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2nd Tdyn RamSeries Training Session

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Agenda

Time	Content
9:45h	Reception of the session attendees
10:00h	Beginning of the session
	Tdyn RamSeries Advanced Tools
11:00h	Coffe *break*
11:15h	Tdyn RamSeries applied case 1
12:30h	Tdyn RamSeries applied case 2
13:30	Questions and comments
13:45h	End of session

Topics

- ✓ Composite and laminate materials within Tdyn library:
  - ➢ Generation/management.
  - ➢ Importing/exporting materials' database.
- ✓ Specific numerical tools implemented in Fibre4Yards: Custom connection modelling
- ✓ Definition of directional local axes over complex geometries.
- ✓ FEA Non-Linear Dynamic Analysis applied to vessels.
- ✓ Fatigue Damage Assessment on composites and laminate materials:
  - ➢ Brief description of theory.
  - ➢ Brief description of methodology.

Composite materials in Tdyn RamSeries

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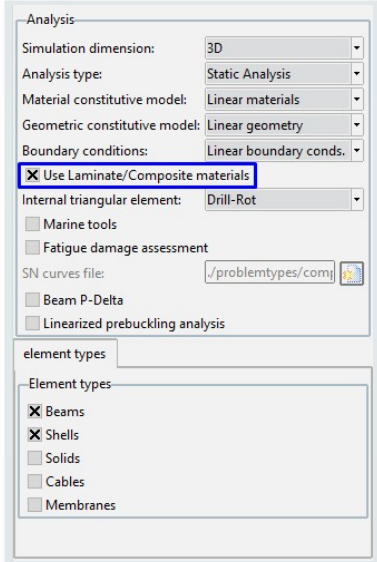
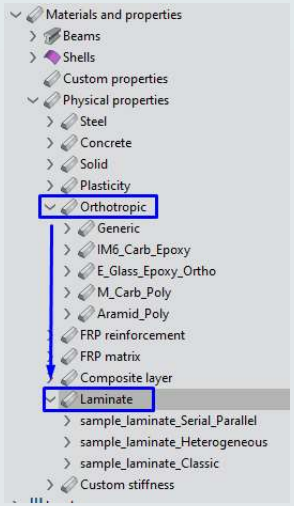
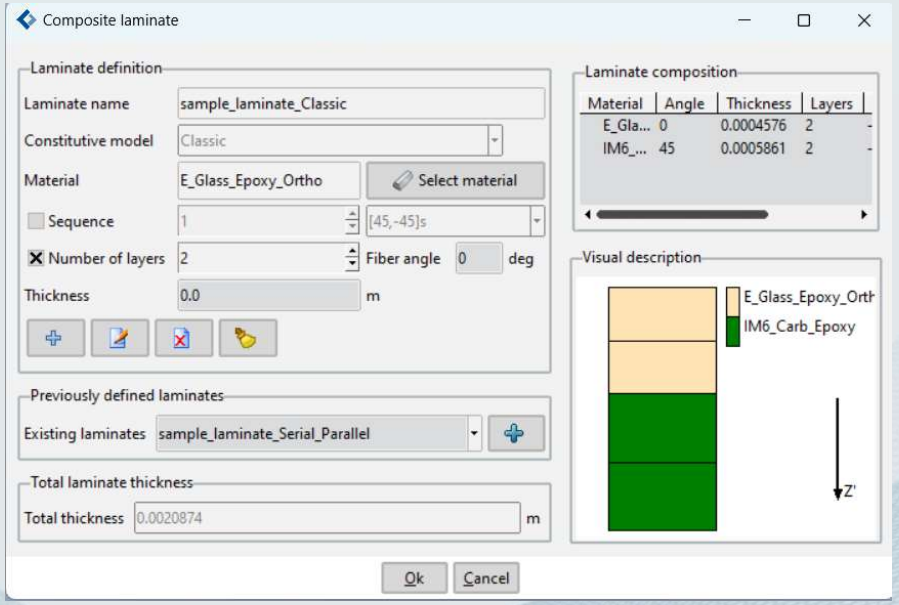
Composites & Laminates generation/management



- ✓ **Based on Class Societies rules.**
- ✓ **Rule of Mixtures theory.**
- ✓ **Allows to customize the properties of the layers, and create laminates.**





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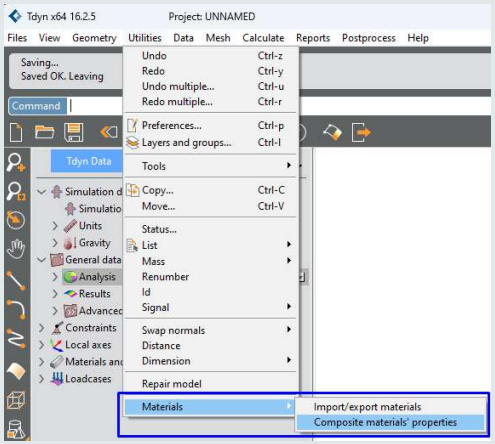
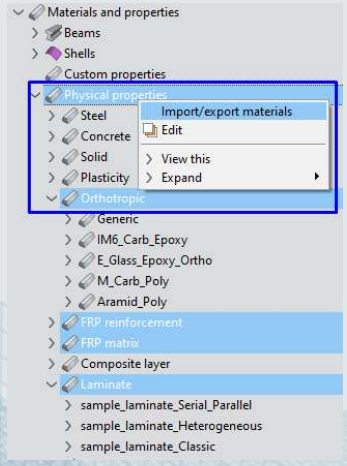
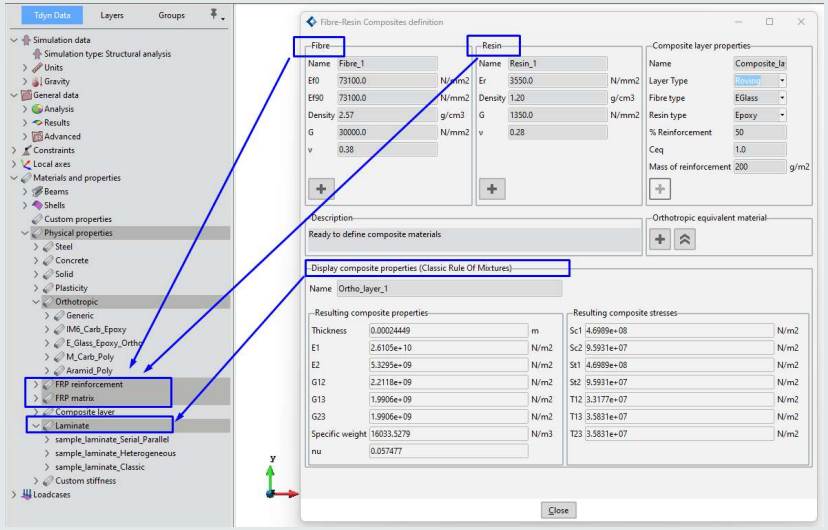
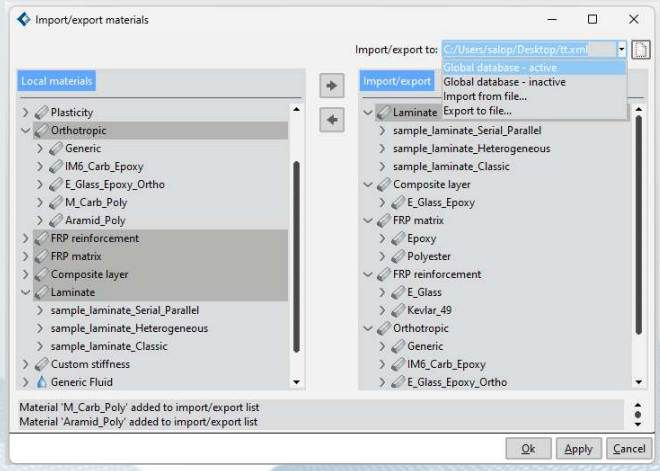
Composites & Laminates generation/management: Materials' Database

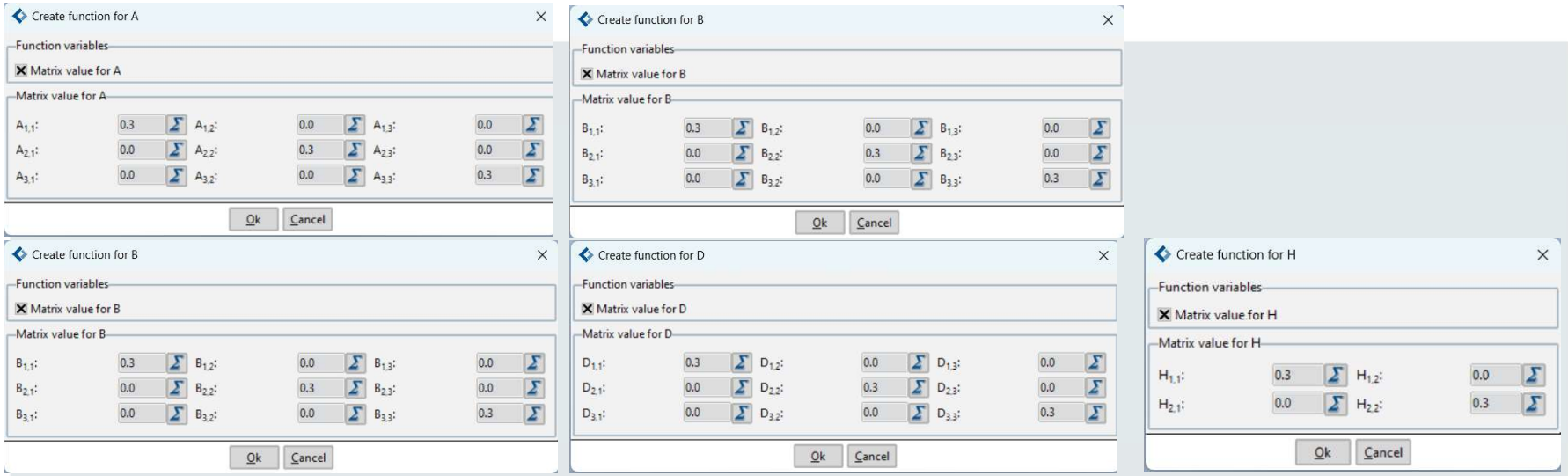


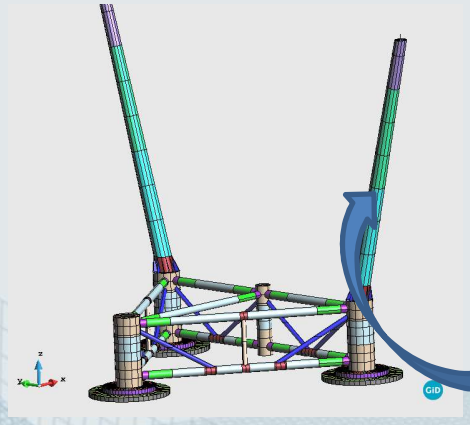




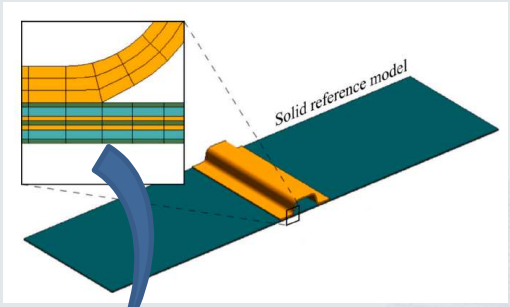


Custom stiffness: connections modelling





$$\begin{bmatrix} A & B & 0 \\ B & D & 0 \\ 0 & 0 & H \end{bmatrix}$$



- *F. Turon, F. Otero, X. Martinez*. “Multi-scale procedure for the mechanical analysis of composite laminate structures considering mixed boundary conditions”. Composite Structures. Vol 322, 15 October 2023. 117343.

Fatigue Damage Assessment for composite and laminate materials

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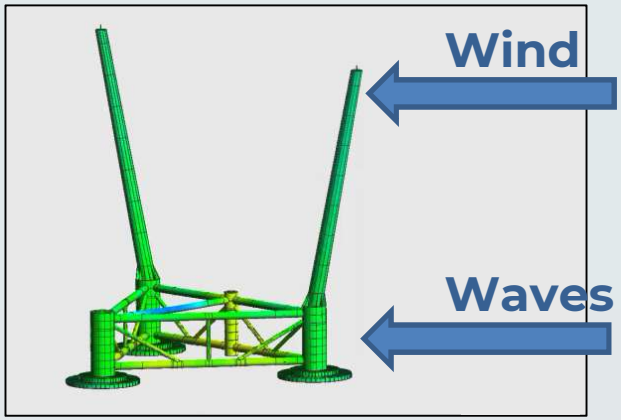
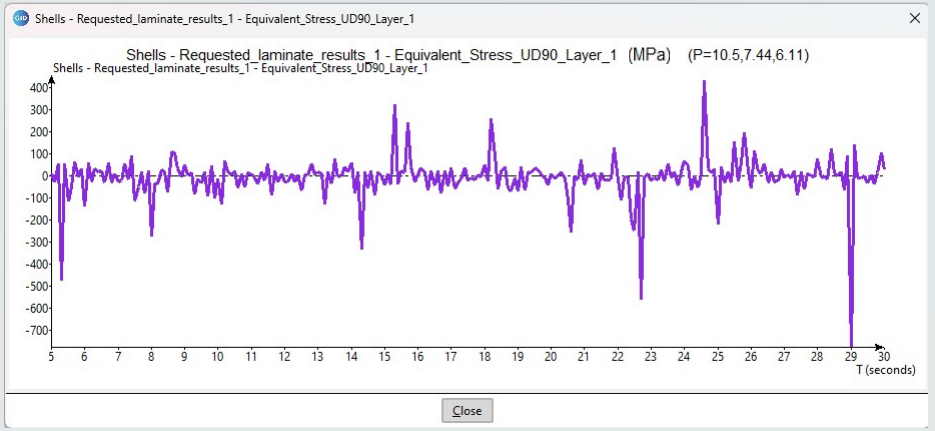
FDA composites: methodology

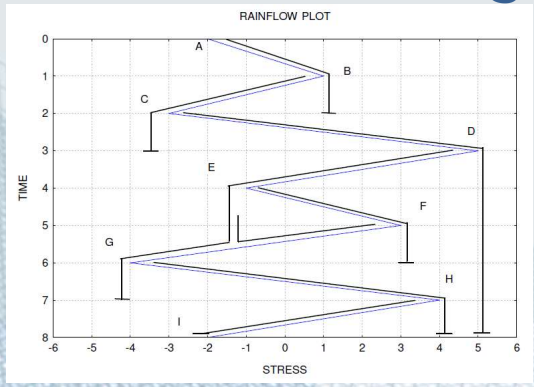
Step 1:
Dynamic analysis: time domain



Step 2:
Obtaining stress history



Step 3:
Rainflow counting



Step 4:
Computing damage

$$d = \sum_{h=1}^{M} \sum_{m=1}^{R} \frac{n_{h,m}}{N_{h,m}} \cdot \left[\frac{t_h^{tot}}{t_h^{sim}} \right] \cdot DFF \leq 1$$

FDA composites: theory

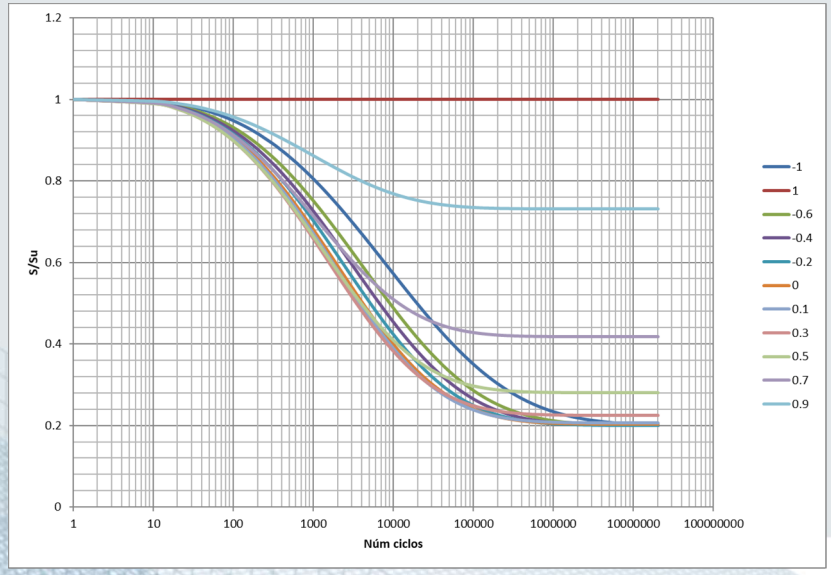
Failure criteria - Equivalent stress

(Based on anisotropic mapping)

$$(\sigma - N)_{UD90} \equiv (\sigma - N)_{matrix} \Longrightarrow \sigma_{UD90} \equiv \sigma_{eq} = \sqrt{\sigma_2^2 + (f_{12} \cdot \sigma_{12})^2}$$

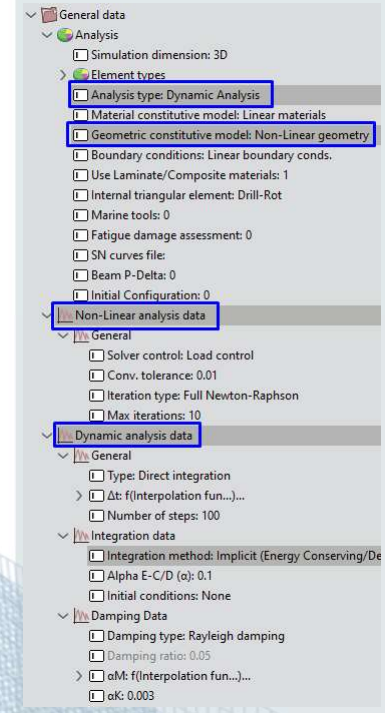
S-N fatigue life curves

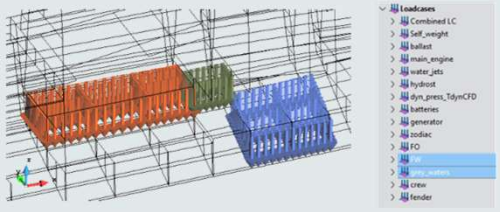
$$S_{(R,Ncycles)} = S_{th(R)} + (S_u - S_{th(R)}) * \exp(-ALFAT_{(R)} * \log_{10}(N_{cyles})^{BETAF})$$



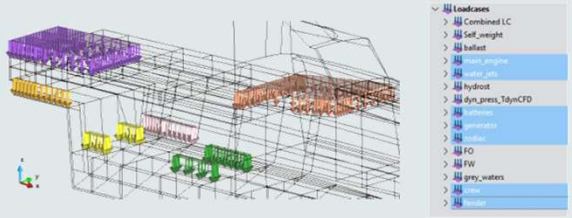
$$R = \frac{\sigma_{min}}{\sigma_{max}}$$

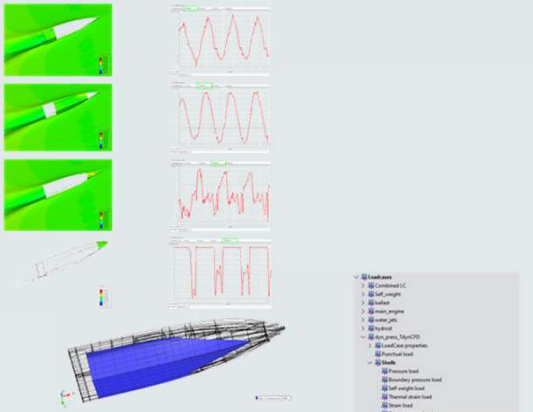
Non-Linear Dynamic FEA applied to vessels



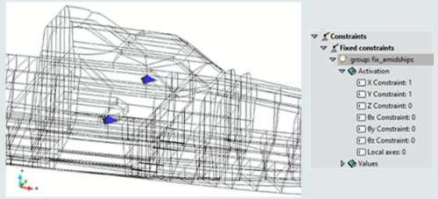


LOADS

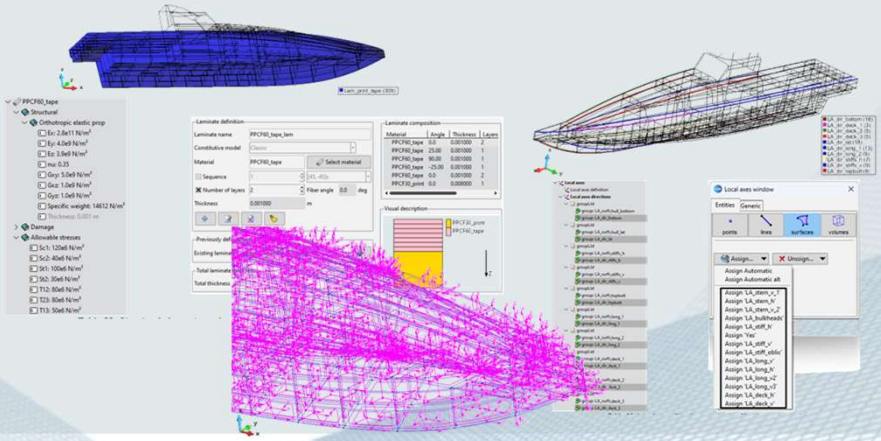




CONSTRAINTS

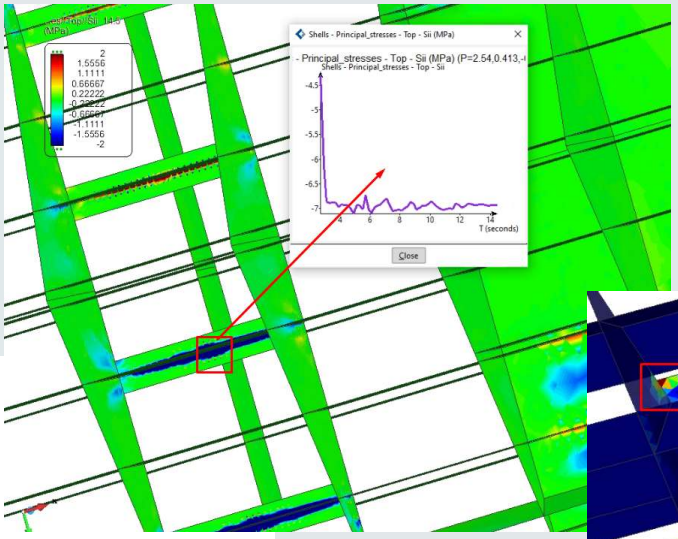


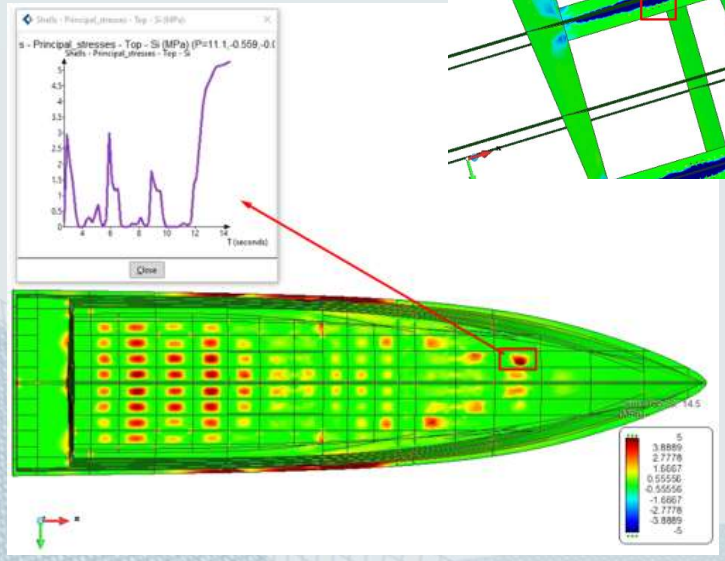
MATERIALS

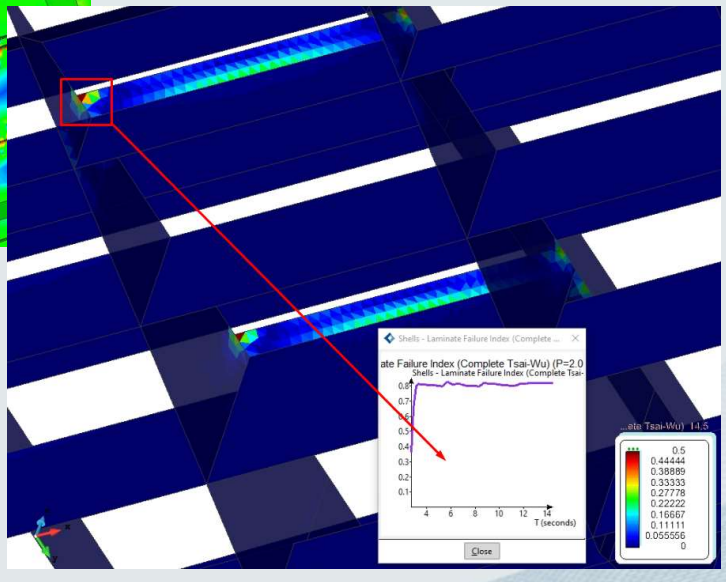


Non-Linear Dynamic FEA applied to vessels

RESULTS







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Thank You!

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