

ROLE OF ENGINEERING IN OCEAN DEVELOPMENT

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The study of any topic generally involves a scientific base (the "Why" and "Where" aspect) and an engineering component or practical application of scientific knowledge (the "How" aspect). The scientific understanding of the oceans is termed "Oceanography", whereas its applied aspect is called "Ocean engineering". The field of ocean engineering was first recognized in academic and professional circles during the 1960's. Ocean engineering is the application of scientific knowledge of the oceans to the economic welfare of man.

Engineering tasks associated with the oceans are vastly more expensive than similar activities on land. The hazards are greater and the organization more demanding. There is an increasing demand on the ocean resources for food, energy, minerals, transportation and recreation.

AN EXAMPLE:

To visualise the role of ocean engineering, let us take an example of a simple operation to be carried out in the ocean. Consider a simple bottom anchored buoy implanted to measure various parameters like wave heights, current speed and direction, tides, temperature, conductivity, salinity, pressure, wind speed and direction etc. in an open ocean. To anchor it, we must know about the sea bed soil conditions and the forces acting on the buoy and its mooring line. But, forces can be computed only from a knowledge of local waves and currents and their effects on the floating body. Does the buoy have more than one stable position? What kind of material should be used to connect the anchor with the buoy? Would it corrode and what would be its life? What about launching procedures, retrieval methods, the sinking of the mooring and the reduced strength due to corrosion of the mooring line? How shall we record the data, self recording or by telemetry systems? How shall we deploy the mooring system? Should we use a diver to inspect the mooring to ensure that it has taken the correct position and all connections are in tact? Answers to all these questions will have to be found by an ocean engineer.

The present engineering design procedures start by assuming an estimate for wind and oceanographic parameters which could be substantially wrong because of lack of adequate data on the complex environment of the oceans. Uncertainties can also occur while trying to estimate the sea bed soil properties and the fatigue life of the structure. In addition to these uncertainties, one should also take into consideration the problems and uncertainties involved with marine construction materials and technology.

COASTAL ENGINEERING

The nearshore ocean engineering activities with particular reference to

Efforts are being directed towards:

- (a) The development of ocean transportation for commercial purposes by improving the existing ports and harbours and undertaking new harbour projects including deep water harbours and port facilities.
- (b) Development of new fishing grounds and fish farming technology and improvement of fish processing techniques which are directly related to the development of marine living resources.
- (c) Development of marine mineral resources especially petroleum and natural gas.
- (d) Development of desalination technology for providing drinking water supply in certain regions of the country.
- (e) Development of engineering systems for extracting non-depletable energy from the sea, for example, tidal power plants, wave power plants, ocean thermal energy conversion (OTEC) plants etc.
- (f) Control of coastal erosion by using suitably designed protective measures.
- (g) Development of coastal shipping and inland water transport facilities.
- (h) Control of nearshore water pollution by adopting suitable effluent disposal systems.
- (i) Development of coastal recreational facilities and marine parks.

OFFSHORE ENGINEERING

Offshore Production Systems for Oil and Gas

The problem of offshore oil exploration and production is technologically far more complex than on land. A typical offshore production system consists of a well-platform, a process platform, a flare structure, a submarine pipeline and a Single Buoy Mooring System. The following factors are to be given due to importance while planning and designing of an offshore production systems:-

i) The offshore work is of multi-disciplinary in nature requiring an effective inter-action between geologists, petroleum engineers, oceanographers, ocean engineers, naval architects etc who should adopt a systems approach.

ii) In many cases, as in India, the basic environmental data are generally not available or very limited when available, and to predict design parameters from these inadequate data implies a great deal of uncertainty.

iii) The offshore production systems are, in general, set up much before all the necessary data regarding the extent of oil and gas reservoir, its possible behaviour etc. are adequately known. This leads to a situation where

systems are installed which need continuous reappraisal and modifications depending upon the actual data being collected from the reservoir.

The problems associated with the design of offshore structures can be broadly divided into four parts:

- (a) Obtaining the basic environmental data for defining the design and operating parameters for the various types of offshore structures.
- (b) Design of various elements associated with the offshore structures on a sound engineering principles and design codes.

Erection procedures and the maintenance of structures in the ocean and their impact on the design.

- (c) Management and logistics so that whole operations connected with the construction, installation and operation of the offshore structure are planned in a very systematic and cost effective manner so that there are minimum of risks and loss of time at sea.

Basic environmental data are required for estimating the maximum probable forces on the structures and for laying down the conditions under which the structures can operate during their life time with safety. For this purpose adequate data on meteorological, oceanographical and marine geotechnical engineering aspects should be obtained before an offshore structure at a particular location can be properly designed and operated.

A problem involved with the maintenance of offshore structure is the possibility of oil pollution and the problem of waste disposal. The gas, which is produced in an oil well, has either to be dehydrated and transported to the shore through a submarine pipeline or flared. To dispose of the oil and the sand containing oil, special treatment measures have to be employed. Minor oil spills may require special collection units for safety reasons.

SEA BED MINING

Deep sea mining systems now in operation in the technically advanced countries are variations of the four basic types namely, bucket ladde dredges, surface pump hydraulic dredges, wireline dredges (drag and grabs) and air-lift hydraulic dredges. Necessary capabilities can be developed and through intensive R&D programmes and training. Efforts are being made in the country for determining the techno-economic feasibility of mining the poly-metallic nodules from the mid-Indian Ocean region from a depth of about 5000 m.

OCEAN THERMAL ENERGY CONVERSION (OTEC)

It is well known that the tropical oceans offer great potential for renewable sources of energy in the form of ocean thermal energy. Energy can also be extracted from tides, waves and salinity gradients. As an example, let us consider the design and construction of an OTEC plant in India. Multi-

disciplinary studies based on systems approach will be needed for the following:

- (i) Evaluation of the complex environment of the sea, based on long-term data on surface meteorology, oceanography and the sea bed soils.
- (ii) R & D works for the design of heat exchangers after studying various types of materials of construction, compatibility with working fluid, heat transfer characteristics, availability etc.
- (iii) Selection of a working fluid based on heat transfer characteristics, compatibility with heat exchanger materials, safety, availability, effect on external environment, effect of contamination of the fluid etc.
- (iv) R & D activities for the design of a suitable thermal turbine for converting the thermal energy of the working fluid into mechanical energy.
- (v) R & D for the design of a condenser system where deep-sea water cools the working fluid and converts it into liquid.
- (vi) Studies for the design of pumps for drawing cold and warm water and feed pumps to raise the pressure of working fluid from condenser pressure level to evaporator pressure level.

Considerable R&D is involved in the design of a suitable station keeping platform, mooring, cold water pipe etc. Construction and operation of various subsystems of an OTEC plant including transmission of power, ancillary industries etc. are to be properly studied.

In this lecture an outline is presented highlighting various ocean engineering aspects needed in the coastal and offshore development. Right kind of manpower, technology, facilities and indigenous capabilities are to be developed for the successful implementation of an ocean engineering project. My Colleagues in the Ocean Engineering Division would deliver lectures on the specific activities undertaken by us at the Institute.