STUDY OF THE IMPACT FROM DROPPING A CONTAINER FROM THE MANOEUVRING SYSTEMS ON THE MAIN DECK OF A PSV

Costel-Iulian Mocanu
“Dunarea de Jos” University of Galati, Faculty of Naval Architecture, Galati, Domneasca Street, No. 47, 800008, Romania,
E-mail: Costel.Mocanu@ugal.ro

Andreea-Georgiana Darie
“Dunarea de Jos” University of Galati, Faculty of Naval Architecture, Galati, Domneasca Street, No. 47, 800008, Romania,
E-mail: darie.andreeag@yahoo.com

Daniela-Mihaela Loică
“Dunarea de Jos” University of Galati, Faculty of Naval Architecture, Galati, Domneasca Street, No. 47, 800008, Romania,
E-mail: daniela.0911@yahoo.com

Alin Pohilca
“Dunarea de Jos” University of Galati, Faculty of Naval Architecture, Galati, Domneasca Street, No. 47, 800008, Romania,
E-mail: Alin.Pohilca@ugal.ro

ABSTRACT

The topic approached in this paper regards the impact between a container dropped from the manoeuvring systems and main deck of a PSV, without considering the wood material. This study was done to verify the structural resistance of the deck in the most difficult conditions of loading and unloading containers.

The dropping test of the container is pretty difficult because it involves a detailed analysis of the stresses that occur in the deck’s structure, as well as in the container’s structure.

Keywords: container, stress, deformation, PSV.

1. INTRODUCTION

One of the important opportunities offered by platform supply vessels is that they can allow the transport of goods that are suitable for containerisation. Thus, a number of containers can be transported on the main deck, for which special fastening systems have been produced.

Container transport is considered to be one of the most efficient means of transport for goods worldwide, since the risk of damage is minimal and the cost of handling is low.

For loading/unloading operations of containers, adequate equipment must be used to ensure safe transfer. Supply vessels must be equipped with one or two cranes, but most often the platforms are equipped with the tools required for manoeuvring.

There have been situations where, for various reasons, the containers dropped from the manoeuvring systems, effectively collapsing on the deck with adverse consequences on the integrity of the structure. Most of the times, the wood on the main deck does not provide sufficient protection.

2. CONTENT

The proposed research was carried out for a platform supply vessel, PSV5000. The main dimensions of the ship may be seen in Table 1.
Table 1. Main characteristics

| Characteristic                  | Value  |
|--------------------------------|--------|
| Length over all, $L_{oa}$ [m]  | 85.6   |
| Length between perpendiculars, $L_{bp}$ [m] | 79.25  |
| Beam, $B$ [m]                  | 22     |
| Depth, $D$ [m]                 | 8.5    |
| Draft, $T$ [m]                 | 6.7    |
| Displacement, $\Delta$ [t]    | 9668   |
| Design speed, $v$ [Nd]         | 14.5   |
| Block coefficient, $C_B$       | 0.776  |

2.1. Material Selection

One of the major considerations for the hull structure of the ship is the material of construction. Steel remains the most popular material for ship structures. Two categories of steel are considered: normal hull structural steel grade A and high tensile hull structural steel grade AH36. AH36 steel has a nominal yield stress of 355 MPa and a breaking limit of 490 - 630 MPa.

2.2. PSV’s Structure Modeling

In order to accomplish the proposed study, the structure of the deck and the structure of the container were generated. The thickness of the longitudinal and transverse members and transverse are shown in Table 2.

Table 2. The thicknesses of the structural elements

| Element                     | Thickness [mm] |
|-----------------------------|----------------|
| Bottom plating              | 10             |
| Double bottom plating       | 12             |
| Deck plating                | 9              |
| Shell plating               | 12             |
| Bottom longitudinals plating| 140x8          |
| Tank top longitudinals plating| 180x9         |
| Deck longitudinals plating  | 140x8          |

The structure was generated in AutoCad. Geometry was imported into the Explicit Dynamics module provided by Ansys Workbench.

2.3. Container particulars

The ship’s structure was studied using a 20 TEU container. Its dimensions are shown in Table 3.

Table 3. Container dimensions

| Dimension                  | Value           |
|----------------------------|-----------------|
| External dimensions [mm]   | 6058x2438x2591  |
| Internal dimensions [mm]   | 5898x2352x2393  |
| Own weight [t]             | 22              |
| Load weight [t]            | 24              |
| Volum [m³]                 | 33.2            |

3. STRENGTH ANALYSIS USING FINITE ELEMENT METHOD

The studied model was analyzed in the absence of double shell structures, applying the suitable boundary conditions. Following meshing was obtained a network of quadrilateral quad type, whose size varies according to the body surface, having an average size of 50 mm. The result was a number of 30210 elements and 29869 nodes. The discretization of the deck and container structure is shown in the figure.
3.1. Boundary conditions and loads

As for boundary conditions, in the Center Plane the symmetry conditions were applied. On the contour of the fore and aft of the model, the translation in the y direction and the rotation in the z direction are free. At the bottom, where the structure is welded to the double bottom plating, all translations and rotations are blocked.

It was considered fully loaded container, and so a force of 240 KN distributed on the surface of the lower four corner pieces of the container was applied. Also, the gravitational acceleration was defined to take into account the weight of the structure itself.

Impact analysis requires the declaration of a linear velocity, which is determined by the height of fall and the gravitational acceleration. The structure of the container was placed at a distance of 100 mm from the deck and it was applied a speed of 5 m/s, calculated for a height of 1.25 m.

Several cases were considered for the impact of the container with the deck.

3.2. Ideal case

After running the program, it was found that the stress of the analyzed structure in the ideal case had values between 0.154 MPa and 328.1 MPa. This situation is not dangerous because the yield stress is not exceeded, and therefore the deck has no plastic deformations.
3.4. Case 3 - the front edge of the container is the one that strikes first the deck

The maximum stress of 669.79 MPa is detected in the container structure near the corner pieces. The deformations found are between 0 and 426.9 mm. By evaluating the results it can be stated that the structure of the container is the one that fails structurally.

3.5. Case 3 - Fall on the corner

The maximum values are identified in the deck stiffners, located near the collision zone. The total deformation is between 0 and 569.2 MPa. To avoid structural failure, the thickness and quality of wood used for protection should be chosen rationally. Another solution would be to dimension the deck stiffening elements according to the results obtained.

4. CONCLUDING REMARKS

The distribution of the stresses resulted from the generation of the finite element analysis allows selecting the critical structural regions, and therefore indicates the necessity for the following solutions: increased attention to the selection of the material placed on the deck, the increase of the deck thickness, the choice of some profiles that increase resistance. These solutions must be carefully considered in terms of both the weight of the ship and the costs involved.

REFERENCES

[1]. Ovidiu Ionăș, “Nave tehnice”, Galati University Press (GUP), 2014.

Paper received on December 31th, 2018