Analysis of Scale Effects on the Behavior of Composite Structures: Case of Automotive Body

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Abstract

For many years, composite materials include automotive industries to improve their performance. Manufacturers are constantly looking for a method of reducing scales presents various advantages. This work aims to show the influence of folds fittings techniques during the downscaling of a multilayer composite structure notched or un-notched, requested static. A numerical study is conducted on the plate-shaped structures. The results confirm the interest of the similarity. Similarities of meaningful relationships appear to be subject to the reproduction of the same modes of deformation and crushing. The results show that there is no difference between "ply level" technique and technology "sub laminate" and the technique of "reducing neutral report."

Index terms— scale effects, behavior, multilayer composites, nicks, similarity.

1 Introduction

utomotive structures integrate the many years since the composite materials for increased performance **??**AGI01]. A continuing need to increase the capacity leads to develop technological prowess with these materials. The complexity results from various sources: The elementary components, which interact by associating on their respective characteristics; methods of manufacture and the complexity of the geometry, seen point create a significant history within the material as regards their behavior. Designers are constantly in search of new methodologies, experimental approaches and digital tools to facilitate the structural optimization tasks. But experimental studies handicaps and view digital in the automotive sector is the large size of structures and therefore adequate means of testing.

The main objective of this work is to analyze the influence of the dimensions of the behavior of multilayer structures to form plaque, notched and un-notched, carbon / epoxy for body applications, static compression solicited by the similarity of technical. Abaqus software has enabled us to certain assumptions to determine the reactions to the build level based on the number of interface, maximum efforts and energies absorbed by the structures according to slits.

2 II.

3 Materials And Methods

4 a) Materials

Considering the results of laminated composites of elastic moduli (Table 1) of stacking sequence, carbon/epoxy for conducting our [YCH01] studies. The material is orthotropic. Technical elastic moduli are given in the table below. i. Presentation of test specimens and assumptions ? Presentation of the Specimens Consider three types of specimens and will be named according to the type of notch: a. UN for UN-Notched, corresponding to the nonnotched specimens. The size of notch is 0; b. FN for Four-Notched, corresponding to test pieces with a small notch, notch size is 0.25 times the thickness; c. HN for Half-Notched, corresponding to test pieces with a large gash. The size of notch is 0.5 times the thickness. These test pieces are shown in Figure 1. The dimensions of its test pieces are given in Table2 below. Whose thicknesses are generally those used for the manufacture of composite structures for automotive bodies.

5 ? Test Hypothesis b) Downscaling Methods

This is the direct application some of Vaschy-Buckingham theorem. In our study, we will use the geometric similarity Cauchy coupled with reordering techniques ply notched and not notched plate structures form.

6 This technique is based on several assumptions:

A factor called scale factor allows the passage of the prototype model. The table below (tab.3) summarizes the mechanical quantities depending on the model of Cauchy. ii.

Wide passage Method 1/4 scale 1/2 and 1/2 scales on scale 1.

7 The method of crossing is one used by Dany Dormegnie [DDO03]. It consists:

? to move from a model 1/4, 4 ply and orientation three model stratifications 1/2, 8 ply, 2,4 and 6 interfaces, oriented respectively ,and et (fig. 3).

? to move from a model 1/2, 8 plies, interface 2, 4, 6 and respective guidance (+2/-2)S , and , to six stratification interface 2, 4, 6, 8 , 12, and 14 (fig. **??**).

8 Comparison of E fforts

The graphs below show the effort peaks in test tubes UN, FN and HN plate to scale 1/4, 1/2 and 1 depending on the notches.

9 Fig.10: To maximize efforts in terms of cuts iv. Comparison of E nergy

The graphs below show the work effort of the specimens UN, FN and HN plate to 1/4, 1/2 and 1 scale depending on the notches.

10 Discussion

The fig. **??**, fig. **??** and fig. **??**show that the deformations are delayed. UN14 the samples show growth of deformation around the recess. This change is certainly due to the existence of embedding reactions that oppose the compressive force. It decreases gradually between 0.020*L and 0.05*L. appears to be constant for values greater than 0.200*L. The peak of the deformation of 1.7630 to 2.500 mm and the minimum is 0. 9304, about 10mm in length. As for FN14 and HN14 samples tested the maximum deformations of 17,560 and 12.34 respectively. To compare the efforts and energies between different scales we use the following steps:

-The values for each stratification in the lower scale are determined from those of the scale 1 and the crushing. -Efforts to embedding (or level of effort) are determined by the same method as before. -The highest energies are calculated by the relationship. With : the peaks efforts and : the maximum displacement.

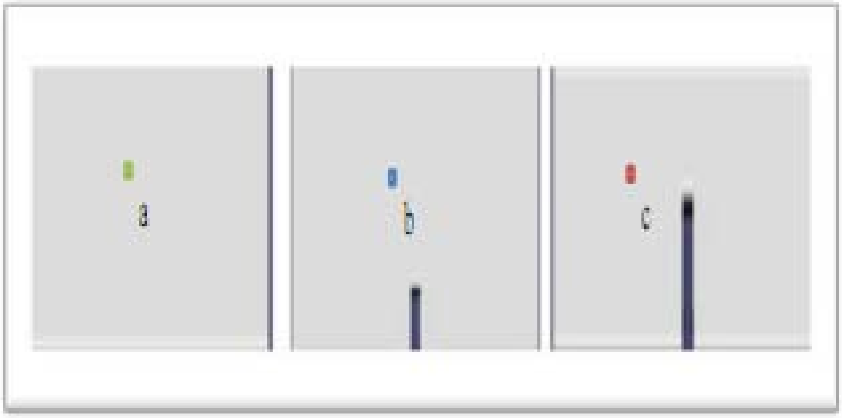
The Cauchy relations of the three parameters: the reactions to the installation, the peaks efforts and energies on one scale are compared to those of the lower scales. The solutions obtained depend on the dispersion of the fillers in the structure. Fig. **??** shows that maximum efforts at embedding remain virtually constant for all number of interfaces between deferred orientations folds (vary little 1%). This confirms our first ii.

11 Comparison reactions underrun

The above fig. **??**presents the results of the reactions at the recessed portion of the specimens study test. These results will be presented according to the type of taps and the number of interfaces in order to highlight the effect of tiller and the number of interfaces on the behavior of structures. A growths energy are mainly due to the presence of notch, the delamination and the friction between the pleats. There is a similarity in relation to all the parameters presented in scale 1 and 1/2.

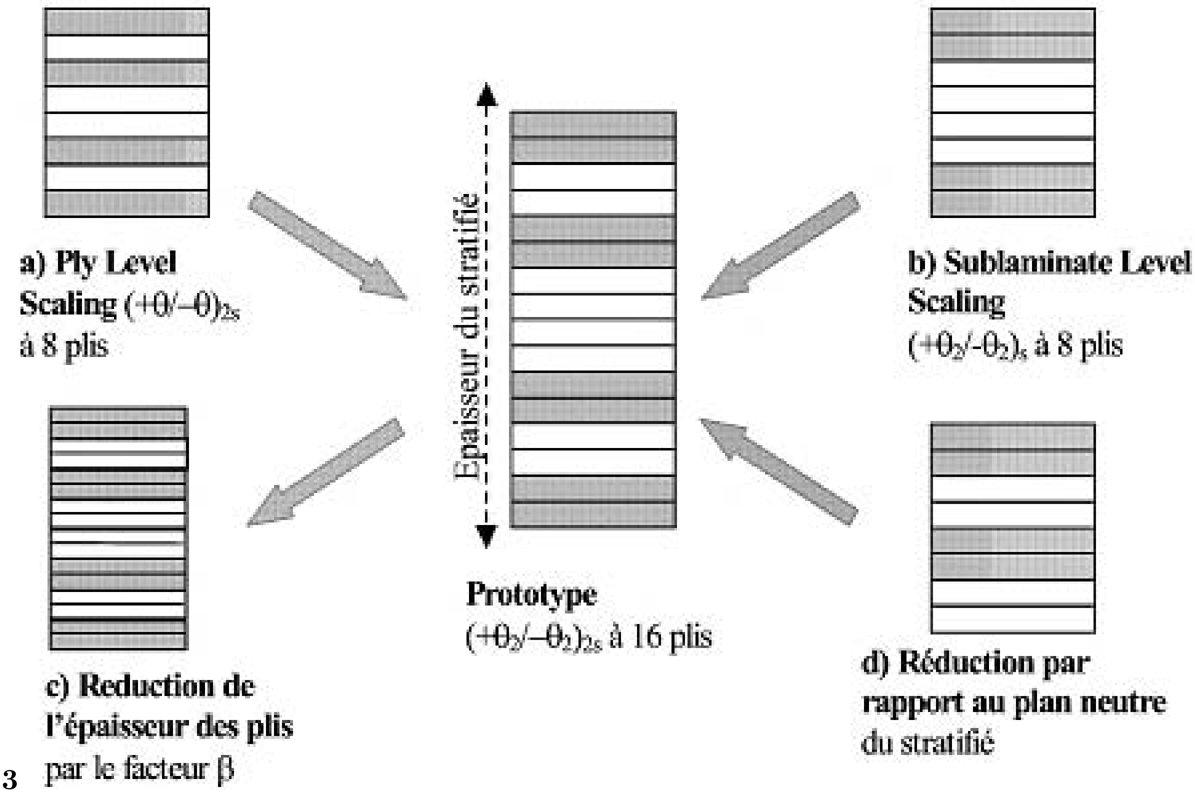
12 V.

This work highlights the scale effects on the behavior of multilayer composite structures in carbon / epoxy notched and un-notched. It shows that the plates 1/4 scale absorb a significant amount of energy that the scale plates 1/2 and 1. The results show that there is no difference in behavior between the technical "ply Level", the "sub Laminate" technique and the technique of "reducing neutral report". We can conclude that, for static compression uses the FN or HN plates are solicited. than those structures in omega unlike crashed. This difference is from more to the fiber properties, the specimen geometry and boundary conditions. While for slotted structures, efforts bearing believe with sizes of notches. We cannot say that in this case there's notch effect. However it can be concluded that the plate's structures in carbon / epoxy more resistant to shocks than structures omega-E glass / epoxy and one has to do to a size effect. The maximum forces (fig. 10) in the test specimens linearly uncross when the size of test specimens and the notch size become important. This confirms our last two assumptions of the size effect on the behavior of composite structures [BZP84, BZP04, and WWE39]. The specimens to 1 and 1/2 scale are less resistant to compression than the specimens in 1/4 scale [DDO03] because the presences of notches are obstacles to the uniform redistribution of efforts in test tubes and are considered of initial defects. The energy of curves in Fig. 11 believes exponentially. These hypothesis static loading (imposed). We clearly observe that efforts to embedding are more important for all types of specimens of small dimensions. These efforts to bearings UN plated structures are more important [1,2]



1

Figure 1: Fig. 1 :



3

Figure 2: Table 3 :

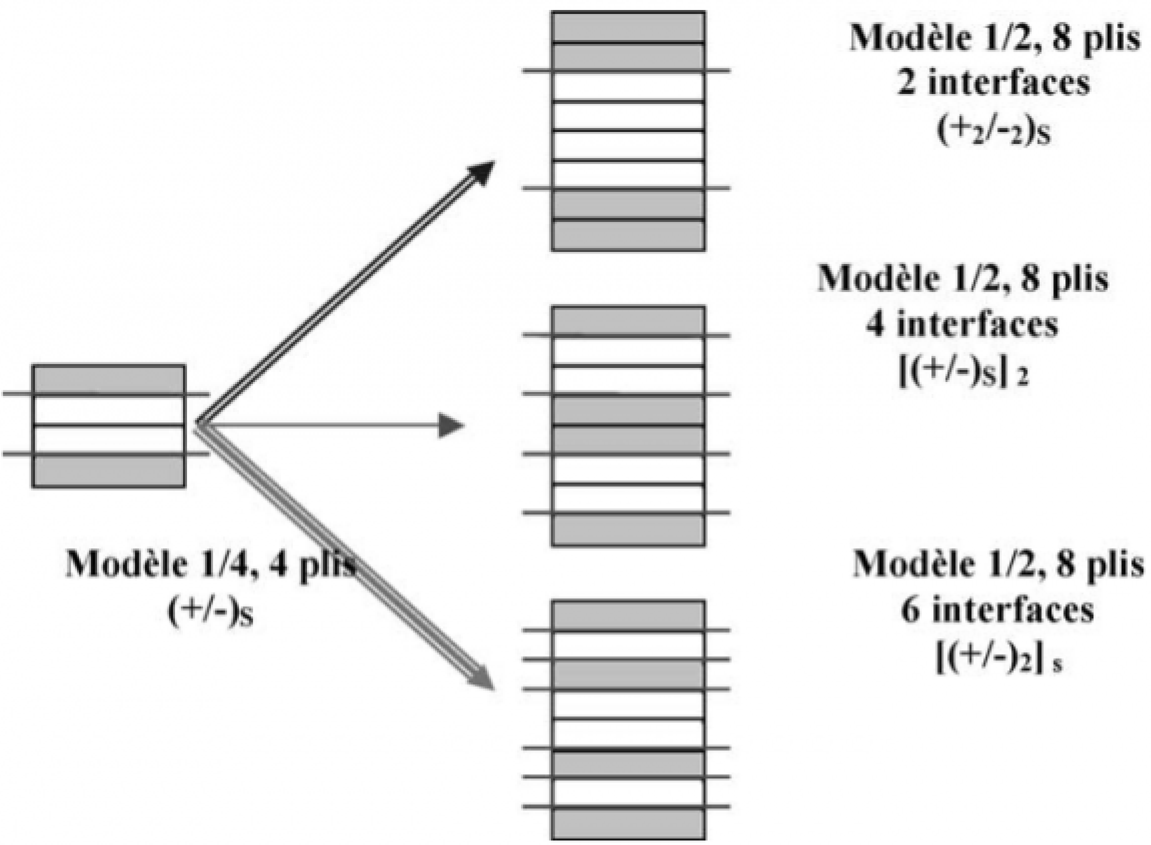


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Figure 3: Fig. 2 :

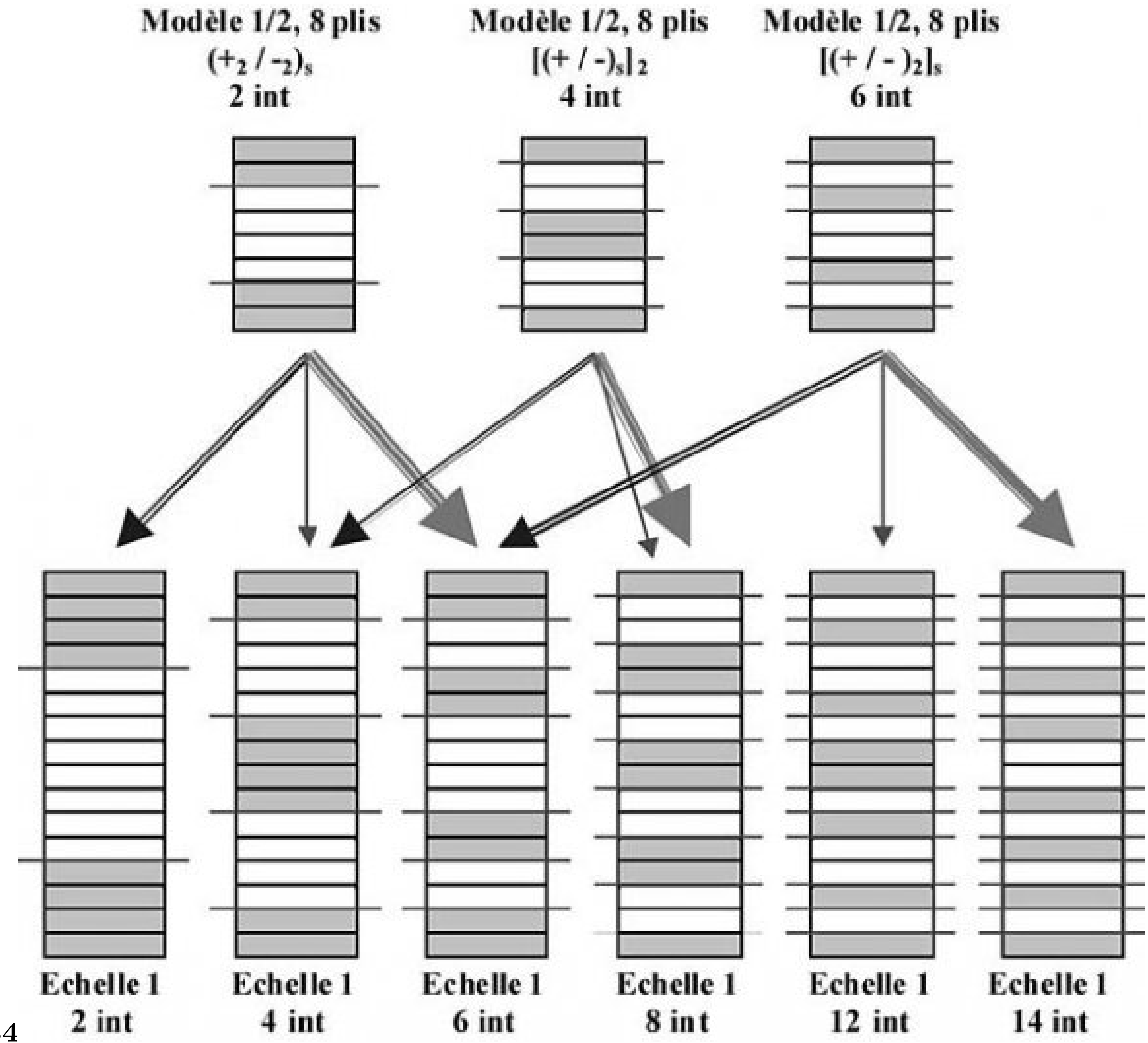

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Figure 4: Fig. 3 :Fig. 4 :

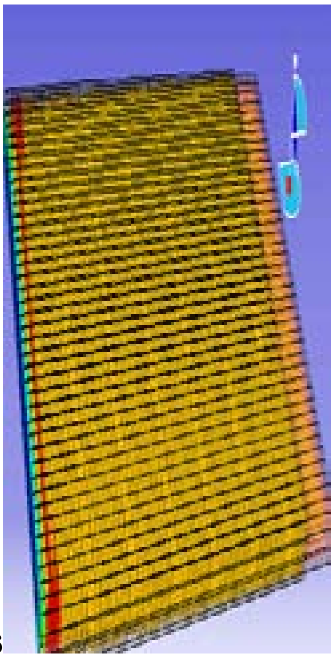
56 

Figure 5: Fig. 5 :AFig. 6 :

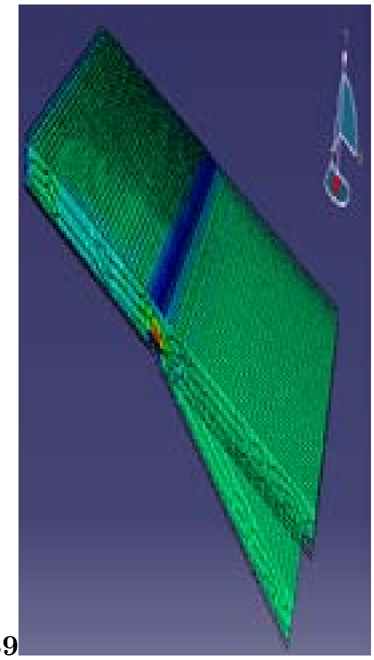
789 

Figure 6: Fig. 7 :Fig. 8 :Fig. 9 :

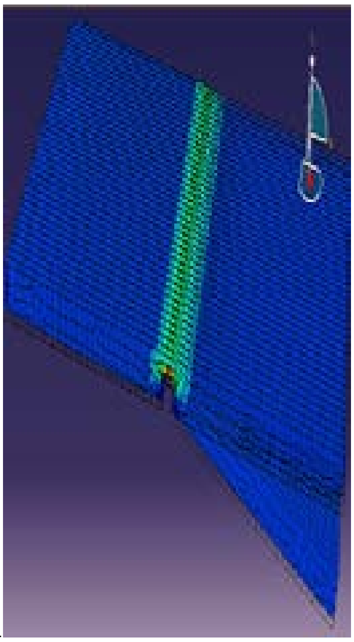
11 

Figure 7: Fig. 11 :

1

Modulus	1 E		E	2	E	3
of elasticity	( ) a MP	( ) a MP			( ) a MP	
Values	16700	16700			11000	
Modulus of elasticity	23 (-) ?		12 (-) ?		? (-) 13	
Values	0.178	0.69			0.178	
Modulus of elasticity	23 ( ) G a MP	(	G 13	)		

[Note: a MP 12 G ( ) a MP]

Figure 8: Table 1 :

2

Ladders	1/4	1/2

Figure 9: Table 2 :

50	100	200
30	60	120
2.4	4.8	9.6
4	8	16
0.75	1.5	3

Figure 10: 1 Length (mm) Width (mm) Thickness (mm) Number of folds Approximation of the mesh

[1]

[2] Analysis of Scale Effects on the Behavior of Composite Structures: Case of Automotive Body

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