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ANALYSIS OF VERY LARGE FLOATING STRUCTURE USING ANSYS

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ABSTRACT

The pontoon-type VLFS just floats (lies) on the sea surface. The pontoon-type VLFS is very flexible compared to other kinds of offshore structures, so that the elastic deformations are more important than their rigid body motions. Gill cells are introduced to minimizing the central deformation and stress of the floating structure. The gill cells are introduced within the floating structure with holes or slits at the bottom floor to allow water to flow in and out freely. In this floating structure containers are filled throughout the structure by using the crane at the end of the structure. If one layer is filled another layer is placed above the first layer. One layer of container loading also called as one tier loading. Up to eight tiers loading the structure has been analyzed.The 3D model of the floating structure is designed by using the pro e wildfire 5.0software. The analysis can be taken by ansys workbench 14.5 software to find the deformation, stress and strain values for different loading condition.

KEYWORDS: 3D Modelling, Meshing, Gill Cells, Concrete, 8 Tires of Loading, Equivalent Elastic Strain**.**

INTRODUCTION

VLFS may be classified to two categories, i.e. the pontoon-type and the semi-submersible-type. The pontoon-type of floating structure is a simple flat box structure, like a giant plate floating on the water. It features high stability, low manufacturing cost and easy maintenance and repair. Very large floating structures (VLFS) have attracted the attention of architects, city planners, and engineers because they provide an exciting and environmentally friendly solution for land creation from the sea as opposed to the traditional land reclamation method. The applications of VLFS as floating piers, floating hotels, floating fuel storage facilities, floating stadia, floating bridges, floating airports, and even floating cities have triggered extensive research studies in the past two decades. The VLFS technology has developed considerably and there are many innovative methods proposed to minimize the hydro elastic motion, improve the mooring system and structural integrity of the VLFS. This keynote paper summarizes the applications, research and development of VLFS over the past two decades.

Very Large Floating Structure of several meters long is being considered for various applications such as floating airplanes and so on. The very large floating structure recently designed as a thin mat-like configuration and very large horizontal area. Therefore this type of structure is very flexible and the elastic deformation due to wave forces is more critical than the rigid body motions. Recent investigation of hydro-elastic response analysis of very large floating structure have been much improved, the behavior of structural body induced by the wave force have been cleared. From those results of hydro-elastic response analysis, global and generous stress distribution have been able to estimated, however detail analysis cannot be estimated directly because it is difficult to solve full scale structural model. Since there are many discontinuous and stress concentrated positions in the structure of multi-purpose very large floating structure, we proposed the detail structure by using phase structural analysis method applied the results of analysis to the detail local structure.

MATERIALS AND METHODS

MODELING

The very large floating structure, has the dimensions of total length 270 m, Total width 210 m, Total height 10 m, Thickness of top and bottom slabs 400 mm, Thickness of intermediate level slab 200 mm, Thickness of vertical walls 300 mm, Height of beam stiffeners for top and bottom slabs 1 m. This model has been entirely modeled by PRO E software. First of all sketch command of the pro e is opened. Then by using rectangles slabs and beams of floating

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structure is created. Then 3D model of single block created and then patterning of that single block with specified direction to create a full assembly of very large floating structure.

TRANSFORMATION OF MODEL

Then the model is converted in to the IGES format which is most suitable and easy access for any other software's. Using the IGES format we can import the vlfs model from PRO-ENGINEER to ANSYS. Now we can make structural analysis.

MESHING

After the complete structure is modeled, the beams, slabs, stiffeners and walls are individually meshed. This has been done by using ansys workbench software. The last step to be completed before meshing the model is to set the meshing controls, i.e. the element shape, size, the number of divisions per line, etc. Selecting the various parts of the model, one by one finite element mesh is generated. The critical portions are plates with sharp corners, curvature etc. These areas can be remeshed with advance mesh control options. "Smart element sizing" is a meshing feature that creates initial element sizes for free meshing operation. Proper care has to be taken to have the control over the number of elements and hence the number of degrees of freedom associated with the structure. This is done to have a control over the solution time. However, no compromise is made on the accuracy of the results.

LOADING

The types of loading that can be applied in a static analysis include:

- Externally applied forces and pressures
- Steady-state inertial forces (such as gravity or rotational velocity)
- Imposed (nonzero) displacements.

ANALYSIS

A static structural analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time.

MATERIAL PROPERTIES

CONCRETE

Density kg/m^3	1900
Poisson's ratio	0.2
Modulus of elasticity GPa	22.9
Compressive stress MPa	70
Flexural tensile stress MPa	7.2

PRO E

- Create 2d sketch of single block by using sketch tool
- Create 3d model of the single block of structure using extrude command
- Pattern the single block in both direction to create floating structure.
- Create 2d sketch of gill cell at bottom of the structure.
- Complete the modeling of the floating structure extrude the gill cells.

EXTRUDE – This command is used to create the material (to make 3D object from 2D sketch) from the sketched entities. The entities may be circle, line or rectangle, etc,...

Select the extrude icon from the right tool chest then select the sketched part in the window, enter the extrude length and press the middle mouse button to finish the extrude command. There is a provision for removing material in pro –e which is called cut. The main condition to create the solid model is the sketched section must be closed.

Fig. 1 Elevation view of VLFS in Pro E

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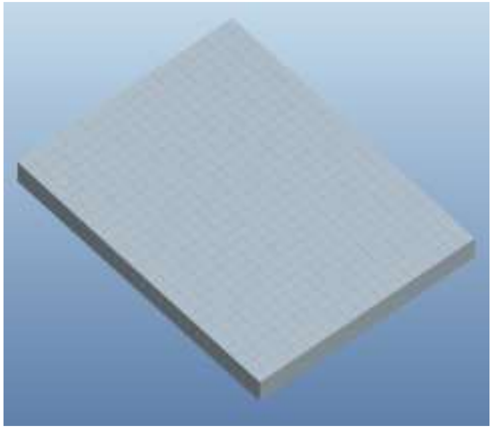

Fig. 2

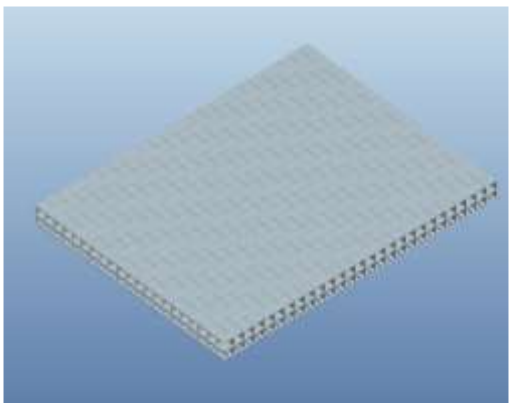

Fig. 3 3D view of VLFS in Pro E

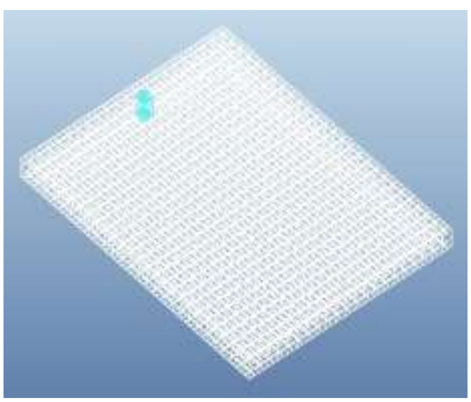

Fig. 4 3D wire frame of VLFS in Pro E

AutoCAD

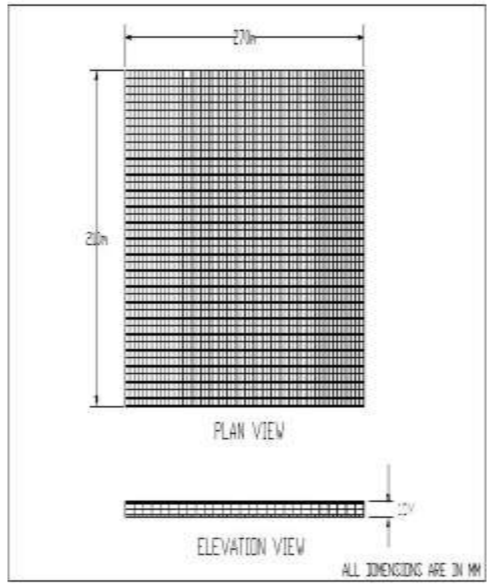

Fig. 5 2D view of VLFS without Gill cell in AutoCAD

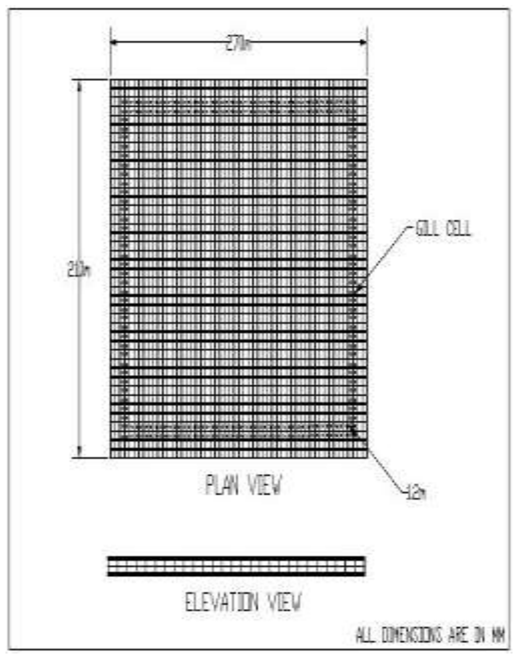

Fig. 6 2D view of VLFS with Gill cell in AutoCAD

ANSYS

ANSYS WORKBENCH 14.5 HIGHLIGHTS

ANSYS 14.5 Geometry Highlights

Geometry Interfaces

– Support for new CAD releases

– Speed Improvements for large models

ANSYS DesignModeler

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– Performance Improvements
– Usability Improvements

SpaceClaim Direct Modeler
– 2012 Release
– 2012+ Release
– Network installation
– Workbench integration enhancements
– Robustness

PERFORMANCE IMPROVEMENTS

Design Modeler

• Large model reading time reduced
– 25%
– 10X

• Smarter handling of databases
– Reload only modified parts
– Associatively linked models show biggest improvements

• Transfer to Meshing faster
– 20-40% faster

14.5 Workbench Meshing

- Object generator allows user to copy objects attached to 1 object to several.
- With mesh controls it provides an easy way to assign similar controls to a group of objects.

MultiZone improvements

• Improved face meshing
– Surface mesh methods: Program controlled, Pave, Uniform
– Support for Advanced Size Function

• Edge biasing and hard/soft sizes

• Improved imprinting, map-ability, side handling, inflation

Speeding up Design Exploration

Analyze more design variations in less time, resulting in more insight and better products at a lower cost

Before 14.5
– Sequential execution could result in very long solution times
– Cost of simultaneous execution could be financially impractical

New feature at 14.5
– Enhanced RSM and simultaneous design point technology along with a new license product, i.e. HPC Parametric Pack

FEATURES OF ANSYS WORKBENCH 14.5:

- Better usability
- Faster and more robust simulations
- Improved multiphysic integration in Workbench platform
- Integration of advanced meshing tools

New ANSYS HPC Parametric Pack for simultaneous design point update

- Tool kits for custom templates
- Remote access

FINITE ELEMENT METHOD

The Finite Element Method (FEM) is a reliable numerical technique for analyzing engineering designs. FEM replaces a complex problem with many simple problems. It divides the model into many small pieces of simple shapes called elements.Elements share common points called nodes. The behavior of these elements is well-known under all possible support and load scenarios. The motion of each node is fully described by translations in the X, Y, and Z directions. These are called degrees of freedom (DOFs). Analysis using FEM is called Finite Element Analysis (FEA). Ansys formulates the equations governing the behavior of each element taking into consideration its connectivity to other elements. These equations relate the displacements to known material properties, restraints, and loads.

Next, the program organizes the equations into a large set of simultaneous algebraic equations. The solver finds the displacements in the X, Y, and Z directions at each node. Using the displacements, the program calculates the strains in various directions. Finally, the program uses mathematical expressions to calculate stresses.

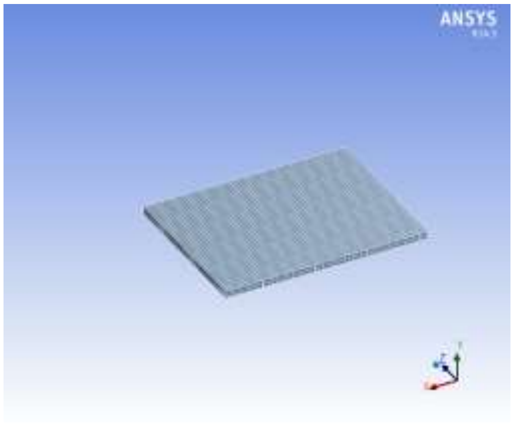

Fig. 7 Geometry import view in ANSYS workbench

INPUT VALUES APPLIED ON THE VLFS- 8 TIER LOADING IN ANSYS WORKBENCH

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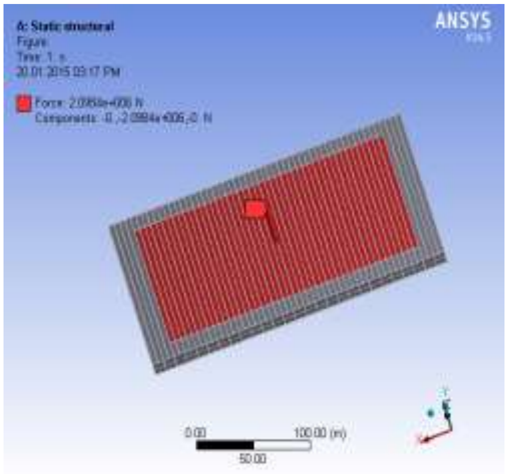

Fig. 8 Results for VLFS without Gill cell

ONE TIER LOADING

TOTAL DEFORMATION

Deformation in continuum mechanics is the transformation of a body from a reference configuration to a current configuration.

A configuration is a set containing the positions of all particles of the body. As deformation occurs, internal inter-molecular forces arise that oppose the applied force. If the applied force is not too great these forces may be sufficient to completely resist the applied force and allow the object to assume a new equilibrium state and to return to its original state when the load is removed. A larger applied force may lead to a permanent deformation of the object or even to its structural failure. So the deformation value should in allowable limit.

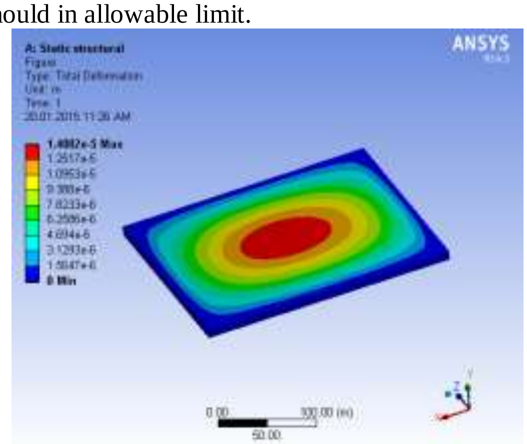

Fig. 9

EQUIVALENT ELASTIC STRAIN

Equivalent elastic strain in which the distorted body returns to its original shape and size when the deforming force is removed.

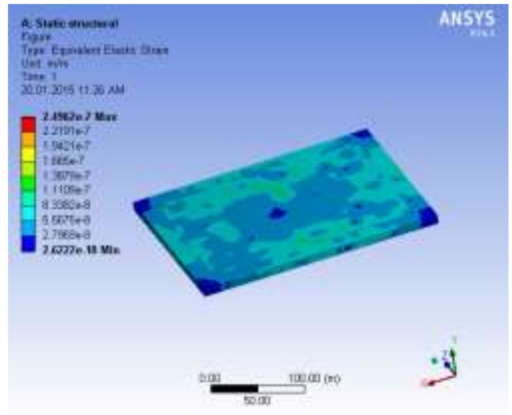

Fig. 10

EQUIVALENT STRESS

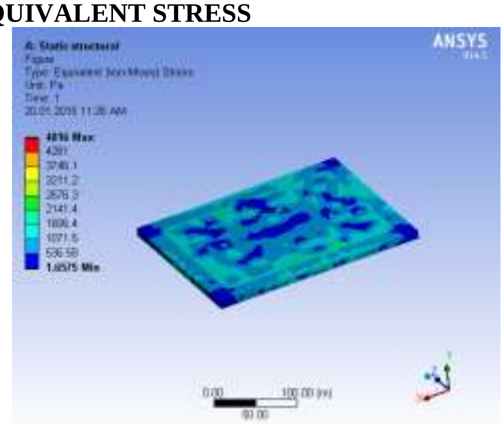

Fig. 11

TWO TIER LOADING

TOTAL DEFORMATION

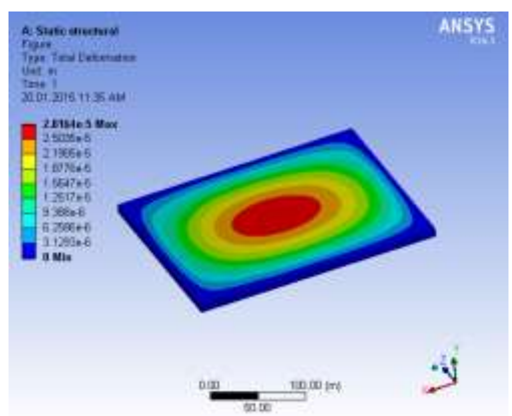

Fig. 12

EQUIVALENT ELASTIC STRAIN

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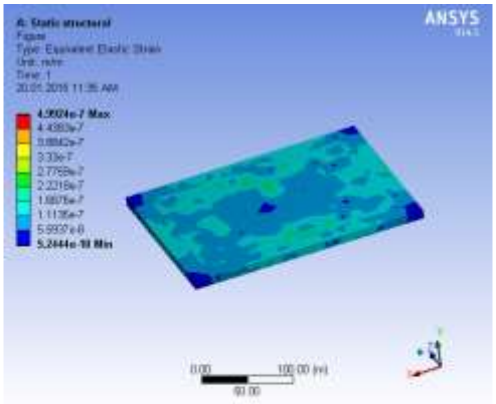

Fig. 13

EQUIVALENT STRESS

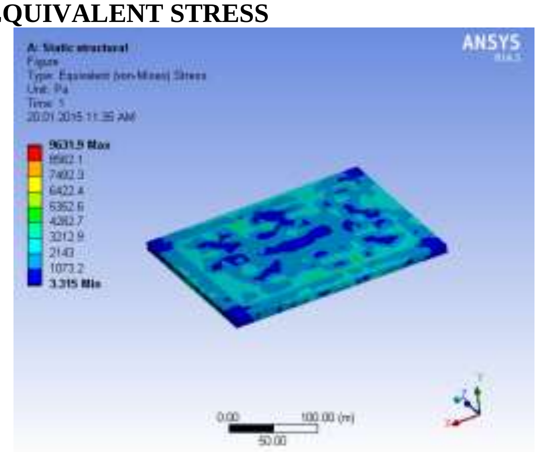

Fig. 14

THREE TIER LOADING
TOTAL DEFORMATION

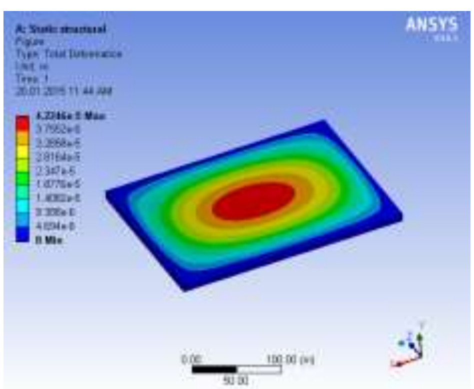

Fig. 15

EQUIVALENT ELASTIC STRAIN

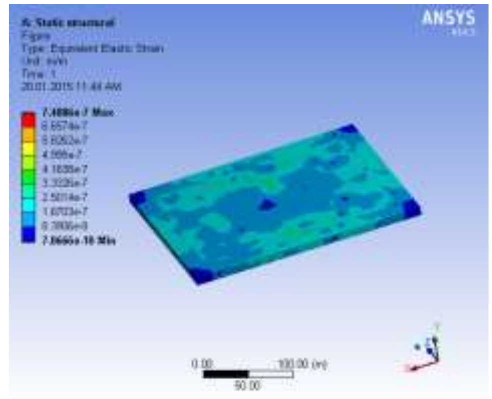

Fig. 16

EQUIVALENT STRESS

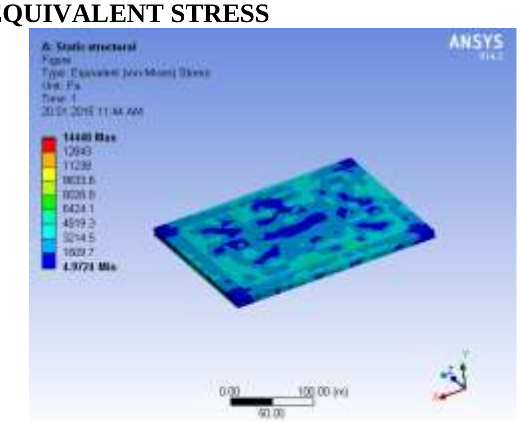

Fig. 17

FOUR TIER LOADING
TOTAL DEFORMATION

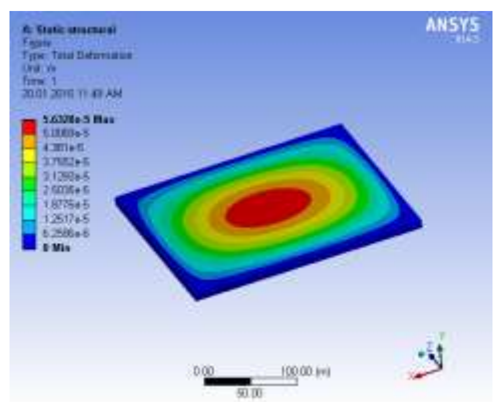

Fig. 18

EQUIVALENT ELASTIC STRAIN

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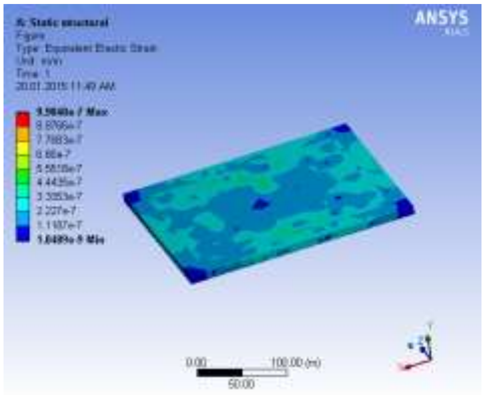

Fig. 19

EQUIVALENT STRESS

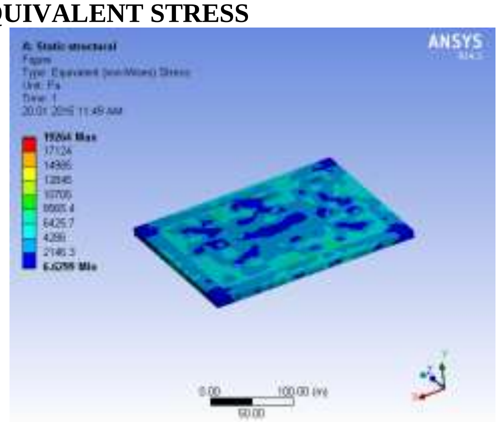

Fig. 20

FIVE TIER LOADING
TOTAL DEFORMATION

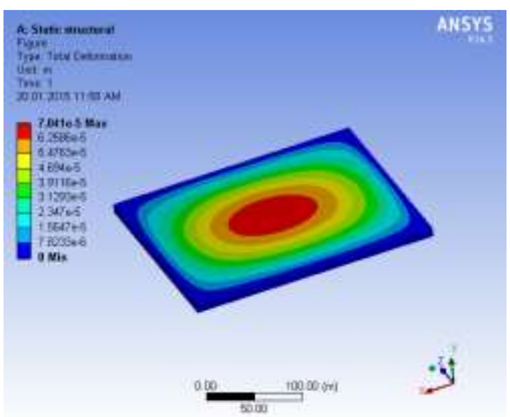

Fig. 21

EQUIVALENT ELASTIC STRAIN

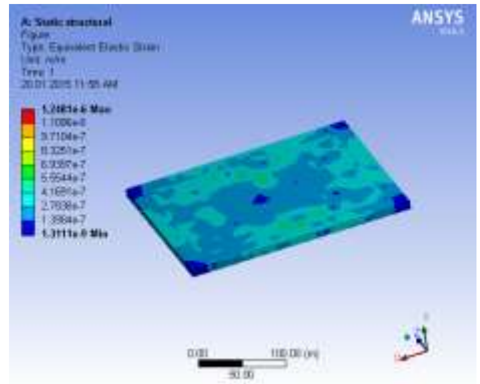

Fig. 22

EQUIVALENT STRESS

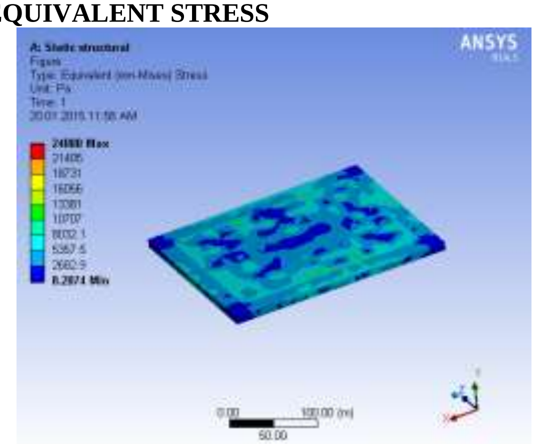

Fig. 23

SIX TIER LOADING
TOTAL DEFORMATION

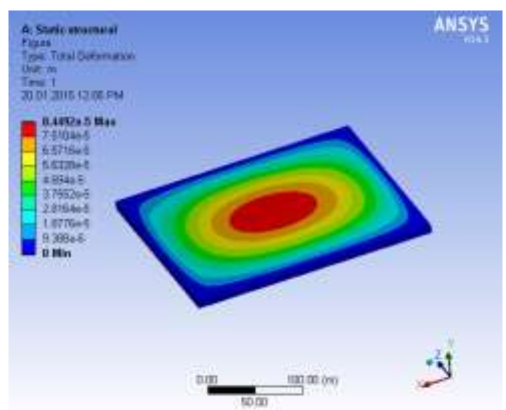

Fig. 24

EQUIVALENT ELASTIC STRAIN

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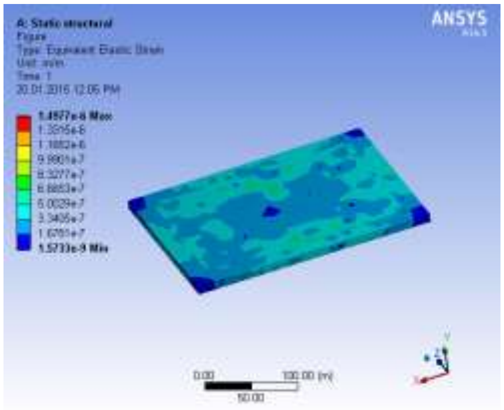

Fig. 25

EQUIVALENT STRESS

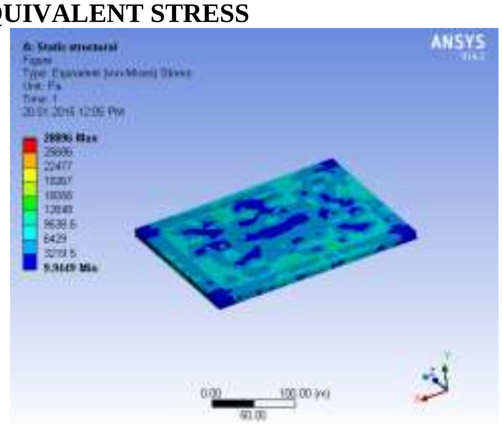

Fig. 26

SEVEN TIER LOADING
TOTAL DEFORMATION

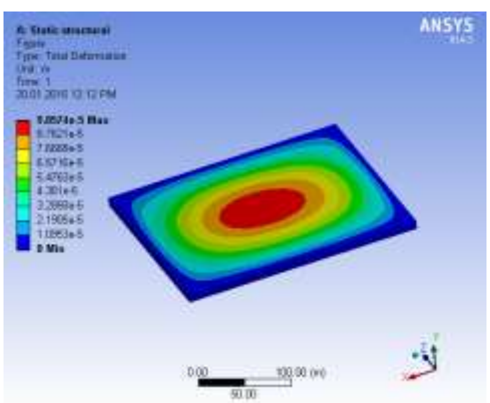

Fig. 27

EQUIVALENT ELASTIC STRAIN

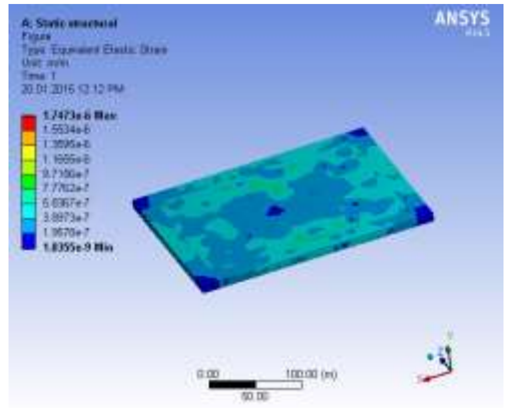

Fig. 28

EQUIVALENT STRESS

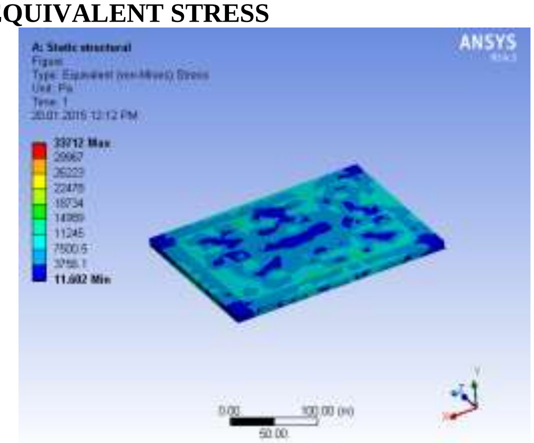

Fig. 29

EIGHT TIER LOADING
TOTAL DEFORMATION

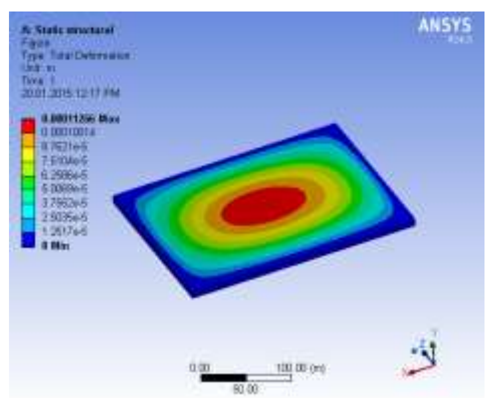

Fig. 30

EQUIVALENT ELASTIC STRAIN

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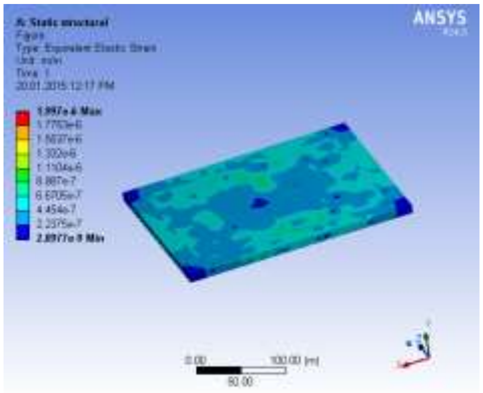

Fig. 31

EQUIVALENT STRESS

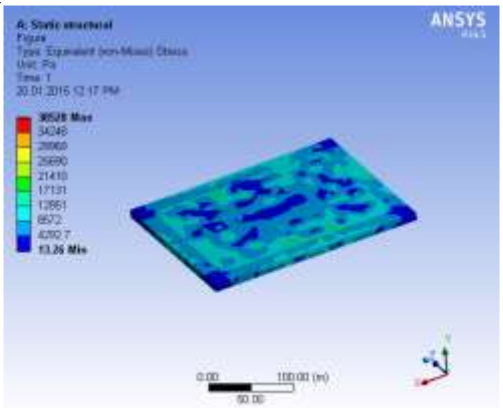

Fig. 32

RESULTS FOR VERY LARGE FLOATING STRUCTURE WITH GILL CELL

ONE TIER LOADING
TOTAL DEFORMATION

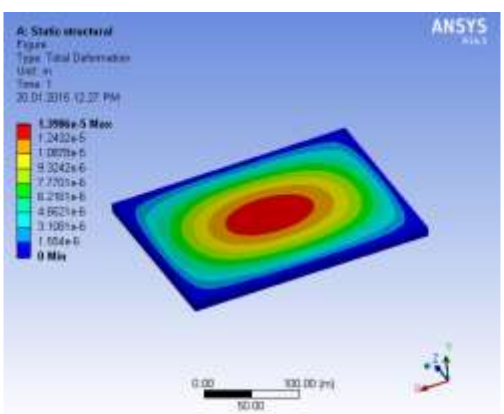

Fig. 33

EQUIVALENT ELASTIC STRAIN

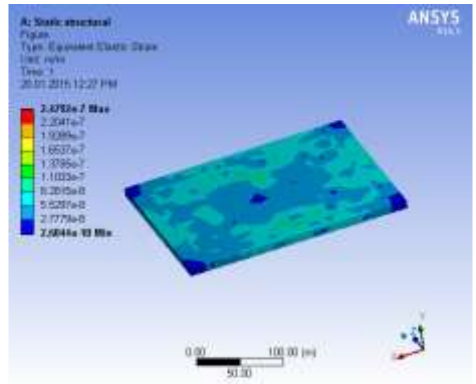

Fig. 34

EQUIVALENT STRESS

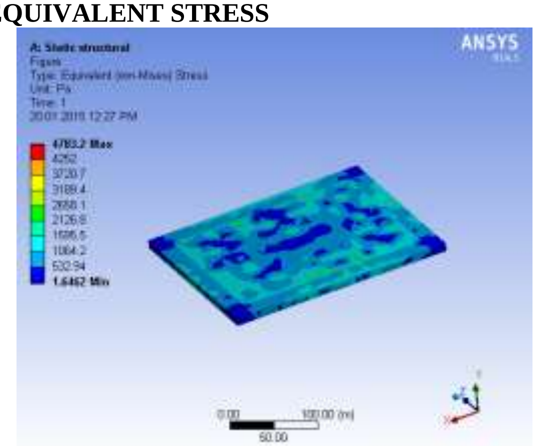

Fig. 35

TWO TIER LOADING
TOTAL DEFORMATION

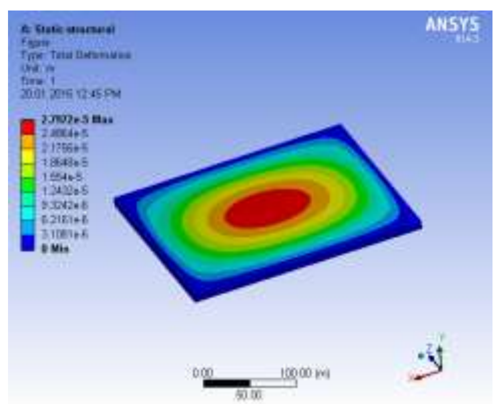

Fig. 36

EQUIVALENT ELASTIC STRAIN

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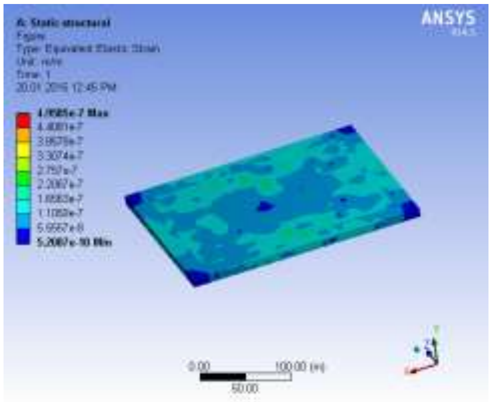

Fig. 37

EQUIVALENT STRESS

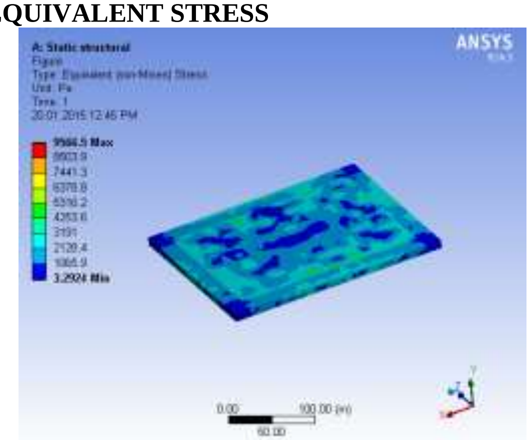

Fig. 38

THREE TIER LOADING

TOTAL DEFORMATION

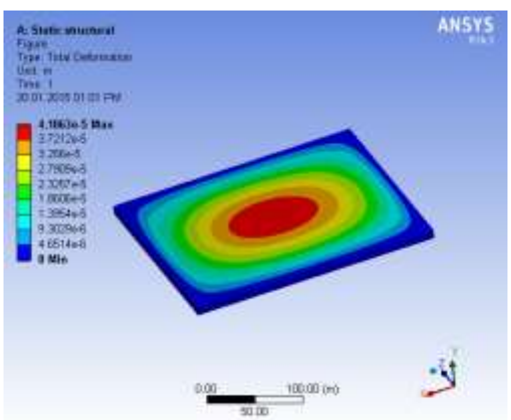

Fig. 39

EQUIVALENT ELASTIC STRAIN

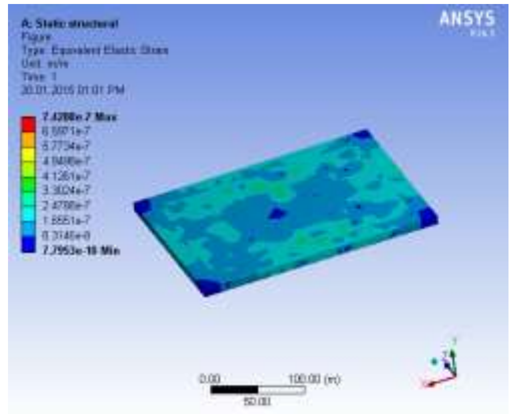

Fig. 40

EQUIVALENT STRESS

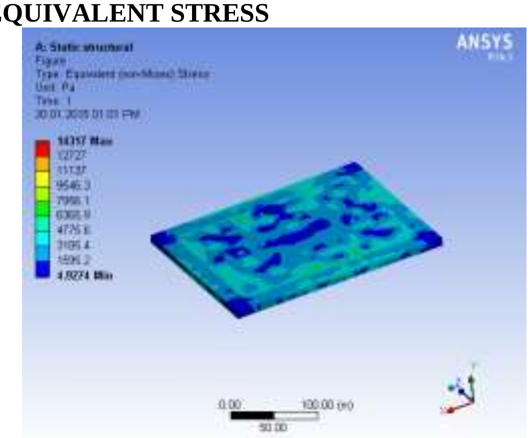

Fig. 41

FOUR TIER LOADING

TOTAL DEFORMATION

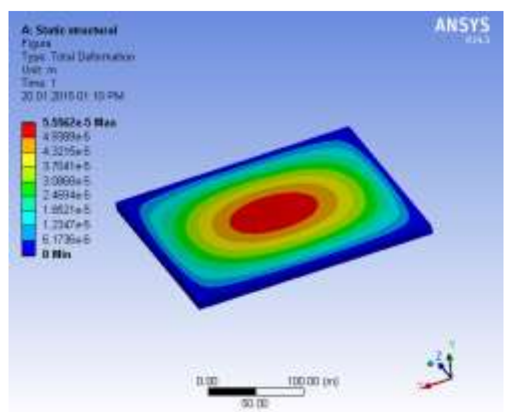

Fig. 42

EQUIVALENT ELASTIC STRAIN

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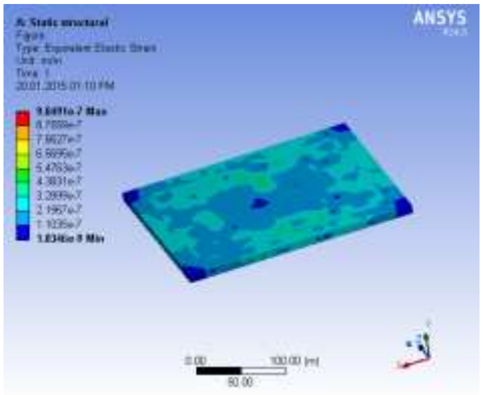

Fig. 43

EQUIVALENT STRESS

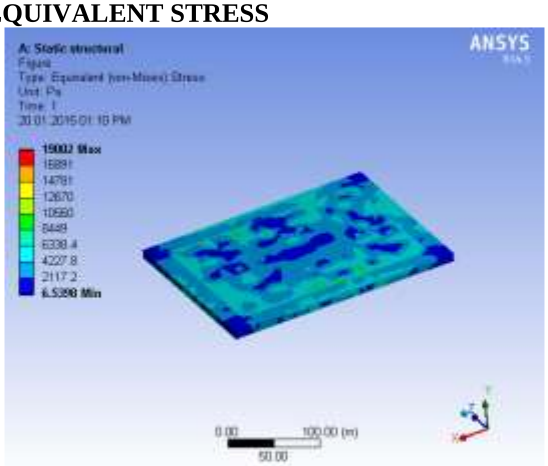

Fig. 44

FIVE TIER LOADING
TOTAL DEFORMATION

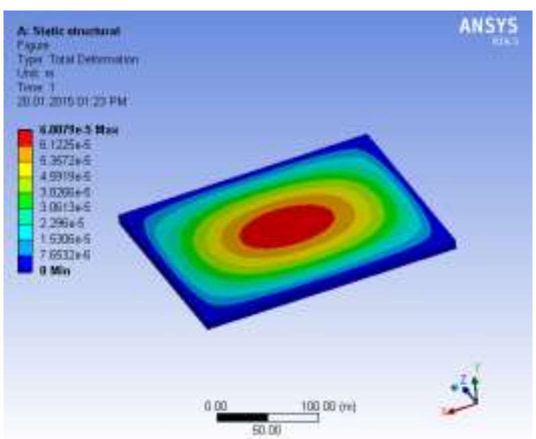

Fig. 45

EQUIVALENT ELASTIC STRAIN

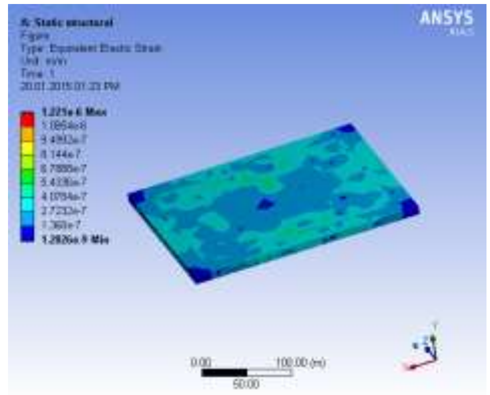

Fig. 46

EQUIVALENT STRESS

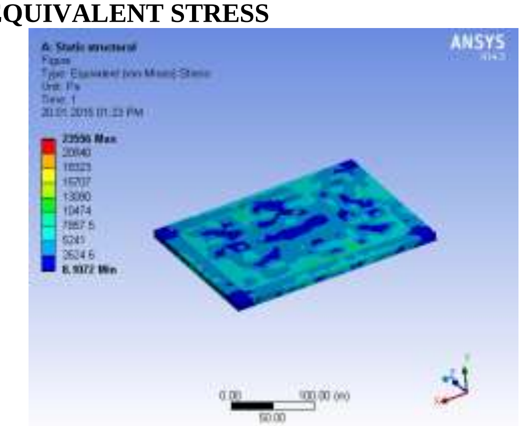

Fig. 47

SIX TIER LOADING
TOTAL DEFORMATION

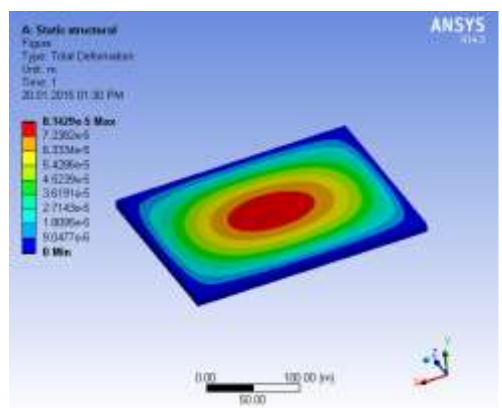

Fig. 48

EQUIVALENT ELASTIC STRAIN

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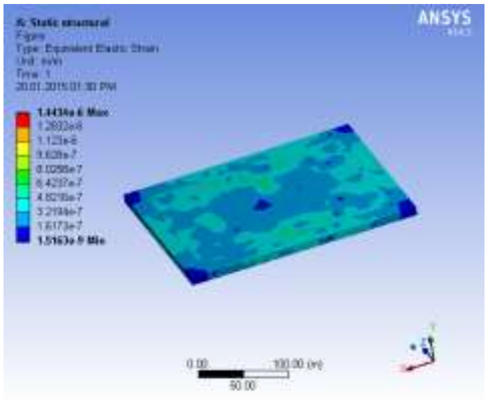

Fig. 49

EQUIVALENT STRESS

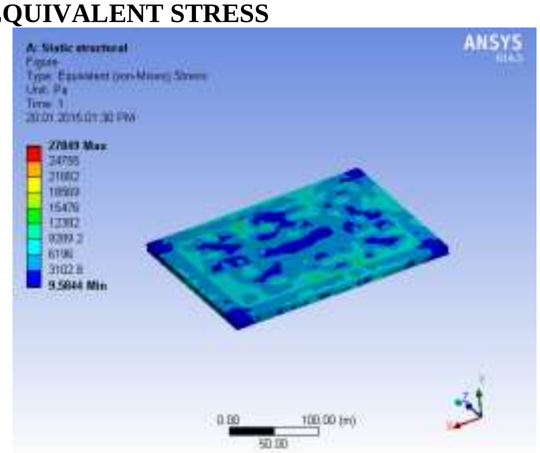

Fig. 50

SEVEN TIER LOADING
TOTAL DEFORMATION

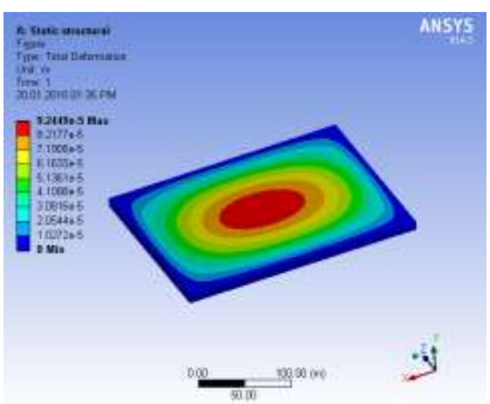

Fig. 51

EQUIVALENT ELASTIC STRAIN

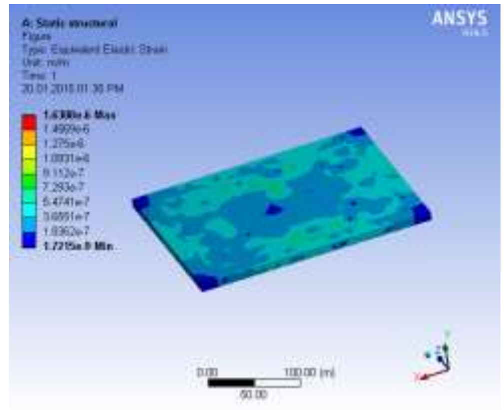

Fig. 52

EQUIVALENT STRESS

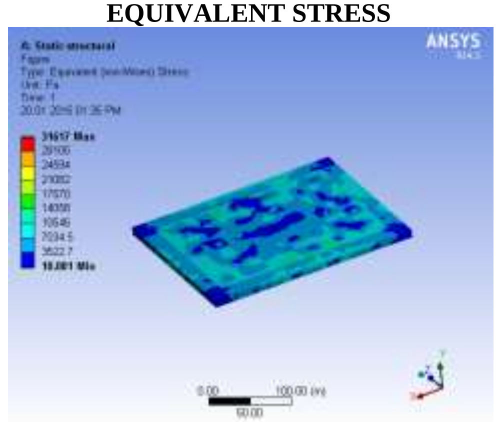

Fig. 53

EIGHT TIER LOADING
TOTAL DEFORMATION

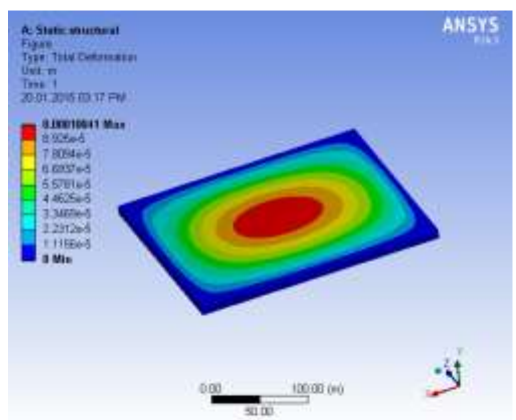

Fig. 54

EQUIVALENT ELASTIC STRAIN

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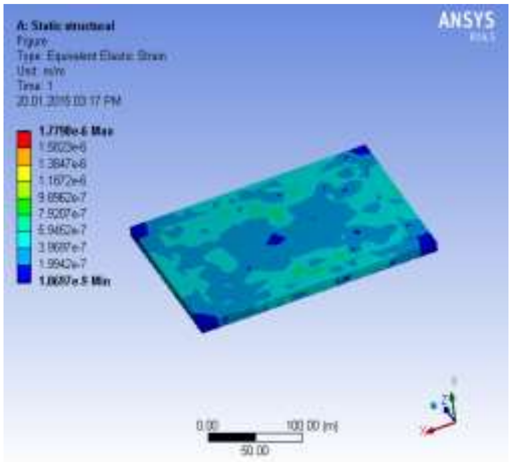

Fig. 55

COMPARISON TABLE
VLFS WITHOUT GILL CELL

	TOTAL DEFORMATION (m)	EQUIVALENT ELASTIC STRAIN (m/m)	EQUIVALENT STRESS (Pa)
1 TIER LOADING	1.408e-5	2.496e-7	4816
2 TIER LOADING	2.816e-5	4.99e-7	9631.9
3 TIER LOADING	4.22e-5	7.488e-7	14448
4 TIER LOADING	5.63e-5	9.98e-7	19264
5 TIER LOADING	7.041e-5	1.248e-6	24080
6 TIER LOADING	8.449e-5	1.4977e-6	28896
7 TIER LOADING	9.857e-5	1.747e-6	33712
8 TIER LOADING	1.126e-4	1.997e-6	38528

VLFS WITH GILL CELL

	TOTAL DEFORMATION (m)	EQUIVALENT ELASTIC STRAIN (m/m)	EQUIVALENT STRESS (Pa)
1 TIER LOADING	1.398e-5	2.479e-7	4783.2
2 TIER LOADING	2.797e-5	4.958e-7	9566.5
3 TIER LOADING	4.186e-5	7.42e-7	14317
4 TIER LOADING	5.556e-5	9.849e-7	19002
5 TIER LOADING	6.887e-5	1.221e-6	23556
6 TIER LOADING	8.143e-5	1.44e-6	27849
7 TIER LOADING	9.245e-5	1.638e-6	31617
8 TIER LOADING	1.004e-4	1.779e-6	34339

CONCLUSION

Analysis results of the very large floating structure with and without gill cells are listed in the Table. Analysis has been carried out from one tier to eight tier loading. Here one tier represents the 30 tons of containers in very large floating structure.

The results such as total deformation, equivalent elastic strain and equivalent stress for each modal of very large floating structure upto eight tier loadings

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are determined. Comparing the vlfs with gill cells optimized materials and the vlfs without gill cells, vlfs with gill cells has the low values of total deformation, equivalent stress and equivalent elastic strain. Hence it is concluded that vlfs with gill cells is suitable for the very large floating structure. While carrying out this project we are able to study about the 3Dmodelling software (PRO-E) and Study about the analyzing software (ansys) to develop our basic knowledge to know about the structural design.

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