AN OVERALL GUIDANCE AND PROPOSITION OF A WBS TEMPLATE FOR CONSTRUCTION PLANNING OF HARBORS

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ABSTRACT
The harbors have very important roles in linking the harbors of a country to the overseas harbors, in exchanging the cultures between nations and in import and export of goods and have big impacts on the economy of countries. As an example, for the case study country of this research, Iran, the contribution of harbors and waterways is more than 85% of total goods imported to Iran or exported from this country. Therefore, special attention should be directed to the right planning of harbors. Since the available templates in the literature for WBS to construct a harbor, having the rubble mound breakwaters, are not sufficient, in this paper, a detailed Work Breakdown Structure (WBS) template is proposed for construction of this type of infrastructures. The proposed WBS gives a good guidance to design and construction a harbor and is useful for client, contractor and consultant parties. The proposed WBS template may be used for planning in conceptual, basic and detail design phases. To validate the proposed WBS, a case study was performed on the existing harbors of Iran in the Persian Gulf.

Keywords: Harbor, rubble mound, breakwater, template, WBS

INTRODUCTION
Ports and harbors are important infrastructures that have big impacts on the economy level and industrial progress of a country. Furthermore, harbors have very important roles in linking a country to overseas harbors and in the import and export of goods. As an example for the case study country of this research, Iran, the contribution of harbors and waterways is more than 85% of total goods imported to Iran or exported from Iran (Nouban Sadeghi, 2014). Therefore, special attention should be directed to the planning and management of coastal zones and harbors.

The goal of this paper is submitting an overall guidance and proposing a WBS template for construction of harbors as a general guidance.

Since in the phases of planning, conceptual and basic design, some important decisions such as selection of location for construction of the harbor, the allocation of budget for getting the related approvals from top management of the Port and Maritime Organization, Ministry of Transportation, to submit the conceptual and basic design documents to the Planning and Budget Organization, and finally the Parliament for getting approvals and budget, as well as for the bid process and selection of contractor, having WBS for construction of a harbor is necessary.

Since the available templates in the literature for WBS to construct a harbor, having the rubble mound breakwaters, are not enough, a detailed WBS template is proposed. Using the proposed WBS template, helps the client, contractor and consultant parties, particularly at the planning phase of a harbor, and also gives general guidance at design and construction.
phases. The proposed WBS template may be used for planning, conceptual, basic and detail design phases. For construction design phase a more detailed WBS is required.

**METHODOLOGY FOR PLANNING A HARBOR**

To prepare the planning to construct a harbor, the following aspects should be considered:

- Importing/exporting cargo and passengers traffics,
- Existing facilities,
- Physical locations of the existing ports,
- Location of the harbor, taking into account the population, access roads, railways and distances,
- Requirements for harbor master plan,
- The different development phases,
- Application of ICZM rules and regulations. (Nouban & Sadeghi, 2013)

**Sea Wave Theories and Spectrums**

Wave height, wave length and water depth are the three independent characteristic parameters to calculate the wave characteristics.

Bretschneider, JONSWAP and Pierson-Moskowitz spectrums and formulas are typically employed in the calculation and analysis of the wave parameters in seas and oceans (US Army Corps of Engineers, 2002; US Army Coastal Engineering Research Center, 1980; Sadeghi, 2008). Stream Function, Solitary and Cnoidal wave theories are used mainly for evaluation of waves in shallow waters. Airy, Stockes’ (second and fifth orders), and Trochoidal waves are used to determine the wave characteristics in deep waters. See (Sadeghi, 2007a, 2007 b, 2010, 2013; Sadeghi & Nouban, 2013).

**Proposed Section for Breakwaters of Harbors**

The following figure presents the proposed typical section for trunk body of breakwaters. The proposed section is suitable for construction of breakwater from land by using dump trucks for handling and purring or placement of materials. The top level of core layer is considered at the Maximum Design SWL (Sea Water Level) in astronomic high tide. This is due to giving opportunity to the trucks to work in a dry level on core layer (Nouban, 2015).

![Proposed typical section for breakwaters of a typical harbor](image)

Fig. 1. Proposed typical section for breakwaters of a typical harbor

**Breakwaters’ Components Description**

Breakwaters are normally constructed to protect a harbor and create appropriately calm water, thereby providing protection for safe navigation, berthing and mooring of vessels, and
other harbor activities. Breakwaters are classified in three main types: rubble mound, vertical and composite breakwaters.

Since among the different types of breakwaters, the rubble-mound breakwaters are the most commonly constructed type of breakwater, the rubble mound structures are presented in this paper.

The conventional rubble-mound breakwaters consist of core, filter layer and armor layer are also referred to as multilayer structures. Core is made of finer material which is covered by bigger size filter layer. Filter layer is covered by big blocks forming the armor layer. Filter layer (also called underlayer) is used to prevent finer material being washed out through the armor layer.

Except in cases of shallow-water structures, the lower part of the armor layer is typically supported by a toe berm.

In the zones subjected to rough waves or at sites where an adequate amount of big quarry stones is unavailable, concrete armor units are used.

**Significant Criteria to Sketch the Layout of Breakwaters**

The significant criteria in sketching and proposing the layout of the breakwaters of a harbor are as follows:

i. The main breakwater should be constructed against the prevailing and greatest wave direction. Lesser wave heights from other directions should also be protected by construction of the lee (secondary) breakwater.

ii. To design the layout of the heads of the main and lee breakwaters, it is preferred to give an overlap between main and lee breakwaters to prevent direct penetration of the most severe waves into the basin of the harbor.

iii. The diffracted waves inside a harbor’s basin may be estimated using the diagrams given in the figures given by US Army Corps of Engineers (2002).

**Weight of Armor Units**

To determine the weight of armor units, the Hudson or the Vander Meer formulas are usually used.

Since the Hudson formula does not take account of some factors such as wave period and wave spectrum, angle of incident wave, and effect of the crest elevation relative to wave height, this formula should not be used for low crest breakwaters.

The Technical specifications of different types of concrete armors including Tetrapod, Dolos, Tribar, Quadrupod, Hegzapod and modified cube along with the instructions to design and construct the breakwaters are given in some references such as (Sadeghi, 2001; US Army Coastal Engineering Center, 2002).

**Jetties**

Deck-on-piles jetties and caisson jetties are normally the main types of jetties.

Jetties design loading are ship impact, mooring, dead and live loads, current, wind, earthquake and temperature loading (Sadeghi, 2001, 1989).

Ultimate strength of piles subjected to the lateral loading are calculated using the equations proposed by Hansen, Brooms, Robinson, Davisson, Rise and Matlock. (Sadeghi, 1989, 2001, 2008).
The analysis and design of the jetties are normally performed according to the recommendations of by the ACI, AISC and API codes or other codes.

**Proposition of a WBS for Construction of Harbors**

WBS is used to define the work for the project and to develop the project’s schedule. (Project Management Docs, 2014).

A WBS can show the followings at a glance:

1. What the various elements of the project are?
2. How the necessary work is distributed between the elements of the project?
3. How the larger elements of the project are subdivided into smaller ones (workbreakdownstructure.com, 2015)?

In different references (Project Management Docs, 2014; MS Project, 2015, Sadeghi & Babolian, 2016), general guidance and templates for different phases of various projects are submitted. In general, the available templates for WBS in literature are not enough for construction of a harbor. Therefore, by combining the literature review and experiences from execution of harbors in Iran (PMO, 1995, 1974a, 1974b), a WBS template to construct the harbors sheltered by the rubble mound type breakwaters is proposed.

The Proposed WBS template can be a good guidance for client, contractor and consultant parties to construct a harbor is as follows:

**Initiation**

1.1 project definition
1.1.1 Project description
1.1.2 Preliminary project timetable
1.1.2 Preliminary project budget
1.2 Preliminary scope of work
1.3. Perform feasibility study
1.3. Preliminary drawings
1.4 Evaluation of project needs
1.4.1 Evaluation of short term benefits.
1.4.2 Evaluation of long term benefits.
1.5 Complete major studies and market recommendations
1.6 Develop project charter
1.7 Deliverable: submission of project charter
1.8 Project charter approval

**Planning**

2.1 Creation of preliminary scope statement
2.2 Determination of project team
2.3 Project team Kick-Off Meeting
2.4 Developing of project plan
2.4.1 Preliminary harbor layout
2.4.1.1 Preliminary breakwaters layout
2.4.1.2 Preliminary jetties layout
2.4.1.3 Preliminary storages and administration buildings layout
2.4.1.4 Preliminary roads and railways layout
2.5 Submission of project plan
2.6 Milestones and project plan approval

**Conceptual design**

3.1 Conceptual scope of work
3.2 Conceptual calculations
3.2.1 Calculation of breakwaters sections’ layers
3.2.2 Calculation of jetties piles and deck
3.2.3 Calculation of storages and administration buildings
3.2.4 Calculation of basin, channels and needed dredging
3.3 Conceptual drawings
3.3.1 Conceptual harbor drawings
3.3.2 Conceptual breakwater drawings
3.3.3 Conceptual jetties drawings
3.3.4 Conceptual storages and administration buildings drawings
3.3.5 Conceptual roads and railways drawings
3.4 Conceptual MTO and requisition
3.5 Conceptual project budget
3.6 Conceptual project performance time schedule

**Site assessments**

4.1 Identify potential sites
4.2 Assess regulatory and environmental impacts
4.3 Identify requirements
4.4 Identify project site
4.5 Recommend site
4.6 Apply for permits
4.6.1 Secure Port and Maritime Organization (PMO) permit
4.6.2 Secure Environmental Organization permit
4.6.3 Secure Army Organization permit
4.6.4 Secure harbor owner organization permit
4.6.5 Secure miscellaneous permits
Scope Management
5.1 Develop scope management plan
5.2 Develop scope statement
5.3 Approve scope statement
5.4 Create work breakdown structure (WBS)

Basic design
6.1 Endorsing conceptual design documents
6.2 Performing soil investigation
6.2.1 Cone penetration test
6.2.2 Vane shear test
6.2.3 Standard Penetration Test (SPT)
6.2.4 Unconsolidated and consolidate un-drained tri-axial tests
6.2.5 In-situ pile test
6.3 Performing calculations (design)
6.4 Preparing drawings
6.5 Preparing the specifications/procedures
6.6 Submitting the MTO and requisition
6.7 Selection of final alternative (Selected variant)
6.8 Approve basic design

Time/Cost Management
7.1 Activity definition
7.2 Activity sequencing
7.3 Activity resource estimates
7.4 Activity duration estimates
7.5 Develop schedule

Risk Management
8.1 Risk management planning
8.2 Risk identification
8.3 Qualitative risk analyses
8.4 Quantitative risk analyses
8.5 Risk response plan

Bidding process & selection of EPC contractor
9.1 Advertise publicity to interested contractors
9.2 Evaluation of the received proposal
9.2.1 Evaluation of technical proposal
9.2.2 Evaluation of method statement
9.2.3 Evaluation of commercial proposal
9.2.4 Evaluation of bond statement
9.3 Selection of successful contractor
9.3.1 Comparison of received technical proposals
9.3.2 Comparison of received commercial proposals
9.3.3 Weighting the selection factors and applying the selection criteria
9.3.4 Selection of the successful contractor
9.4 Contracting process
9.4.1 Preparation of contract documents
9.4.2 Submit bond and insurance documents
9.4.3 Receive notice to proceed and sign contract
9.4.4 Signing and awarding the contract

Detail Design
10.1 Basic documents endorsements
10.1.1 Endorsement of basic calculations
10.1.2 Endorsement of basic drawings
10.1.3 Endorsement of basic technical specifications
10.1.4 Endorsement of basic fabrication procedures
10.1.5 Endorsement of soil mechanics reports
10.1.6 Endorsement of topography and bathymetry drawings
10.2 Preforming Calculations
10.2.1 Breakwaters calculations
10.2.1.1 Waves analysis
10.2.1.2 Main breakwater analysis
10.2.1.2.1 Main breakwater head analysis
10.2.1.2.1.1 Breakwater section design
10.2.1.2.1.1.1 Calculation of armor unit weight
10.2.1.2.1.1.2 Calculation of armor layer thickness
10.2.1.2.1.1.3 Calculation of under layers and core
10.2.1.2.1.1.4 Calculation of crest width
10.2.1.2.1.1.5 Design of the toe protection
10.2.1.2.1.2 Stability analysis of breakwater
10.2.1.2.1.3 Settlement of breakwater
10.2.1.2.1.4 Hydraulic performance
10.2.1.2.1.4.1 Wave run-up calculation
10.2.1.2.1.4.2 Wave overtopping analysis
10.2.1.2.1.4.3 Permissible overtopping calculation
10.2.1.2.1.4.4 Wave reflection analysis
10.2.1.2.1.4.5 Wave transmission analysis
10.2.1.2.2 Main breakwater trunk analysis
10.2.1.2.2.1 Breakwater section design
10.2.1.2.2.1.1 Calculation of armor unit weight
10.2.1.2.2.1.2 Calculation of armor layer thickness
10.2.1.2.2.1.3 Calculation of under layers and core
10.2.1.2.2.1.4 Calculation of crest width
10.2.1.2.2.1.5 Design of the toe protection
10.2.1.2.2.2 Stability analysis of breakwater
10.2.1.2.2.3 Settlement of breakwater
10.2.1.2.2.4 Hydraulic performance
10.2.1.2.2.4.1 Wave run-up calculation
10.2.1.2.2.4.2 Wave overtopping analysis
10.2.1.2.2.4.3 Permissible overtopping calculation
10.2.1.2.2.4.4 Wave reflection analysis
10.2.1.2.2.4.5 Wave transmission analysis
10.2.1.3 Secondary breakwater analysis
10.2.1.3.1 Secondary breakwater head analysis
10.2.1.3.1.1 Breakwater section design
10.2.1.3.1.1.1 Calculation of armor unit weight
10.2.1.3.1.1.2 Calculation of armor layer thickness
10.2.1.3.1.1.3 Calculation of under layers and core
10.2.1.3.1.1.4 Calculation of crest width
10.2.1.3.1.1.5 Design of the toe protection
10.2.1.3.1.2 Stability analysis of breakwater
10.2.1.3.1.3 Settlement of breakwater
10.2.1.3.1.4 Hydraulic performance
10.2.1.3.1.4.1 Wave run-up calculation
10.2.1.3.1.4.2 Wave overtopping analysis
10.2.1.3.1.4.3 Permissible overtopping calculation
10.2.1.3.1.4.4 Wave reflection analysis
10.2.1.3.1.4.5 Wave transmission analysis
10.2.1.3.2 Secondary breakwater trunk analysis
10.2.1.3.2.1 Breakwater section design
10.2.1.3.2.1.1 Calculation of armor units’ weights
10.2.1.3.2.1.2 Calculation of armor layer thickness
10.2.1.3.2.1.3 Calculation of under layers and core
10.2.1.3.2.1.4 Calculation of crest width
10.2.1.3.2.1.5 Design of the toe protection
10.2.1.3.2.2 Stability analysis of breakwater
10.2.1.3.2.3 Settlement of breakwater
10.2.1.3.2.4 Hydraulic performance
10.2.1.3.2.4.1 Wave run-up calculation
10.2.1.3.2.4.2 Wave overtopping analysis
10.2.1.3.2.4.3 Permissible overtopping calculation
10.2.1.3.2.4.4 Wave reflection analysis
10.2.1.3.2.4.5 Wave transmission analysis
10.2.1.4 Waves diffracted in basin analysis
10.2.2 Jetties calculations
10.2.2.1 Jetties in-situ analysis
10.2.2.2 Jetties earthquake analysis
10.2.2.3 Jetties ship impact analysis
10.2.2.4 Piles analysis
10.2.2.5 Piles drivability analysis
10.2.2.6 Deck analysis
10.2.2.7 Fenders analysis
10.2.2.8 Mooring systems analysis
10.2.1.9 Piles Cathodic protection analysis
10.2.3 Basin and channels calculations
10.2.3.1 Required sheltered conditions for vessels at berth
10.2.3.2 Maneuvering areas of vessels within the shelter area
10.2.3.3 Adequate stopping distance for vessels entering the entrance
10.2.3.4 Checking the extent of wave penetration
10.2.3.5 Environmental impact analysis
10.2.3.6 Port operation and navigation analysis
10.2.4 Dredging calculations
10.2.5 Storages calculations
10.2.5.1 Covered storages calculations
10.2.5.2 Containers storage areas calculations
10.2.5.3 Bulk materials open storage areas calculations
10.2.5.4 Oil storages calculations
10.2.5.5 Gas storages calculations
10.2.6 Building calculations
10.2.6.1 Administration buildings calculations
10.2.6.2 Navigation aids building calculations
10.2.6.3 Weighing balance buildings calculations
10.2.7 Roads, railways and parking areas calculations
10.2.7.1 Roads calculations
10.2.7.2 Railways calculations
10.2.7.1 Parking areas calculations
10.2.8 Ships serving facilities calculations
10.2.8.1 Loading-unloading facilities analysis
10.2.8.2 Ships water supplying facilities analysis
10.2.8.3 Ships electricity supplying facilities analysis
10.2.8.4 Ships fuel supplying facilities analysis
10.2.9 Mechanical calculations
10.2.9.1 Water pipelines facilities analysis
10.2.9.2 Oil pipelines facilities analysis
10.2.9.3 Gas pipelines facilities analysis
10.2.9.4 Sanitary facilities analysis
10.2.10 Electrical calculations
10.2.10.1 Electricity supplying facilities analysis
10.2.10.2 Lightening facilities analysis
10.3 Preparing drawings
10.3.1 Breakwaters drawings
10.3.2 Jetties drawing
10.3.3 Basin and channels drawings
10.3.4 Dredging drawings
10.3.5 Stores drawings
10.3.6 Administration buildings drawings
10.3.8 Roads, railways and parking areas drawings
10.3.9 Navigation aids buildings drawings
10.3.10 Ships serving facilities drawings
10.3.10.1 Loading-unloading facilities drawings
10.3.10.2 Ships water supplying facilities drawings
10.3.10.3 Ships electricity supplying facilities drawings
10.3.10.4 Ships fuel supplying facilities drawings
10.3.11 Mechanical drawings
10.3.11.1 Water pipelines facilities drawings
10.3.11.2 Oil pipelines facilities drawings
10.3.11.3 Gas pipelines facilities drawings
10.3.11.4 Sanitary facilities drawings
10.3.12 Electrical Drawings
10.3.12.1 Electricity supplying facilities drawings
10.3.12.1 Lightening facilities drawings
10.4 Preparing Material-Take-Off (MTO)
10.4.1 MTO of different sizes of required quarry stones
10.4.2 MTO of required amount of concrete
10.4.3 MTO of different sizes of required steel pipes
10.4.4 MTO of different sizes of required steel sheets
10.4.5 MTO of required fenders
10.4.6 MTO of required mooring chains and appurtenances
10.4.7 MTO of required mechanical equipment
10.4.8 MTO of required electrical equipment
10.4.9 List of required machinery
10.5 Preparing Technical specifications
10.5.1 Technical specifications for different sizes of quarry stones
10.5.2 Technical specifications for concrete
10.5.3 Technical specifications for steel pipes
10.5.4 Technical specifications for steel sheets
10.5.5 Technical specifications for fenders
10.5.6 Technical specifications for mooring chains and appurtenances
10.5.7 Technical specifications of required mechanical equipment
10.5.8 Technical specifications of required electrical equipment
10.5.9 Technical specifications of required machinery
10.6 Preparing fabrication procedures
10.6.1 Fabrication procedure for breakwaters
10.6.2 Fabrication procedure for jetties
10.6.2.1 Fabrication procedure for piles drivability
10.6.2.2 Fabrication procedure for deck construction
10.6.2.3 Fabrication procedure for fenders installation
10.6.2.4 Fabrication procedure for mooring systems installation
10.6.3 Fabrication procedure for dredging
10.6.4 Fabrication procedure for storages
10.6.4.1 Fabrication procedure for covered storages
10.6.4.2 Fabrication procedure for containers storage areas
10.6.4.3 Fabrication procedure for bulk material storage areas
10.6.4.4 Fabrication procedure for oil storages
10.6.4.5 Fabrication procedure for gas storages
10.6.4.6 Water pipelines facilities analysis
10.6.4.7 Oil pipelines facilities analysis
10.6.4.8. Gas pipelines facilities analysis
10.7 Performing fire and safety engineering and design

**Procurement**

11.1 Preparing procurement procedures and requisitions
11.1.1 Requisition for different sizes of required quarry stones
11.1.2 Requisition for required amount of concrete
11.1.3 Requisition for different sizes of required steel pipes
11.1.4 Requisition for different sizes of required steel sheets
11.1.5 Requisition for required fenders
11.1.6 Requisition for required mooring chains and appurtenances
11.1.7 Requisition for required anodes
11.1.8 Requisition for required steel bars and secondary materials
11.1.9 Requisition for required mechanical equipment
11.1.10 Requisition for required electrical equipment
11.1.11 Requisition for required machinery
11.1.1.1 Requisition for crane ordering
11.1.1.2 Requisition for grab ordering
11.1.1.3 Requisition for truck ordering
11.1.1.4 Requisition for drill wagon ordering
11.1.1.5 Requisition for concrete mixer ordering
11.1.1.6 Requisition for generator ordering
11.1.1.7 Requisition for dredger (cutter or cutter/suction or suction dredger type) ordering
11.1.1.8 Requisition for concrete batching plant
11.1.1.9 Requisition for pipes/plates cutting machine
11.1.1.10 Requisition for welding machine
11.1.1.11 Requisition for navigation aids light
11.2 Preparing expediting and inspection procedures
11.3 Send the technical specifications, MTO and requisitions to suppliers
11.4 Contacting the suppliers
11.5 Performing test on the purchased materials
11.6 Shipment and delivery of materials
11.7 Storing the delivered materials at the site

**Construction**

12.1 Project Kickoff Meeting for construction phase
12.2 Yard and Work-Force Mobilization
12.3 Receipt of Materials
12.4 Evaluation and purchasing of consumables
12.5 Construction design
12.5.1 Preparing Safety Manual and Plan
12.5.2 Preparing Shop Drawings
12.5.3 Preparing QA/QC, NDT and Dimensional Control Plan
12.6 Construction of breakwaters
12.6.1 Supplying quarry stones for different layers of breakwaters
12.6.1.1 Testing the materials
12.6.1.2 Installation of grizzly
12.6.1.3 Extracting quarry stones
12.6.1.4 Segregating of rocks and stones in different size
12.6.1.5 Transportation of stones to construction site
12.6.2 Construction of main breakwater
12.6.2.1 Construction of main breakwater trunk
12.6.2.2 Dredging under bedding layer
12.6.2.3 Placement of bedding layer materials (each 50 m)
12.6.2.4 Placement of core materials (each 50 m)
12.6.2.5 Placement of filter layer rocks (each 50 m)
12.6.2.6 Toe construction (each 50 m)
12.6.2.7 Placement of armor rocks (each 50 m)
12.6.2.8 Construction of access road and parapet walls
12.6.3 Construction of secondary breakwater
12.6.3.1 Construction of main breakwater trunk
12.6.3.2 Dredging under bedding layer
12.6.3.3 Placement of bedding layer materials (each 50 m)
12.6.3.4 Placement of core materials (each 50 m)
12.6.3.5 Placement of filter layer rocks (each 50 m)
12.6.3.6 Toe construction (each 50 m)
12.6.3.7 Placement of armor rocks (each 50 m)
12.6.3.8 Construction of access road
12.7 Construction of jetties
12.7.1 Piles drivability
12.7.2 Preparing piles connections to deck
12.7.3 Deck construction
12.7.4 Fenders installation
12.7.5 Mooring systems installation
12.7.6 Installation of anodes
12.8 Dredging basin and channels
12.8.1 Dredging basin and channels
12.8.2 Transportation of disposal of dredged material
12.9 Construction of storages
12.9.1 Construction of covered storages
12.9.2 Construction of containers storage areas
12.9.3 Construction of bulk materials open storage areas
12.9.4 Construction of oil storages
12.9.5 Construction of gas storages
12.10 Construction of buildings
12.10.1 Construction of administration buildings
12.10.2 Construction of navigation aids building
12.10.3 Construction of Weighting Balance buildings
12.11 Construction of roads, railways and parking areas
12.11.1 Construction of roads
12.11.2 Construction of railways
12.11.3 Construction of parking areas
12.12 Construction of ships serving facilities
12.12.1 Installation of loading-unloading facilities
12.12.2 Construction of ships water supplying facilities
12.12.3 Construction of ships electricity supplying facilities
12.12.4 Construction of ships fuel supplying facilities
12.13 Construction of mechanical facilities
12.13.1 Construction of water pipelines facilities
12.13.2 Construction of oil pipelines facilities
12.13.3 Construction of gas pipelines facilities
12.13.4 Construction of sanitary facilities
12.14 Construction of electrical facilities
12.14.1 Construction of electricity supplying facilities
12.14.2 Installation of lightening facilities
12.15 Installation of navigation aids
12.16 Preparing As-Built drawing and certification dossier
12.17 Preparation of safety manual and plan for operation phase
12.18 Demobilization

Close-out
13.1 Issuing final dossier
13.1.1 Issued As-Built drawings
13.1.2 Issue of final specifications
13.1.3 Issue of final procedures
13.1.4 Issue equipment manuals
13.2 Finalizing administration and financial issues
13.3 Issue Fire and Safety instructions and manuals
13.4 Releasing good performance guarantee
13.5 Delivery of the project

CONCLUSION
An overall guidance and a detailed WBS template is proposed for construction of a harbor having the rubble mound breakwaters. Using the proposed WBS template helps the clients, contractors and consultants, particularly at the planning phase of a harbor. It gives a good guidance to design and construction a harbor. The proposed WBS shows close agreement with the actual procedures used in the harbors constructed, in the case study country, Iran.

REFERENCES


