STRUCTURAL DESIGN OF A REINFORCED CONCRETE FLOATING PONTOON WITH AN ACCESS WALKWAY

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This project report attached here to, entitled "Structural Design of a Reinforced Concrete Floating Pontoon with an Access Walkway" prepared and submitted by Tan Chan Boon in partial fulfilment of the requirements for the Degree of Bachelor of Engineering (Civil) is hereby read and approved by:

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STRUCTURAL DESIGN OF A REINFORCED CONCRETE FLOATING PONTOON WITH AN ACCESS WALKWAY

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I also would like to express my sincere appreciation to all the section leaders and engineers, and draughtspersons in JURUTERA JASA (SARAWAK) SDN BHD for their assistance in completing various tasks.

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ABSTRACT

The project presented herein is the structural design of a reinforced concrete floating pontoon with an access walkway. For the analysis and design purposes, two structural softwares were adopted, which are Staad III and MicroFeap II.

This project is mainly concerned with the detail design of the reinforced floating pontoon, truss analysis and timber decking for walkway. The British Code of practices BS 8110, BS 5950 and BS 5268 are used respectively in this project.

The mooring and anchoring system is not included in this project. Energy absorption, for example, using rubber fenders or timber is also not included.

Output results generated by the software will be analysed and followed by the structural elements design state. Eventually, detail drawings are produced to illustrate how structure is to be constructed on site.

This thesis is concluded in improving the reinforced concrete floating pontoon with conclusion and some recommendations on the project are stated too.

ABSTRAK

Projek tahun akhir ini merangkumi rekabentuk struktur bagi konkrit pontun dan pelalu jalan kaki. Perisian struktur yang digunakan dalam rekabentuk adalah Staad III dan MircoFeap II.

Tumpuan utama diberi kepada merekabentuk struktur bagi konkrit pontun, kekuda dan kayu dek sahaja.Piawaian kode yang digunakan adalah BS 8110, BS 5950 dan BS 5268 dalam projek ini.

Sistem tambatan dan penyerapan tenaga oleh penangkis pukulan tidak termasuk dalam perbincangan projek ini.

Keputusan keluaran daripada perisian sturktur akan dikaji dan diikuti dengan peringkat merekabentuk struktur binaan. Selepas itu lukisan struktur akan dihasilkan untuk memberi gambaran mengenai struktur binaan sebenar di tapak binaan. Cadangan untuk kerja-kerja memperbaiki turut diberi.

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SYMBOLS

For the purpose of this Chapter, the following symbols have been used. These have largely been taken from BS 8110. Note that in one or two cases the same symbol is differently defined. Where this occurs the reader should use the definition most appropriate to the element being designed.

GEOMETRIC PROPERTIES

b	Width of section
d	Effective depth of the tension
h	Overall depth of section
x	Depth to neutral axis
z	Lever arm
d	Depth to the compression reinforcement
l	Effective span
c	Nominal cover to reinforcement

BENDING

F_k	Characteristic load
g_k , G_k	Characteristic dead load

q_k, Q_k	Characteristic imposed load
w_k, W_k	Characteristic wind load
f_k	Characteristic strength
f_{cu}	Characteristic compressive cube strength of concrete
f_y	Characteristic tensile strength of reinforcement
γ_f	Partial safety factor for load
γ_m	Partial safety factor for material strength
K	Coefficient given by $M/f_{cu}bd^2$
M	Design ultimate moment
M_u	Design ultimate moment of resistance
A_s	Area of tension reinforcement

SHEAR

f_{yv}	Characteristic strength of links
s_v	Spacing of links along the member
V	Design shear force due to ultimate loads
v	Design shear stress
v_c	Design concrete shear stress
A_{sv}	Total cross-sectional area of shear reinforcement

For this purposes of this section, the following symbols have been used. These have largely been taken from BS 5268.

GEOMETRICAL PROPERTIES

b	Breadth of beam
h	Depth of beam
A	Total cross-sectional area
i	Radius of gyration
I	Second moment of area
Z	Section modulus

Bending

L	Effective span
M	Design moment
M_R	Moment of resistance
$\sigma_{m,a,\parallel}$	Applied bending stress parallel to grain
$\sigma_{m,g,\parallel}$	Grade bending stress parallel to grain
$\sigma_{m,adm,\parallel}$	Permissible bending stress parallel to grain

Deflection

δ_t	Total deflection
δ_m	Bending deflection
δ_v	Shear deflection
δ_p	Permissible deflection

E	Modulus of elasticity
E_{mean}	Mean modulus of elasticity
G	Shear modulus

Shear

F_v	Design shear force
τ_a	Applied shear stress parallel to grain
τ_g	Grade shear stress parallel to grain
τ_{adm}	Permissible shear stress parallel to grain

bearing

F	Bearing force
l_b	Length of bearing
$\sigma_{c,a,\perp}$	Applied compression stress perpendicular to grain
$\sigma_{c,g,\perp}$	Grade compression stress perpendicular to grain
$\sigma_{c,a,dm,\perp}$	Permissible bending stress perpendicular to grain

Compression

L_e	Effective length of a column
λ	Slenderness ratio
N	Axial load
$\sigma_{c,a,\parallel}$	Applied compression stress parallel to grain
$\sigma_{c,g,\parallel}$	Grade compression stress parallel to grain
$\sigma_{c,adm,\parallel}$	Permissible compression stress parallel to grain

$\sigma_{c,\|\|}$	Compression stress = $\sigma_{c,g,\|\|} K_3$
σ_e	Euler critical stress

For the purpose of this section, the following symbols have been used. These have largely been taken from BS 5950

GEOMETRIC PROPERTIES

A	Area of section
A_g	Gross sectional area of steel section
B	Breadth of section
B	Outstand of flange
D	Depth of section
D	Depth of web
I_x, I_y	Second moment of area about the major and minor axes
L	Length of span
r_x, r_y	Radius of gyration of a member abut its major and minor axes
S_x, S_y	Plastic modulus about the major and minor axes
T	Thickness of flange
T	Thickness of web
U	Buckling parameter of the section
X	Torsional index of section
Z_x, Z_y	Elastic modulus about major and minor axes

Bending

A_v	Shear area
E	Modulus of elasticity
F_t	Tensile force
F_v	Shear force
L	Actual length
L_E	Effective length
M_{max}	Maximum moment
M_c	Moment capacity
M_b	Buckling resistance moment
P_v	Shear capacity of a section
p_c	Compressive strength of the steel
p_b	Bending strength of the steel
p_y	Design strength of steel
ε	Constant=$(275/p_y)^{1/2}$
λ	Slenderness ratio
δ	deflection

COMPRESSION

A_g	Gross sectional area of steel section
L	Actual length
L_E	Effective length
M_b	Buckling resistance moment

CONNECTIONS

T	Thickness of ply
E	End distance
F_s	applied shear force
F_t	Applied tension force
f_v	Shear stress
P_{bb}	Bearing capacity of a bolt
P_{bs}	Bearing capacity of parts connected by ordinary bolts
P_s	Shear capacity of a bolt
p_{bb}	Bearing strength of a bolt
p_{bg}	Bearing strength of parts connected by friction grip fasteners
p_{bs}	Bearing strength of parts connected by ordinary bolts
p_s	Shear strength of a bolt
p_t	Tension strength of a bolt
p_w	Design strength of a fillet weld
S	Leg length of a fillet weld

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CHAPTER 1

INTRODUCTION

1.1 General

Floating pontoon is a broad, flat-bottomed floating structure generally rectangular in shape, used for many purposes in a port, as a ferry landing place, a pier head, or alongside a vessel to assist in loading or discharging.

Historically floating pontoons are used chiefly to support a bridge, to raise a sunken ship, or to float a hydroplane or a floating dock. Pontoons have been built of wood, of hides stretched over wicker frames, of copper or tin sheet metal sheathed over wooden frames, of aluminum, of concrete and of steel.

Pontoons for raising sunken ships are watertight cylinders that are filled with water, sunk, and fastened to the submerged ship; when emptied by compressed air, they float the ship to the surface. A pontoon lifeboat consists of a raft supported by watertight cylinders.

The modern permanent pontoon is composed of many compartments, so that if a leak occurs in one compartment, the pontoon will not sink. Permanent pontoons are fastened together and several anchors are dropped from each. However in

this project, the pontoon unit is small. Therefore no compartmentation is introduced. The partition wall makes the reinforced concrete box unit too heavy.

1.2 Project Objectives

The main objective of this project is to perform a structural design of a reinforced concrete floating pontoon with an access walkway based on BS 8110: Part 1 (1985), BS 5950 (1990), BS 5268 (1996) and BS EN 388 (1995).

In designing the reinforced concrete floating pontoon, computer analysis and manual calculation are used. For steel truss and cross members design, computer software is used. Timber decking design is based on manual calculation according to BS 5268 (1996).

Detail structural drawings are also included to illustrate how the structure is constructed on the site.

1.3 Thesis Overview

This thesis describes the project of structural design of a reinforced concrete floating pontoon with an access walkway. Following the introduction, the next chapter gives an overview of the floating pontoon including a brief history and background of floating pontoons.

The description about the case study and methodology are in Chapter 3 of this report where it focuses on the specification and the procedures involved in designing the reinforced concrete floating pontoon, timber decking and access walkway design. Chapter 4 is concerned with the detailed design and calculation of reinforced concrete floating pontoon with an access walkway. Chapter 4 also included the detailed structural drawings for reinforced concrete floating pontoon and access walkway. The thesis is concluded in Chapter 5.