

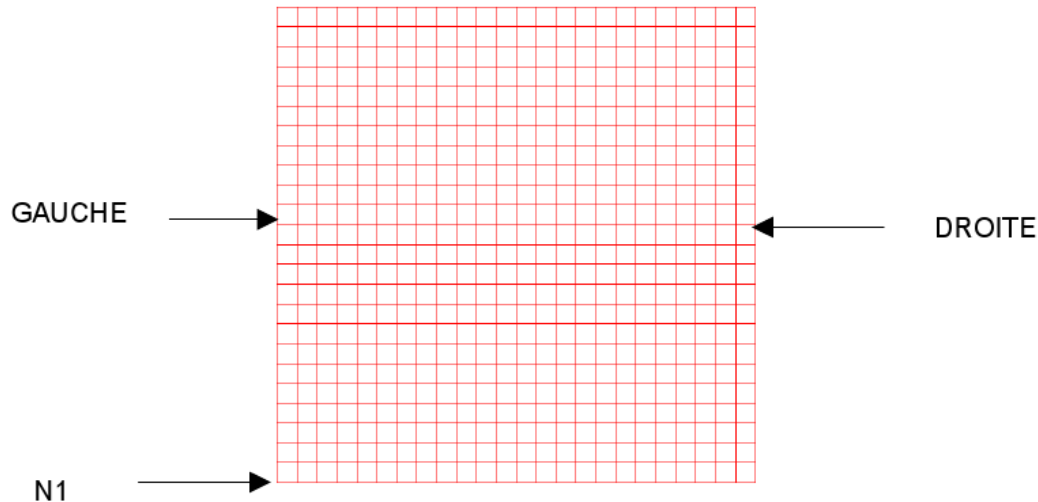
SSLS128 - Static calculation of a plate made up of layers

Summary:

This test makes it possible to validate the case of the multi-layer hulls.

1 Problem of reference

1.1 Geometry



They are a composite material made up of 16 superimposed layers of the same material and fibre directions different forming a plate from 4.48 m of thickness. The longitudinal direction or direction of fibres of each layer is defined by the first direction of orthotropy.

1.2 Property of material

The properties of material are:

- longitudinal Young modulus: $E_L = 59000 \text{ MPa}$
- transverse Young modulus: $E_T = 59000 \text{ MPa}$
- modulus of rigidity in the plan LT : $G_{LT} = 3700 \text{ MPa}$
- Poisson's ratio in the plan LT : $\nu_{LT} = 0.08$
- criterion of rupture in traction in the longitudinal direction: $X_T = 560 \text{ MPa}$
- criterion of rupture in compression in the longitudinal direction: $X_C = -475 \text{ MPa}$
- criterion of rupture in traction in the transverse direction: $Y_T = 560 \text{ MPa}$
- criterion of rupture in compression in the transverse direction: $Y_C = -475 \text{ MPa}$
- criterion of rupture in shearing in the plan LT : $S_{LT} = 48 \text{ MPa}$

The orientation of the first layer is 0° compared to the reference mark of reference, for the second layer 45° , for the third 0° and so on.

1.3 Boundary conditions and loadings

- $N1$ $DY = 0, DZ = 0, DRX = 0, DRY = 0, DRZ = 0$
- $GAUCHE$ $DX = 0$
- $DROITE$ $FX = -784 \text{ N}$

2 Reference solution given by the software "Plates"

In the first layer with 0°

σ_{xx}	σ_{yy}	σ_{zz}
-242	-67	0

Constraints in the reference mark of the plate

SL	ST	SLT
-242	-67	0

Constraints in the reference mark of the layer

Criterion of Tsai-Hill $C_{TH}=0.344$

In the second with 45°

σ_{xx}	σ_{yy}	σ_{zz}
-108	-67	0

Constraints in the reference mark of the plate

SL	ST	SLT
-88	-88	21

Constraints in the reference mark of the layer

Criterion of Tsai-Hill $C_{TH}=0.223$

SL is the constraint in the first direction of orthotropism of the layer, ST the second and SLT the shear stress.

σ_{xx} , σ_{yy} , σ_{zz} are the constraints in the reference mark of the user.

3 Modeling A

3.1 Characteristics of modeling

The hull is modelled by elements DKT. Its characteristics are defined in AFFE_CARA_ELEM :

- thickness: $16 \times 0.28 = 4.48 \text{ m}$
- reference mark of reference of the hull defined by ANGL_REP = 0.

The various layers are defined by the operator DEFI_COMPOSITE who gives for each layer his thickness, his material and his orientation compared to the reference mark of reference defined in AFFE_CARA_ELEM.

3.2 Characteristics of the grid

Many nodes: 624

Many meshes and types: 48 SEG2 and 576 QUA4

3.3 Sizes tested and results

For the layer with 0°

Identification	Standard reference	Reference	% tolerance
σ_{xx}	SOURCE_EXTERNE	-242	0.5
σ_{yy}	SOURCE_EXTERNE	67	0.6

For the layer with 45°

Identification	Standard reference	Reference	% difference
σ_{xx}	SOURCE_EXTERNE	-108	0.5
σ_{yy}	SOURCE_EXTERNE	-67	0.6

4 Synthesis

The got results are satisfactory. The maximum of difference is approximately 0.6% and it is due to the fact that the results resulting from the software "Plate" are given with little precision.