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

Fatemeh Nouban

Civil Engineering Department, Near East University,
TRNC, Mersin 10, TURKEY.

fatemeh.nouban@neu.edu.tr, f.nouban@gmail.com

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

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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).

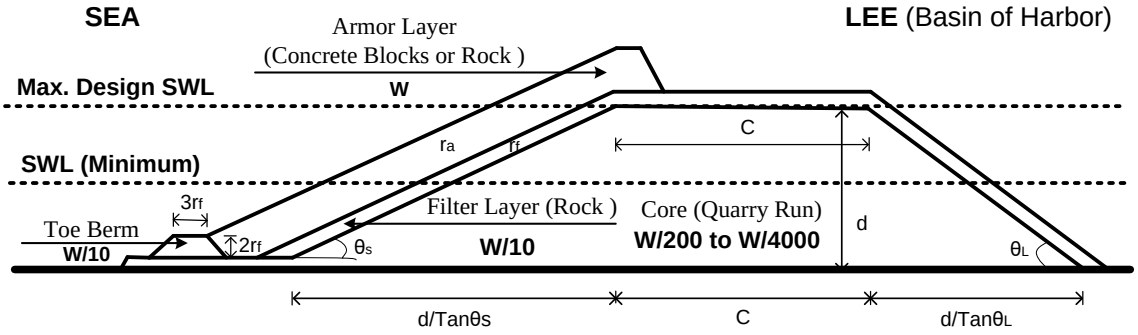

Fig. 1. Proposed typical section for breakwaters of a typical harbor

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

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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, Quadrapod, 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).

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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

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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

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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

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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 technicalspecifications

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

10.2.1.1Waves analysis

10.2.1.2 Main breakwater analysis

10.2.1.2.1Main breakwater head analysis

10.2.1.2.1.1Breakwater 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

10.2.1.2.1.1.4Calculation 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

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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

10.2.1.3.1Secondary 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

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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 drivabilityanalysis

10.2.2.6 Deckanalysis

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

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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 Buildingscalculations

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 Mechanicalcalculations

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 drawings10.3.1 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

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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 specificationsfor 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

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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

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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

11.1.1.11Requisition 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 ofstones 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)

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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

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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

12.13.1Construction 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.

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