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SIMULATION OF AN INDUSTRIAL CONTAINER DESIGNED AT HYDRAULIC PRESSURE IN A COMPOSITE MATERIAL WITH GLASS FIBER

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1. INTRODUCTION

Most of structural models to pressure, handle high relation mechanical between resistance and weight, either between rigidity and weight, relations that can to fulfill if material uses composite, since this it offers the possibility of simulating this mechanical behavior by means of a reinforcement of the material with fibers in the directions where the greater tensions predominate, and to as well optimize the real amount of material required in the construction of the container in function to the reduction of the weight of the same one.

2. COMPOSITION AND CHARACTERISTICS OF LAMINATE AND LAMINATED FOR THE CONTAINER

Like formulation of the material behavior, it was had a model based on hypothesis of anisotropic elasticity, [5]. In order to determine the properties of each lamina the well-known formulation is due to apply as the rule of mixtures. The elastic properties of each component and directions of the stiffener one within the composite, can be determined the mechanical properties of the composite by means of the generalized law of Hooke, [4]. Fiberglas's were used type E and polymeric matrix of polyester noncsaturated. The containers made by means of the successive piling up of three types of sheets: sheet of matrix reinforced with short fibers, sheet with unidirectional long fibers, and sheet with bidirectional long fibers. General formulation for the laminated, the classic theory of thin plates of Kirchhoff-love, that contemplates the connected effects of flat stress to those of flexion in the composite [4].

3. FORMULATION OF THE ELEMENT FOR THE MAPPING AND SELECTION OF THE BROKEN CRITERION

The element used was type Shell 99 for the configuration of the layers, [6]. The theoretical formulation for the constituent matrices of the layer element Shell 99 will be:

$$[E_1]=\sum_{j=1}^{n_L}\int_{r_j^{BT}}^{r_j^{TP}} r[T_m]_j^T[D]_j[T_m]_j\,dr \qquad [E_0]=\sum_{j=1}^{n_L}\int_{r_j^{BT}}^{r_j^{TP}}[T_m]_j^T[D]_j[T_m]_j\,dr$$

$$[E_2]=\sum_{j=1}^{n_L}\int_{r_j^{BT}}^{r_j^{TP}} r^2[T_m]_j^T[D]_j[T_m]_j\,dr \qquad \{S_0\}=\sum_{j=1}^{n_L}\int_{r_j^{BT}}^{r_j^{TP}}[T_m]_j^T[D]_j\left[\varepsilon^{th}\right]_j dr \tag{1}$$

$$\{S_1\}=\sum_{j=1}^{n_L}\int_{r_j^{BT}}^{r_j^{TP}} r[T_m]_j^T[D]_j\left[\varepsilon^{th}\right]_j dr$$

Where: n_L number of layers, $[D]$ relation tension and deformation in the point of interest within the layer, $[T_m]$ matrix of transformation of layer in element, r coordinate in a point of interest within layer j. Thus they are defined the forces and moments:

$$\begin{Bmatrix}\{N\}\\ \{M\}\end{Bmatrix}=\begin{bmatrix}[E_0] & [E_1]\\ [E_1] & [E_2]\end{bmatrix}\begin{Bmatrix}\{\varepsilon\}\\ \{k\}\end{Bmatrix}+\begin{Bmatrix}\{S_0\}\\ \{S_1\}\end{Bmatrix} \tag{2}$$

Where: $\{N\}$ forces by length unit, $\{M\}$ moments by length unit, $\{S_1\}$,$\{S_0\}$ Vectors because of thermal loads, $\{\varepsilon\}$ deformations,$\{k\}$ curvatures. The criterion of Tsai Wu, is the generalization of the criterion of Tsai Hill with some additional terms as they are: the difference between compression and traction, and the interaction between stress.

4. GEOMETRIC MODELING OF THE CONTAINER

The container is conformed by four routes of access and drainage of the liquid outside the container. Figure 1. The container was designed to store water to room temperature to a pressure of 827370,8752 Pa.

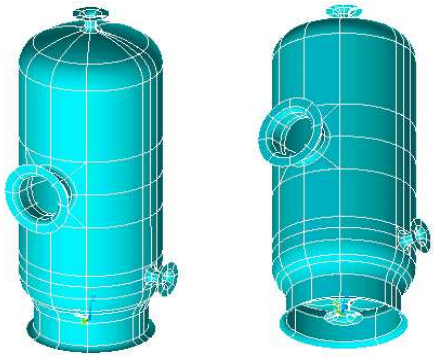

Figure 1. Geometry of the container to pressure

Were altogether generated 4096 elements type shell that have an amount of 12477 nodes. The geometric description of the elements is constituted from the same geometric definition of the model. Figure 2.

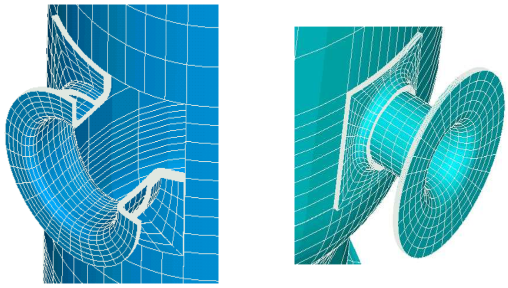

Figure 2. Laminado de las salientes del recipiente a presión.

The lamination of the model begins on the areas of the container with a laminate of 20 layers for zones where discharges can be produced concentrations of efforts. The laminate of 10 layers, occurs in remaining zones.

5. SIMULATION OF THE CONTAINER

The exit of results is: effort in the elementary direction "x" (Sx), figure 3a, and efforts in the elementary direction "y" (Sy), Figure 3b. Other results indicates the zones where it is fulfilled the greater value of the quadratic criterion of breakage of Tsai Wu, figure 3c, and the one that is put under the greater value of the criterion breakage of Tsai Wu, figure 3d.

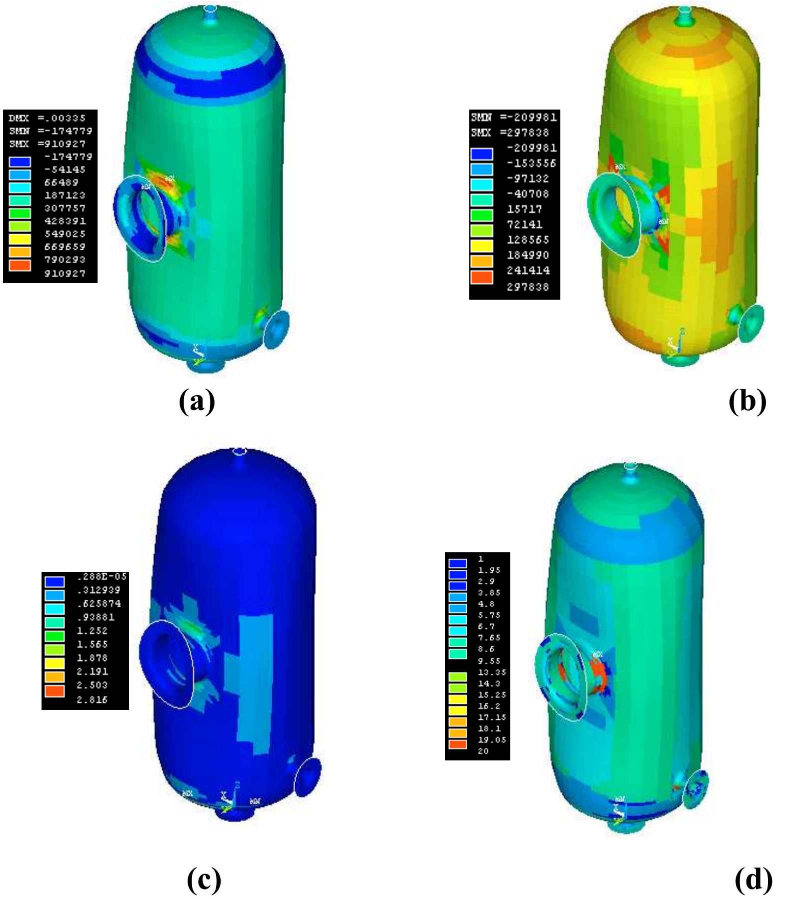

Figure 3. Elementary efforts Sx and Sy, values of the quadratic criterion of breakage of Tsai Wu and sheet location.

4. RESULTS

It is observed that the maximum stress elementary compression (Sx), was of 0.17478E6 Pa, located in element 2697. The maximum stress to elementary traction had a value of 0.9109É6 Pa for the element number 2304. the maximum effort to elementary compression (Sy), was of -0.20998E6 Pa, located in the element number 2403. it is observed that the maximum efforts elementary (Sxy), were of 0.19476E6 and 0.19308E6 Pas, located in elements 2205 and 2219 respectively.

5. CONCLUSIONS

One stands out that too existed compressive stress due to intersections between the lateral fuses and the cylindrical body, of a geometric development of elliptical and concave openings. This generates effects of distortion of the material. 3584 sheet exist that are in the fault limit or that exceeded it, but without implying the failure of the plate laminate of the container. Sheet 2317 obtained the maximum criterion of fault with a without dimensional value of 20. The results of the simulation of the maximum criterion showed that it positions with greater I number of sheet ruptures were between the positions of sheet 5 and the positions of sheet 8. This indicates that the sheet that failed by breaking were the unidirectional ones. In zones you criticize to traction, occurred the breakage of the first sheet and in zones to compression, it was in completes sheet. This indicated the breakage in the short fiber sheet, as much in the interior of the container like in the external surface. They are not really transcendental within the plate, since they are those that less contributes to the total behavior of composite. The results analyzed in global form show that through the entire container the material bucket of stable way without arriving at a complete rupture of the sheet and without exceeding you limit them of established maximum resistance for composite. The results also demonstrate that it is possible to reduce to the thickness of the material and therefore the weight of the same one, degrading the plate y means of the suppression of the laminae that failed.

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