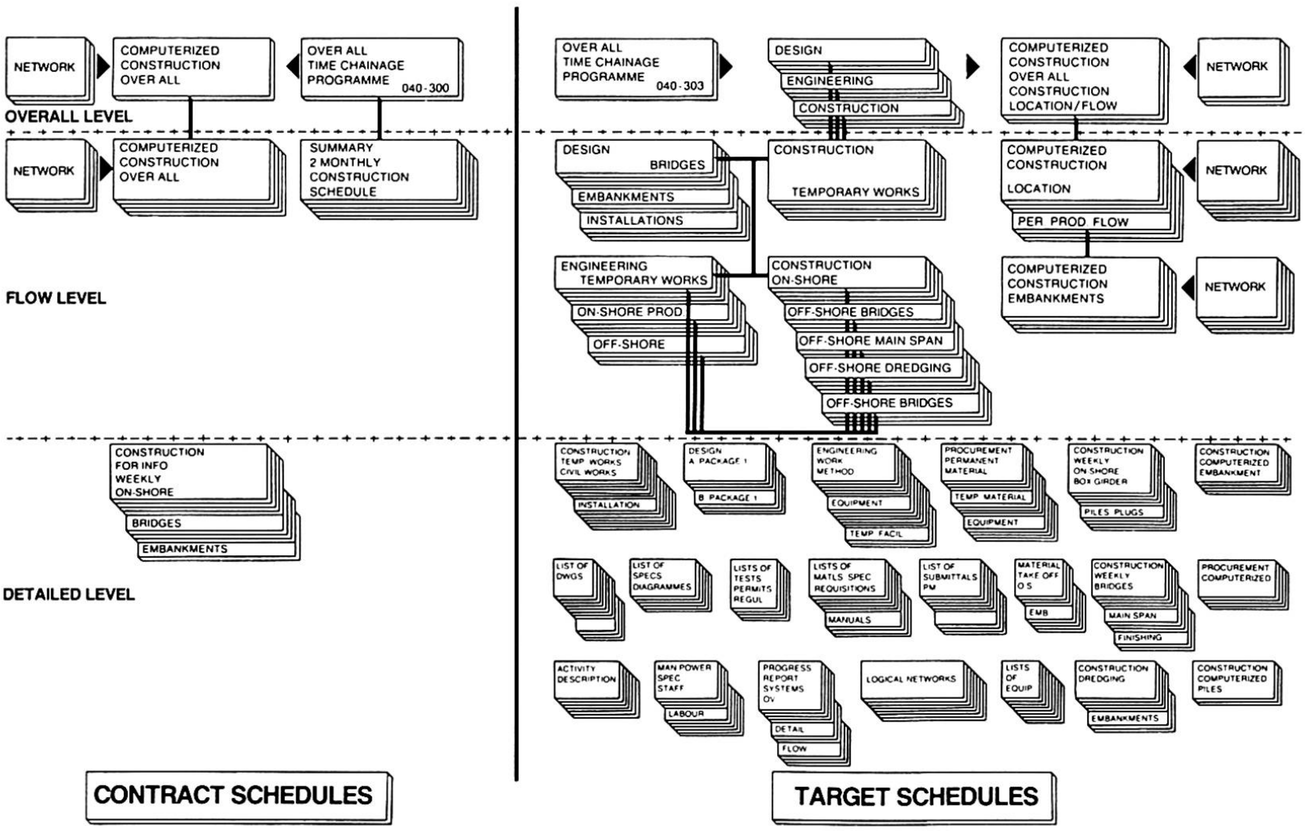
PROJECT MANAGEMENT CONTROL- AND REPORT STRUCTURE - SBC

Figure 4

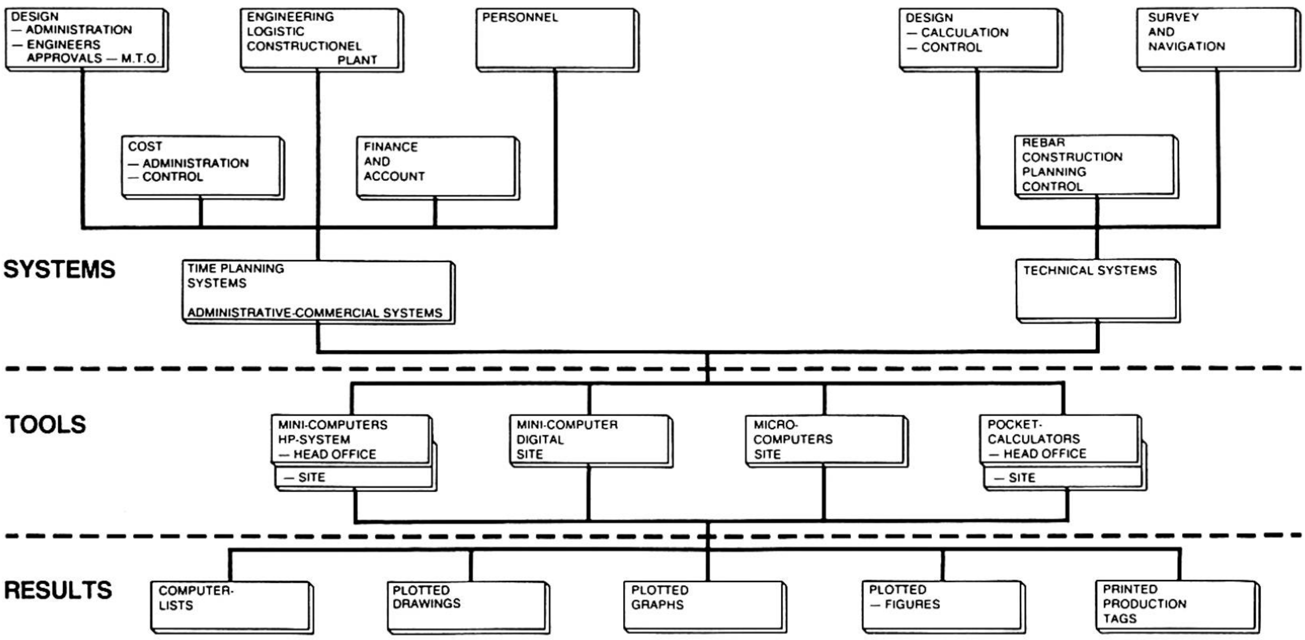


PROJECT OVERALL TIME SCHEDULING MODEL - SBC

Figure 5



COMPUTER SYSTEMS SUMMARY - SBC *Figure 6*



3. ENGINEERING MANAGEMENT

The proven importance of a well organized and accurate Engineering stage was emphasized in this project due to the additional design as well as equipment and material engineering programs resulting from the acceptance of the alternative bridge design. At the same time the huge site preparation and soil investigation programs had to be executed. How vital the management of this project phase was, is reflected by the cost commitment curves (figure 11).

3.1 Design Engineering. Within the milestone fixed in the overall program, detailed breakdowns and planning of activities were made for sub- and superstructure design calculations and drawings, material engineering and testing, all summarized per responsible department and the actual progress monitored against planned progress.

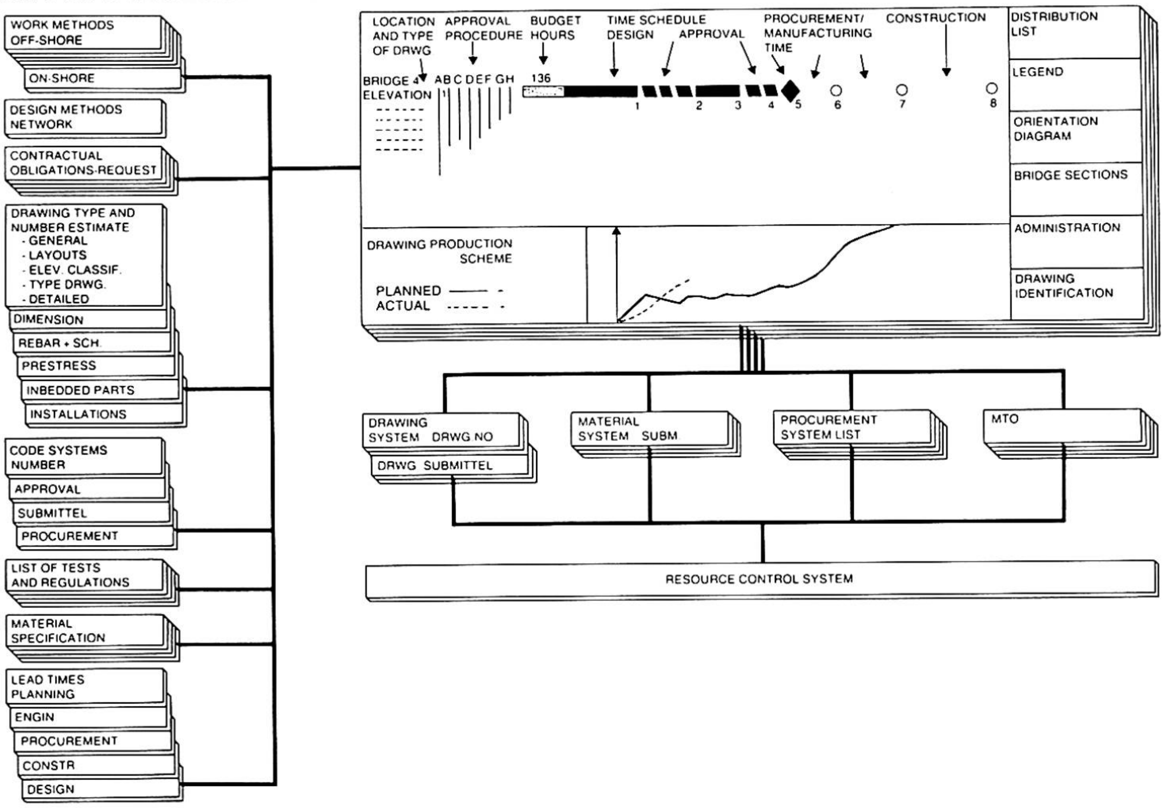
Furthermore, it was again experienced that one of the crucial activities within the engineering processes was the obtaining of approvals from Engineer and Client of tests, drawings, material specifications as well as construction methods. This was solved by an early agreement with the Engineer on a separate submittal system, which provides the control over the approval process time and qualitywise (figure 7).

Additional pressure on the organization during this stage was caused by a number of variation orders which had major consequences on the design concept, such as the shifting of the main span to bridge 3 including an increase or this span from 90.0 m to 150 m and the acceptance of our durability recommendations, which modified the material specifications and testing requirements considerably all without time extension for the completion of the contract.

3.2 Equipment Engineering. Parallel and coordinated with the design, the work methods were developed for prefabrication, transport and placing of 7000 precast elements consisting of more than 30 different types with weights up to 1300 tons per piece. Specially made construction plant worth over US$ 70 million and temporary facilities for on-shore as well as off-shore worth about US$ 50 million had to be designed, ordered and manufactured within nine months. The requirements were established per operation process and finally compiled in drawings, specifications, work-methods, equipment lists, manuals, departmental organisation routines and time schedules, all in relation to the overall programme.

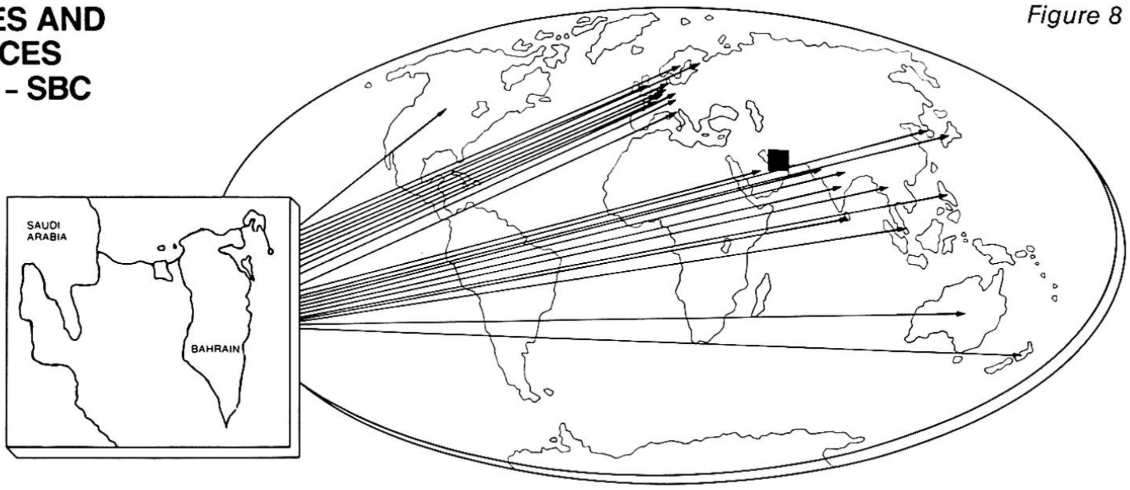
DESIGN MANAGEMENT SYSTEM - SBC

Figure 7



RESOURCES AND THEIR PLACES OF ORIGIN - SBC

Figure 8



STAFF AND PERSONNEL

The Netherlands	Staff
U K	Staff
West Germany	Staff
Finland	Staff
Sweden	Staff
France	Staff
Italy	Staff
U S A	Staff, Client/Advisors
Australia	Staff
New Zealand	Staff
Saudi	Client/Advisors, Labour
Denmark	Client/Advisors
Philippines	Labour
Korea	Labour
Thailand	Labour
Nepal	Labour
Sri Lanka	Labour
India	Labour
Singapore	Labour
Bahrain	Labour
Pakistan	Labour

MATERIALS

Saudi	Stone and rockfill, cables, lighting columns and fittings
Bahrain	Stone and rockfill, consumables, paint, PVC-pipes
The Netherlands	Cement, reinforcement steel, posttensioning - system, general fittings for construction, mortar, injection resin, guardrails, filter fabric, concrete spacers, lenton coupler, blasting grit
West Germany	Inbedded parts and fittings for posttensioning systems, dywidag-posttensioning bars, imbedded parts and fittings expansion joints
Switzerland	Epoxy- coating/piles, posttensioning system (cona-multi) Epoxy glue/main span
U K	Additives for concrete and mortar, reinforcement steel, grout mortar, repair mortar, epoxy resin
Sweden	Welding material, navigation lights
Italy	Elastometric bearings
Belgium	Formoil
Japan	Posttensioning wire and strands, electrical cable
United Arab Emirates	Aggregates for concrete, repair mortar, epoxy resin

EQUIPMENT, SPARE PARTS AND SERVICES

The Netherlands	Selfelevating platforms, girdership, tug boats, 1400 T main gantry and 80 T gantry pontoons, small working boats, diving equipment, moulds and formworks
Singapore	Dredger from idle area
Japan	Sheerleg, desalination plants, forklifts
U K	Rebar sheerline, rebar optimising computer, micro computers, under water video system
Italy	Rebar coil stretching and cutting machine
Sweden	Survey instruments, welding equipment
Australia	Computersystem
U S A	Mini survey positioning system, computers, mac trucks, cranes, engines, compressors, positioning systems
West Germany	Wirth drilling equipment, batchplant, swing pumps, aggregate washing equipment
Switzerland	Survey instruments
Finland	Skylift

SUB-CONTRACTORS, SERVICE-CONTRACTORS

South Korea	Dong Ah placing of wet embankments
Saudi	Truck transports of rock and stonematerial
Bahrain	Truck transports of rock and stonematerial diving service contractor, asphalt sub-contractor
U K	Survey service-contractor
Australia	Survey service-contractor
United Arab Emirates	Computer service-contractor
France	Bachy soil stabilising foundation sub-contractor

3.3 Procurement, logistics. These had to be organized for the import of all materials and equipment for permanent work, as well as all main materials and equipment for the temporary works and maintenance. These imports comprised about 30.000 tons of goods per month. The whole operational structure is coded and based on a requisition system, split up into local and non-local purchase and divided per code into twelve different stages from purchase submittal up to use on site. A market survey of possible suppliers, manufacturers, and sub-contractors was carried out, organized and sorted per material and discipline. The different companies were then gradually selected, approved by the Client and finally incorporated in the detailed design. This entire operation was administered by a computer system based on lead times for the procurement stages.

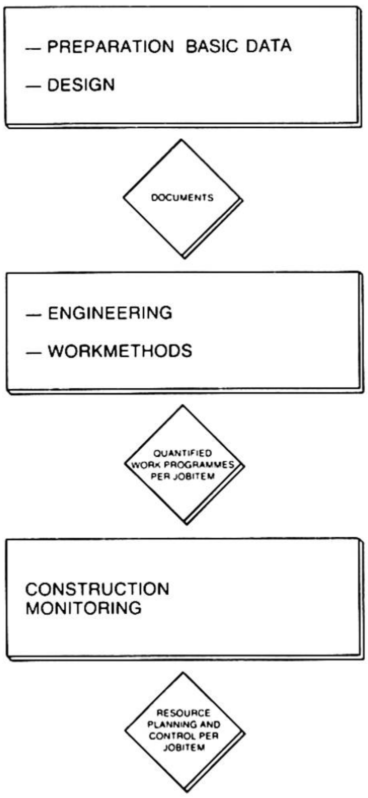
Schedules were developed on site for material deliveries based on a material take-off from preliminary drawings, broken down to usage per unit to be produced on-shore as well as off-shore. These were linked to target production schedules summarized per material code and displayed in graphs. To ensure the material would be on site in time, in the correct quantity and quality, three different consumption graphs were produced per material.
The maximum production rate graph, calculated minimum stock quantities, quality tests, means of transport inclusive of shipping and clearing time, gave the site requested delivery times.

For local purchase and material deliveries a corresponding but simplified system was developed and included a recording system for stock control and usage and distribution of materials to different departments, as well as per supplier.

In addition to this and in order to streamline the quality, reduce the unit prices, secure the deliveries, reduce administration costs and the stored quantities etc., a local supply contracting system was introduced for 30 areas of consumables. This covered about 80-90% of the total requirement and gave fixed annual prices achieved in competition.

OVERALL SYSTEM CONSTRUCTION CONTROL - SBC

Figure 9



All shipments were continuously recorded and controlled via a computer system supplying information about quantities, values, means of transport, arrival dates, bill of entry, custom duties and custom handling charges, letters and bank guarantees for clearance etc.
Staff and labour requirements were extracted from the work estimate, allocated to time schedules and summarized. They formed the basis for recruitment either within Ballast Nedam or externally through service contracts or agencies in Europe and the Far East (figure 8). However, before the final recruiting of for instance the 1400 men labour force, they were tested by Ballast Nedam's own staff.

4. CONSTRUCTION MANAGEMENT

The construction stage, organized and split up into temporary works, on-shore and off-shore production, was first functionally coordinated and then on a time and resource basis. Timewise by means of logical networks based on work method statements, manuals, organization schemes and through production unit rates displayed in time schedules.

Resources, coded and defined into job items in the cost model, are extracted and linked to the planned in order to get the planning usage rate per time unit, which is then controlled and followed up periodically. This basic work preparation was carried out in phases during the design engineering stage and adjusted based on experience gained during the start up of construction (figures 9 and 10). It was then monitored by work analysis studies comprising workmethods, usage of labour, materials, equipment etc.

For example, to organize and minimize the losses of rebar in the prefabrication of reinforcement cages, a special computer program was introduced, which after computerizing the rebar bending schemes for the different types of elements could link them together in accordance with the time program. The computer could then summarize the requirements per diameter and combine them in order to utilize the maximum length of the bars. The program also took into consideration the elongation due to bending and the tolerance allowed for in the norms and specifications. The computer not only printed the different types of reports for the supervision of the work, but also cutting and bending instructions for the operators and 6-colour printed identification tags for the rebar bundles, as well as showing the location for welding and further prefabrication up to the finished element.

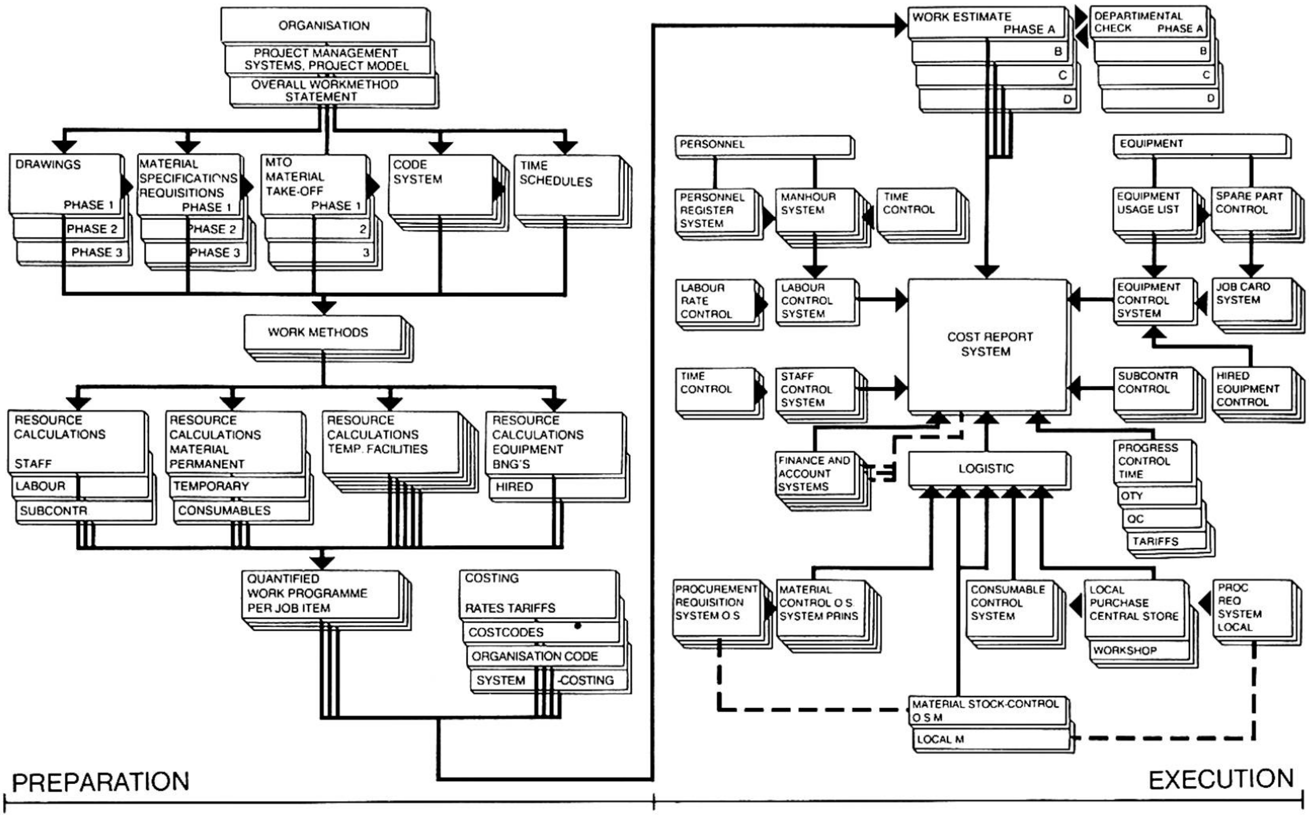
For follow-up and trend analyses of the labour force performance, the daily time record sheets per job item were summarized in weekly labour time sheets, recording all spent hours per job item. These were then computerized and sorted into different report levels as well as being compared with planned and actual measured progress of work. For the trend reports, cost comparisons of labour cost rates using tariff models were used. A corresponding system for equipment was also developed.

The follow-up of production, timewise, was correspondingly made on report levels from day-to-day records, such as cut and bent tonnage of rebar steel, cast m^3 concrete and weekly records of Client-approved elements. Progress is measured per day, per week, per fortnight and compared with the contract schedule as well as the different target schedules (figure 11).

Insurance claim handling, including recording, lodging of claim, estimation, negotiation with underwriters, loss adjustors etc., is an important part of the cost control of construction. Not only because of the total amount of premiums to be paid for the fifteen policies in use, but especially because of the strong possibility that accidents and incidents will happen which have cost consequences ranging up to hundreds of thousands of dollars. Accordingly, a computer system was developed to record and monitor the insurance handling.

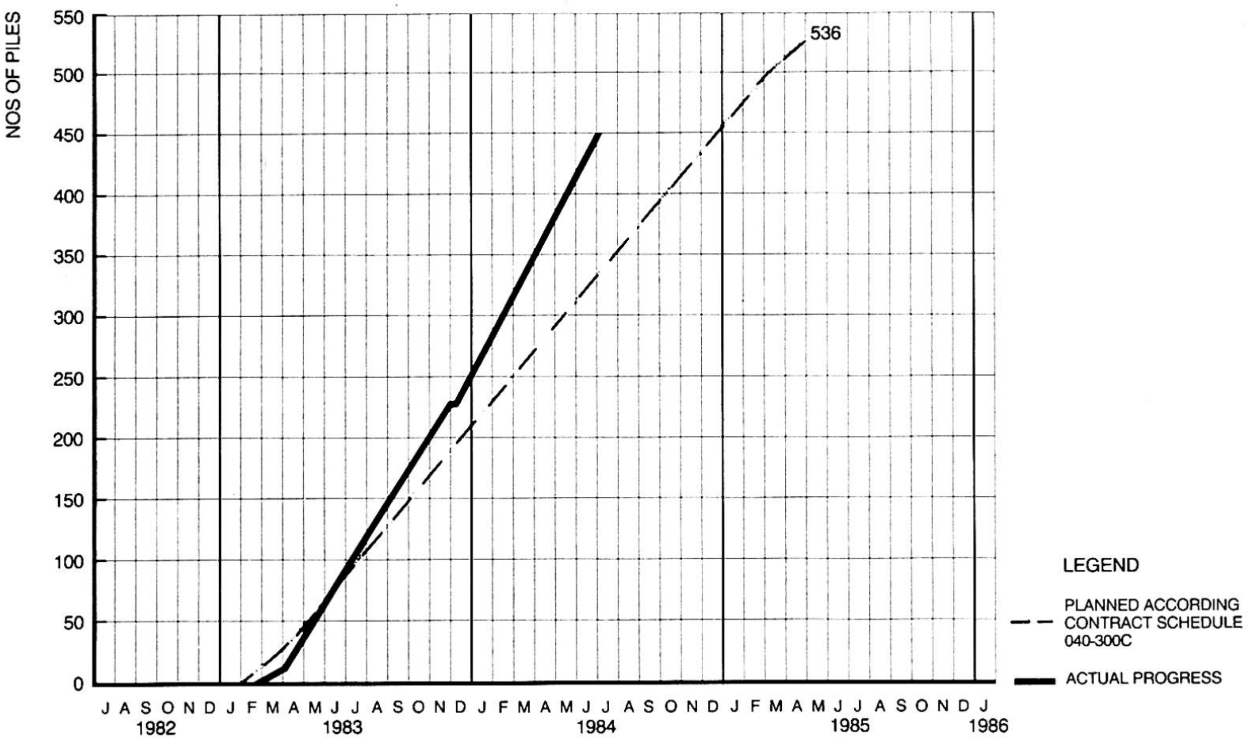
SYSTEM FOR COST CONTROL - SBC

Figure 10



PROGRESS CHART PILES - SBC

Figure 11



5. SUMMARY OF EXPERIENCE

Although there are still about one and half years to go on the contract, the following conclusions of experiences gained can be made, summarized into six major areas and in the decision - milestone summary (figure 12).

5.1 Integration of Design-Construction. In this project no allowance was made by the Client in advance for carrying out an alternative design, the original construction time of 225 weeks had to include this as well, which up to now shows the following:

- the necessity of a total, integrated design-construction approach with phased stages linked via engineering-procurement to construction, in order to ensure correct information for management decisions to be taken within the first few months, but ruling for the remaining years of the project,
- time saving, the total project time can be reduced, presently the sub- and superstructures are 24 weeks and 8 weeks respectively ahead of schedule, estimated time for handing over, (E.H.) see figure 12, is 6 weeks ahead of contract requirements,
- cost saving, about 15% through combined utilization of the design qualifications and the experience from the construction market (see figure 13).

5.2 Extensive Early Preparation and Logistic. The overall work method statement which was the basis of BNG's design alternative called for an on-site manufacture of prefabricated items, limited in numbers of variations to fit a modern industrialised factory production, but flexible enough through a special technique of assembling the items, to accommodate changes required later in the project when the phased design and soil investigation had been finalized. The success of the site operations both in time, cost and quality again underlined the emphasis of proper time and budget allowance for an early extensive preparation and corresponding logistics to be used for:

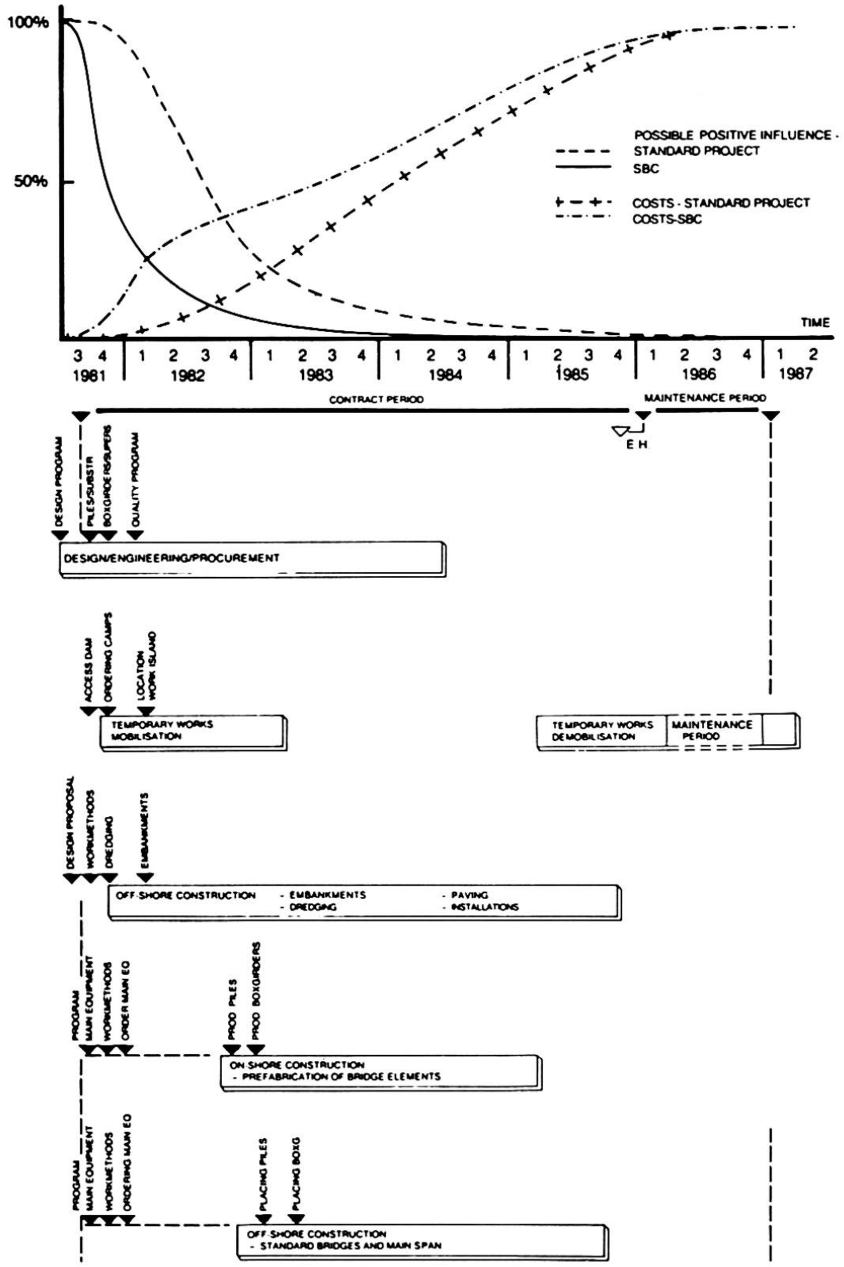
- workmethod studies, especially for those with multy usage of materials and equipment,
- coordination and development together with vendors and suppliers, especially for alternative future use of expensive equipment,
- tests and 'dry runs' of material, equipment and even personnel before sending them overseas because the possibilities for correction locally are limited, time consuming and costly,
- full scale tests on prefabrication and of equipment,
- early approvals from client or engineer for design and engineering principles and test procedures.

5.3 High Quality Demands Versus Execution. The high quality standard and durability demands specified in the Contract and later on increased in variation orders to the Contract were met by an:

- extensive market survey of alternatives of materials and constructional plant including tests, analyses and assistance by external advisors,
- phased design and work method engineering,
- maximized prefabrication, because of the ability to better influence and control the tolerances and quality in the factory than in-situ made off-shore,
- improved accuracy of off-shore placing of the elements both regarding quality and time.

5.4 Project information System. In order to be able to monitor, control and communicate the huge amount number of information, data etc. generated in a project like SBC a well operating project information system is required. Organised in details to suit the day to day operations as well as hierarchly coordinated to enable production of selective summaries, for the different levels within the project organisation, as reliable bases for trend analysis and influence on decisions and actions.

DECISION MILESTONE SUMMARY - SBC *Figure 12*



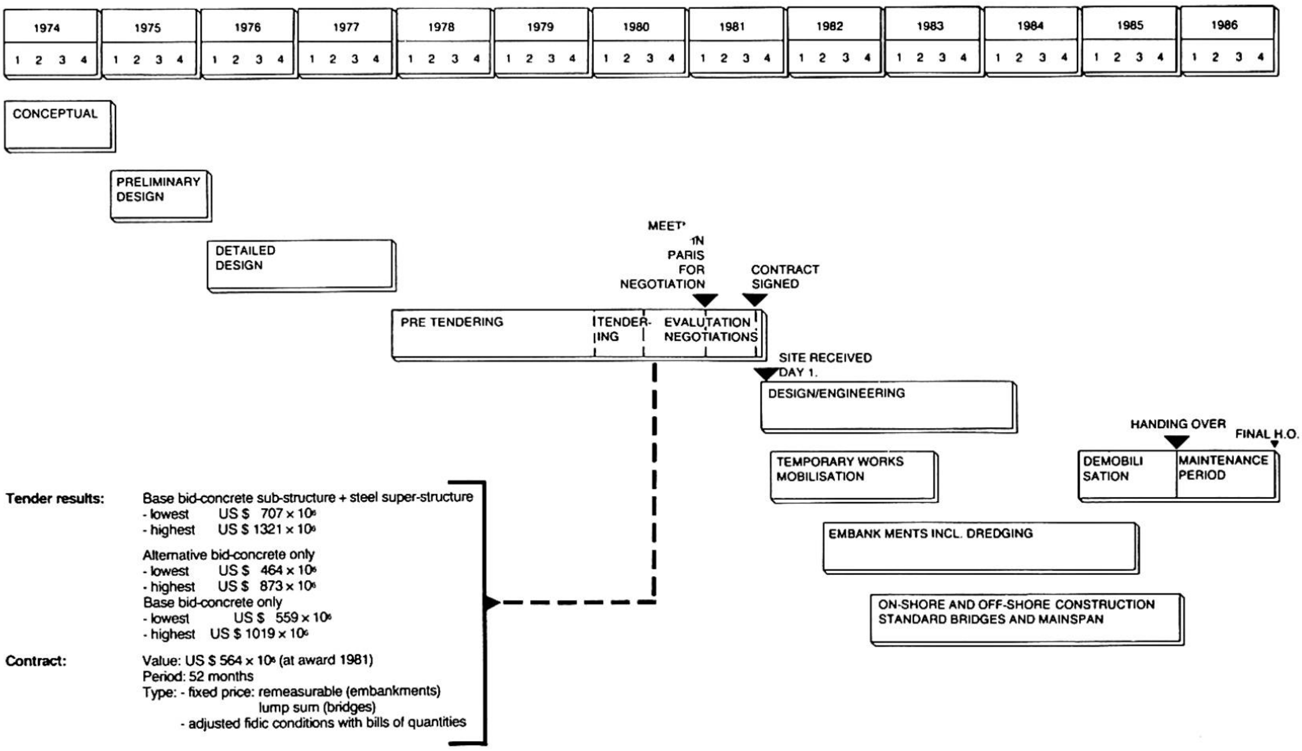
<u>5.5 Established Approval Procedures.</u> The nature of this project as has earlier been described was complicated not only by reason of responsibility due to Ballast Nedam's design alternative versus the Engineer's proposal, the geographical spread of the parties and resources involved, but also by the short period during which the principles and alternative proposals had to be approved by the Client or Engineer.

Those constraints were met by early well established approval procedures including:

- phased approval procedures, for design calculations and basic drawings in Europe, detailed design work methods on site in Bahrain, and variation orders, suppliers, sub-contracts and permits in Saudi Arabia,
- scheduling within the overall work program of all items and approval routines including checking, revision, approval and final delivery of documents and samples.

PRE-CONTRACT AND CONTRACT DATA - SBC

Figure 13



5.6 Relations Client-Engineer-Contractor. In this project with its very high site costs resulting from and consisting of expensive specially made heavy equipment, prefab factory, trained contracted personnel and with a large continuous flow of world wide imported high quality bulk materials, the importance of keeping the production running without disturbances can not be over emphasised. This could only be achieved by establishing and monitoring the routines and operations and a secured follow up by the contracting parties.

It goes without saying that those mega projects in developing countries nevertheless always create unforeseen incidents or events which will require solutions dependent upon positive and flexible well integrated teamwork based on mutual trust between the Client, Engineer and contractor.

Leere Seite
Blank page
Page vide