Makara Journal of Technology

Volume 22 | Issue 2 Article 8

8-2-2018

Strength Structure Analysis of Main Gate Graving Dock Using Pontoons for Condition Repairs

Budianto Budianto
Ship Design Construction Department, Ship Building Institute of Polytechnic Surabaya, Surabaya 60111, Indonesia, budianto.structure@gmail.com

Makara J. Technol. 22/2 (2018), 109-114
doi: 10.7454/mst.v22i2.3384

Strength Structure Analysis of Main Gate Graving Dock Using Pontoons for Condition Repairs

Budianto

Ship Design Construction Department, Ship Building Institute of Polytechnic Surabaya, Surabaya 60111, Indonesia

*e-mail: budianto.structure@gmail.com

Abstract

Main gate graving dock with pontoon type can certainly suffered some level of damage after a long period of operation. Many employments within the graving dock can delay the process repair of main gate. The main gate may not be opened, because employees are still working to ship fabrication process under sea waterline. For accommodate these interrelated conditions, the best solution with repair one side of the main gate with type pontoon and employees can still work ship fabrication process in graving dock conducted simultaneously. The repair process conditions must be required main gate structure that consists of only one part of the shell withstand the forces that occur, such as weight self and sea pressure. It must be considered with analysis of the strength structures of main gate graving dock with pontoon type. Finite element method can solve the problem of structural analysis using the element discretion approach to find a node or joint displacement and the forces that occur in structural repair conditions at main gate. The maximum bending stress value obtained during the main gate repair process is 153 mPa, and the allowable stress value is classified as 157 mPa. Since these conditions are approaching the allowable limit, the main gate needs to be given insert plates for reinforcement. Deformation is found to be 12 mm, and the deformation limit is 35 mm based on the rule's classification.

Abstrak

Analisis Kekuatan Struktur *Main Gate* pada *Graving Dock* Tipe Pontoon pada Kondisi *Repair*. Jenis *main gate* tipe *pontoon* dapat dipastikan mengalami beberapa kondisi kerusakan, setelah beberapa lama dioperasikan. Akan tetapi penuhnya pekerjaan didalam *Graving Dock* tersebut akan mempengaruhi penundaan proses repair. Pintu *dock* tidak mungkin dibuka karena pekerja masih melakukan proses pekerjaan fabrikasi kapal di dalam *Graving Dock* dengan kondisi bawah garis laut.Untuk bisa mengakomodasi kondisi yang saling berkaitan tersebut, solusi terbaik adalah melakukan perbaikan satu sisi main gate dan pekerjaan kapal di *Graving dock* dilakukan bersamaan. Kondisi proses repair tersebut tentunya menuntut struktur main gate yang hanya terdiri atas satu bagian shell yang harus menahan gaya-gaya yang terjadi, antara lain gaya berat sendiri, gaya total horizontal dan tekanan hidrostatik, angin dan arus laut. Sehingga perlu dipertimbangkan analisis kekuatan struktur *main gate graving dock* tersebut. Dengan metode elemen hingga, dapat menyelesaikan masalah analisis struktur menggunakan pendekatan diskretisasi elemen untuk menemukan perpindahan titik simpul atau join dan gaya-gaya yang terjadi pada struktur kondisi repair pada main gate tersebut. Didapatkan nilai tegangan bending maksimal graving dock pada kondisi repair adalah sebesar 153 mPa dengan tegangan yang diijinkan menurut peraturan Klasifikasi sebesar 157 mPa. Akan tetapi kondisi tersebut mendekati batas yang diijinkan, sehingga perlu diberikan rekomendasi penguatan (*reinforcement*) berupa, *insert plate*, penambahan profil, ataupun penambahan *doubling* pelat. Untuk deformasi yang terjadi 12 mm sedangan deformasi yang diijinkan sebesar 35 mm jadi kondisi masih dalam tahap aman dari nilai yang diijinkan secara peraturan Klasifikasi.

Keywords: finite element, graving dock, main gate, pontoon, structure

1. Introduction

Graving dock a ship docking facilities that have a shape like a big pool which location is situated on the sea waterfront. This type of dock built by digging of land large enough on the beach and put up the floodgates (main gate) on one side open. The main gate graving dock serves as infrastructure repair, modification, maintenance, manufacture or assembly of the ship. The types of main gate consist such as pontoon type, the pin

type, and the hinge type , where the latter is hinged at the bottom.

After a long period of operation, types of pontoon, of course some level of damage such as a leak at the plate, there is a leak in the seal construction of the door, there are difficulties withdrawal or movement to open and close the main gate for deformation, corrosion on plate main gate and the presence of marine plants, crust and moss that grows hull main gate that led to the resistance value is increased when the operational process is opened and closed [1]. But full employment within the Graving Dock, the delay will affect the process of repair main gate, because the main gate may not be opened, because there are still work processes under sea waterline. To accommodate these interrelated conditions, the best solution is to repair one side of the main gate and employee still work in graving dock ship conducted simultaneously.

The repair process conditions would require main gate structure that consists of only one part of the shell that must withstand the forces that occur, such as weight gravity alone, a total horizontal force, hydrostatic pressure, winds and ocean currents. So main gate with pontoon type to consider the analysis of the strength structures of main gate Graving Dock.

In the finite element method will be found due to the stress distribution of styles such as load, pressure, temperature, fluid velocity and heat [2]. Then, reasons for any shape deformation from stress, temperature, pressure, and fluid velocity will be explored and expressed through its displacement. Finite element method, problems are solving approach to find the displacement of the discretion element nodes and the forces of the structure [3]. The equation that uses discrete element refers to numerical matrix method for structural analysis and results that can be obtained for identical to the classical analysis for the structure. Discretion made to do can be shaped elements of one-dimensional (line elements), two-dimensional (shell field elements), or three-dimensional (solid elements or continuum). The approach uses elements of the continuum to determine the problem-solving approach that is closer to the true value [4].

2. Methods

Methods and stages of research which includes: Determining the structure of the object main gate

Loa	33.00	M
Lpp	33.00	M
Breadth (MLD)	4:00	M
Depth (MLD)	9.97	M
Draft (MLD)	5:10	M

Structure main gate graving dock with pontoon type shown Figure 1.

Material constituent main gate:
SS 41, JIS G3101 or Equivalent;
Yield stress Fy 2400 Kg/cm^2

Condition of the main gate with only one side of the shell.

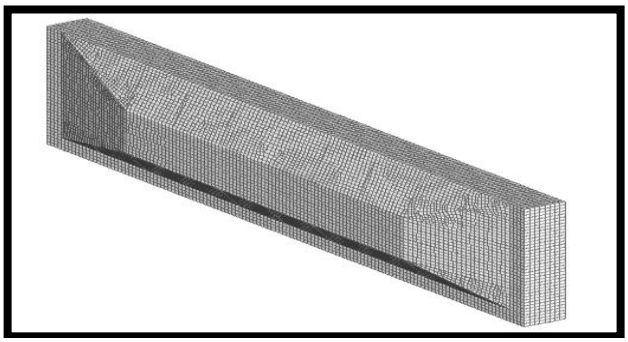


Figure 1. Main Gate with Pontoon Type

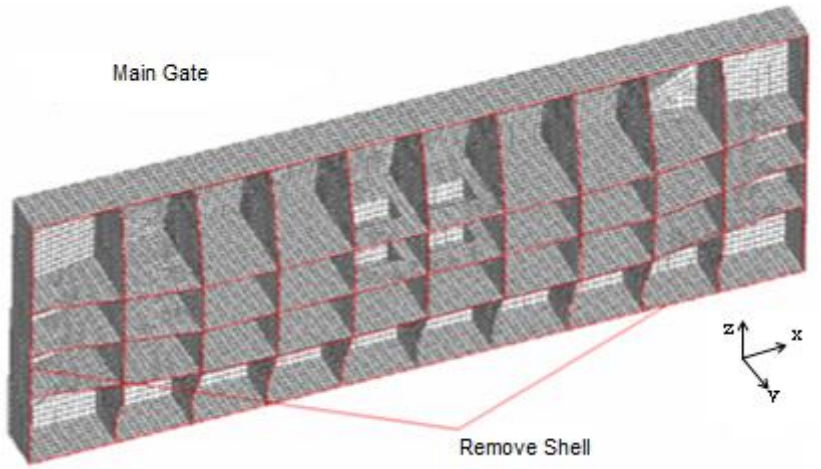


Figure 2. Main Gate Only One Side Shell Operational

Tabel 1. Constrain

Position		
Translation	x	Fixed
Translation	y	Fixed
Translation	z	Free
Rotation	x	Fixed
Rotation	y	Fixed
Rotation	z	Fixed

Conditions main gate only one side, who analyzed the strength of the structure, will give a reaction that occurs when the stress distribution given loading condition and placement to apply structure with finite element method (Figure 2).

Constrain condition. Here is shown the condition of the bearing structure of the main gate shown in the placement conditions as follows (Table 1).

Loading condition. All loading applied to each element of the structure of main gate to the loading conditions of the application loading conditions include: Static water pressure, Dynamic water pressure, Wave load, Wind load.

3. Results and Discussion

Loading. Loading formulae and calculation results are shown below:

Static Water Pressure (Pw)
Formulae static water pressure shown below:

$Pw = \omega o * X$ (1)

Bottom

Pw = ωo * X
Pw = 1025*10*(9,93-0,3165)
Pw = 98538.38 N/m^2
Pw = 98.54 kN/m^2

4th deck main gate

Pw = ωo * X
Pw = 1025*10*6,83
Pw = 70007.50 N/m^2
Pw = 70.01 kN/m^2

3rd deck main gate

Pw = ωo * X
Pw = 1025*10*5,03
Pw = 51557.50 N/m^2
Pw = 51.56 kN/m^2

2nd deck main gate

Pw = ωo * X
Pw = 1025*10*3,23
Pw = 33107.50 N/m^2
Pw = 33.11 kN/m^2

top deck main gate

Pw = ωo * X
Pw = 1025*10*0
Pw = 0.00 N/m^2
Pw = 0.00 kN/m^2

Dynamic Water Pressure (Pdi)
The seismic coefficient calculation is:

$Kd = C \times l \times K$ (2)

where :

K = 2 factor of type structure
C = 0.05 Basic coefficient
I = 1 Important factor.
Kd = 0.1
h = high of HHWL 9.93 m

Lower

$Pdi = 7/8 * \omega o * Kd * (h * X)^{1/2}$
$Pdi = 7/8*1025*10*0.1*(9.93*9.6135)^{0.5}$
Pdi = 8861.01 N/m^2
Pdi = 8.86 kN/m^2

Upper

$Pdi = 7/8 * \omega o * Kd * (h * X)^{1/2}$
$Pdi = 7/8*1025*10*0.1*(9.93*6.83)^{0.5}$
Pdi = 7386.13 N/m^2
Pdi = 7.39 kN/m^2

Wave Load (Pl) (Table 2)

Reference for the 50 years period is from the guidance manual book of building Dry Dock books [5].

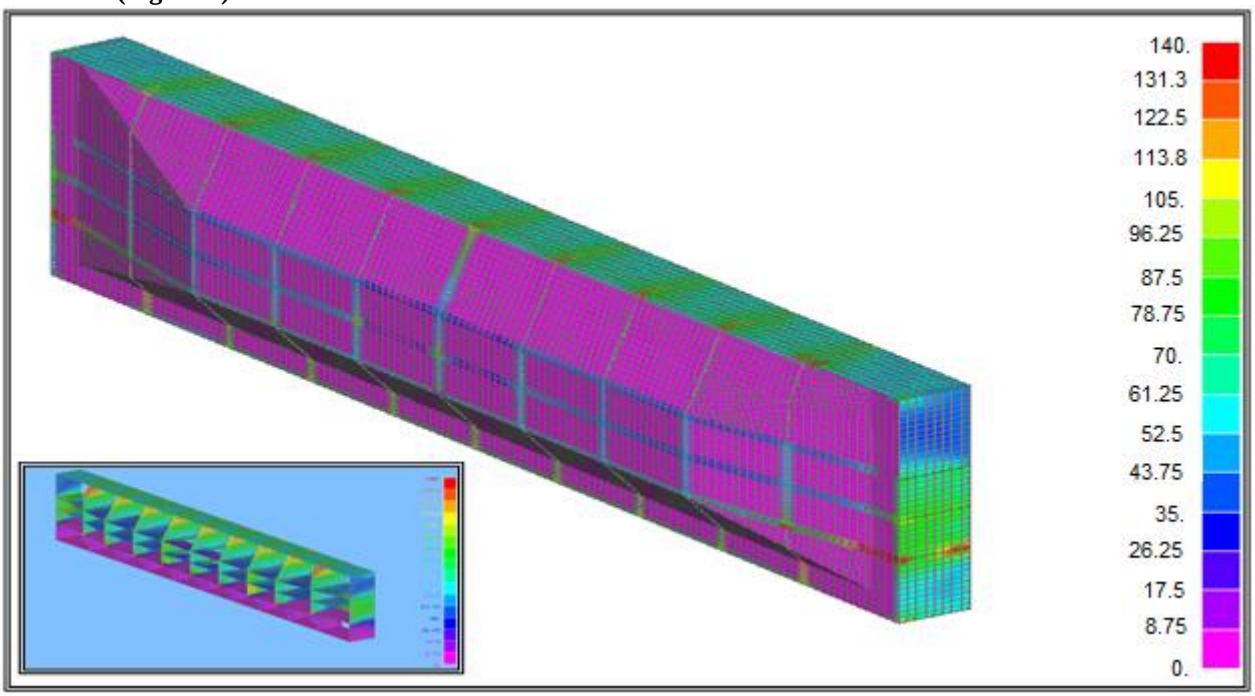
Wind Load Force (Fw)
Calculation force effect of wind load shown:

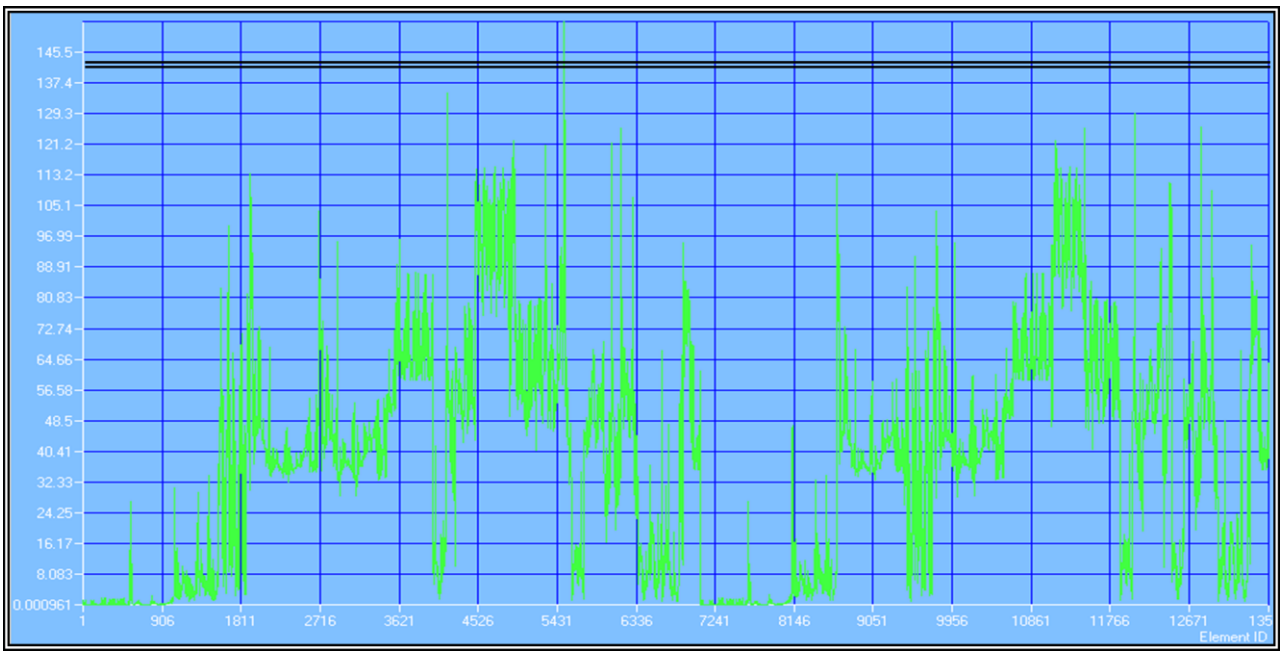
$Fw = 0.5 * \rho * Cd * V^2 * A$ (3)
Fw = 0.1089 N

Tabel 2. Wave load Reference

Wave Condition	NE		NW		W	
Time	H1/3 (m)	T1/3 (s)	H1/3 (m)	T1/3 (s)	H1/3 (m)	T1/3 (s)
10 years	0.6	2.5	0.6	2.5	1.1	3.2
30 years	0.9	3.0	0.8	3.1	3.1	3.9
50 years	1.1	3.4	0.9	3.4	3.4	4.2

FEA result (Figure 3)





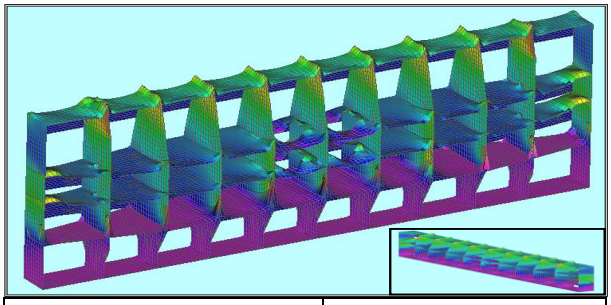
Type		ID	Value
Element	Maximum	5516	86.63103
	Minimum	7347	1.91225E-4
Element	Maximum	5516	153.3676
	Minimum	760	0.0215101

Figure 3. Finite Element Analysis

Evaluation post processing of yielding stress & shear stress Graphic Vonmises stress. Maximum bending stress values obtained on condition repair graving dock is at 153 mPa with allowable stress according to the classification of 157 mPa. Analysis of the structural strength main gate graving dock at the pontoon-type repair with the state of structure deformation conditions as shown Figure 4.

For deformation 12 mm and deformation is permitted by 35 mm of rule clasification [6]. The condition is still being safe from the permitted values.

Recommendation. However, the stresses conditions approaching the allowable limit, so it needs to be given on the insert plate can be reinforcement, the addition of profiles, or additional doubling plate. Result of FEA with reinforcement (Table 5).



Position		Thickness (mm)		
Btm. Shell	CR	12	--->	15
End Shell	P/S	12	--->	13
Shell	Aft/fore	13	--->	15

Figure 4. Deformation

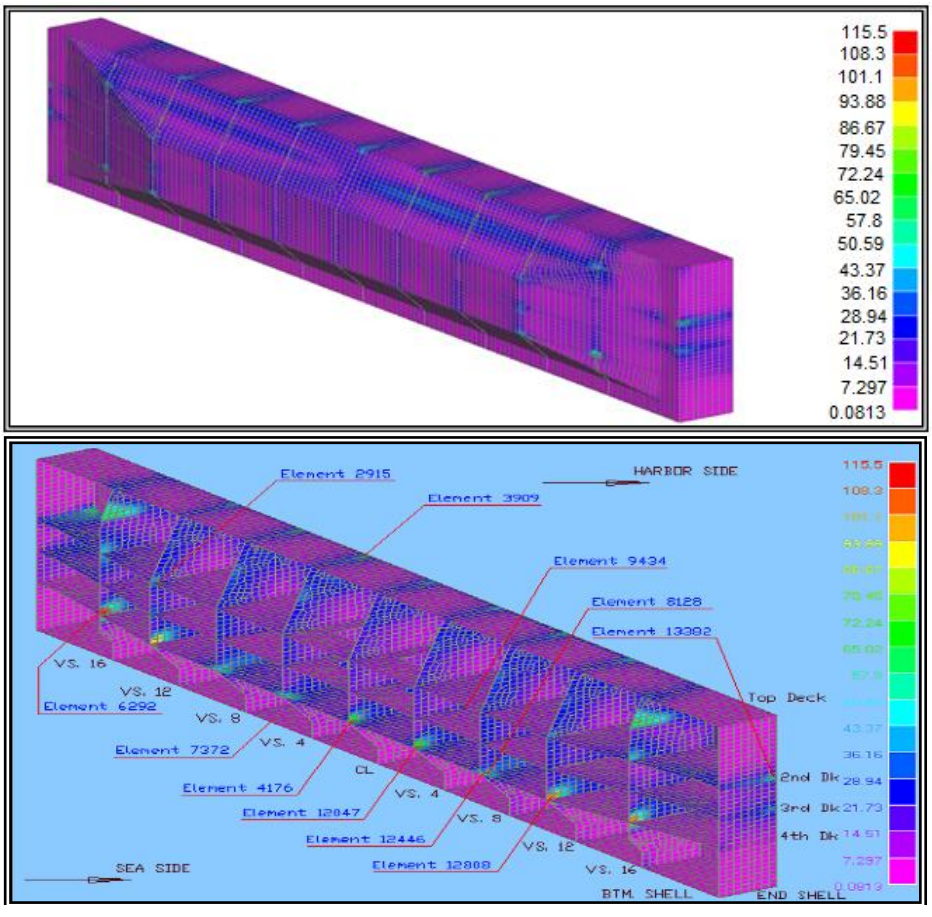


Figure 5. Additional Reinforcement

4. Conclusion

Maximum bending stress values obtained at the main gate repair condition is at 153 mPa with allowable stress according to the Classification of 157 mPa. However, these conditions approaching the allowable limit, so it needs to be given on the insert plate as reinforcement. For deformation 12 mm and deformation is permitted by 35 mm of rule clasification.

Acknowledgement

This study funded by research grant from Ministry of Research, Technology and Higher Education with first lecture research scheme for year 2016.

References

[1] J.J. Hassani, J. Ship. Produc. 3/3 (1987) 155.
[2] Wirjosoedirdjo, Metode Elemen Hingga. Erlangga, Jakarta, 1988, p.398
[3] D. Roy, Analysis structural, Copyright © 2001, Shortismag coth, US, 2001
[4] M.L. Bucalem, K.J. Bathe, Finite Element Analysis of Shell Structures, Springer, Netherland, 1997, p.61
[5] Mithsui Engineering, Manual Building Dry Dock Books, Japan, 1982.
[6] Rules BKI, Rule of Hull, Jakarta, 2016.