Multi-Shape Modeling of Line Welds in Crash Models using ANSA

16th LS-DYNA Forum 2022

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BETA

SIMULATION SOLUTIONS

Acknowledgments & Team

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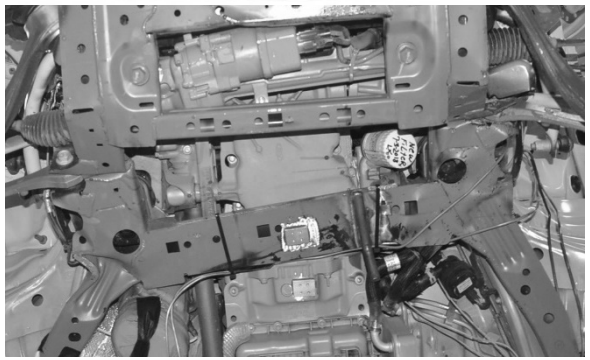
Contents

- Motivation and History
- CAE Approach and Implementation
- Pre-processing
  - CAD XML Heritage
  - Templates
  - Process Demonstration
- Conclusion and Outlook

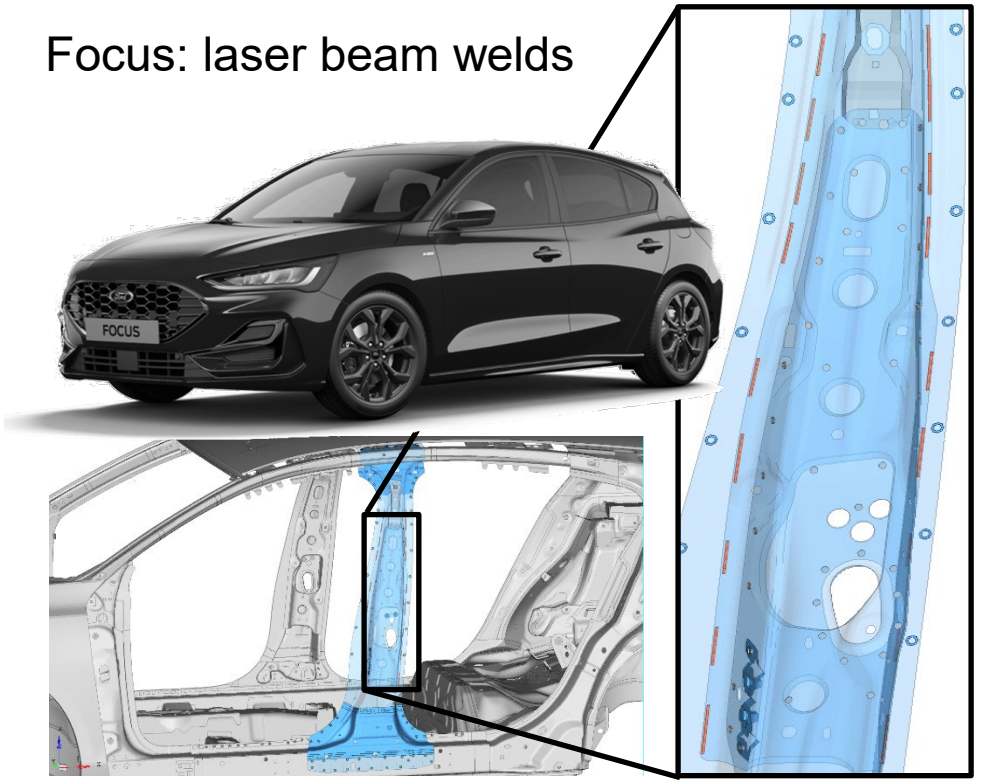
Motivation

- Examples

Explorer: gas metal arc welds



Focus: laser beam welds

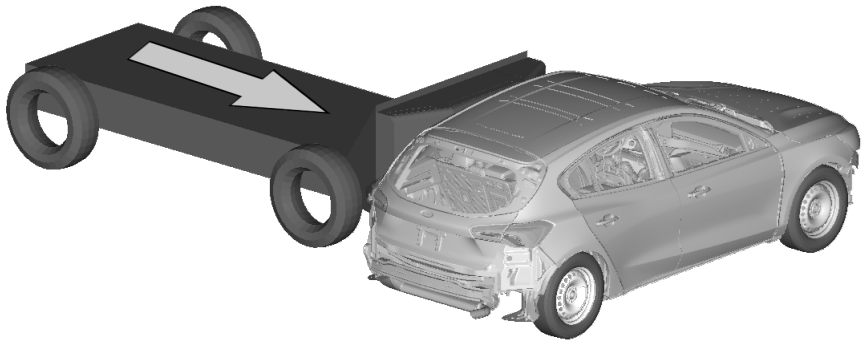


Line welds are well known and several applications are in production!

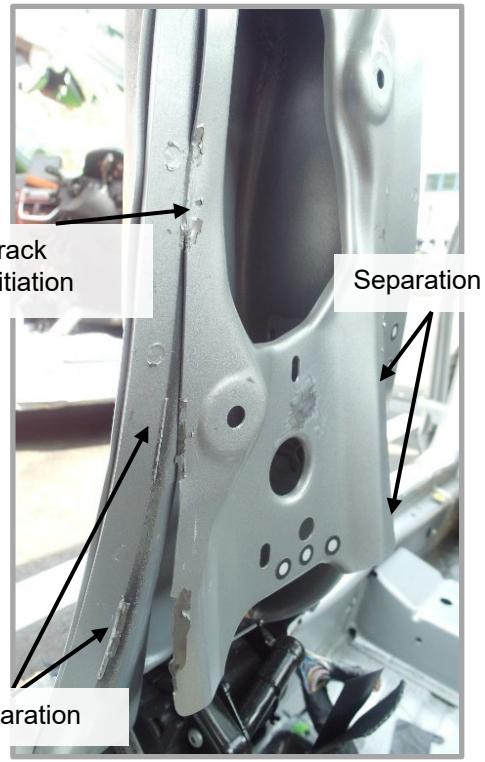
History

- Prototype example

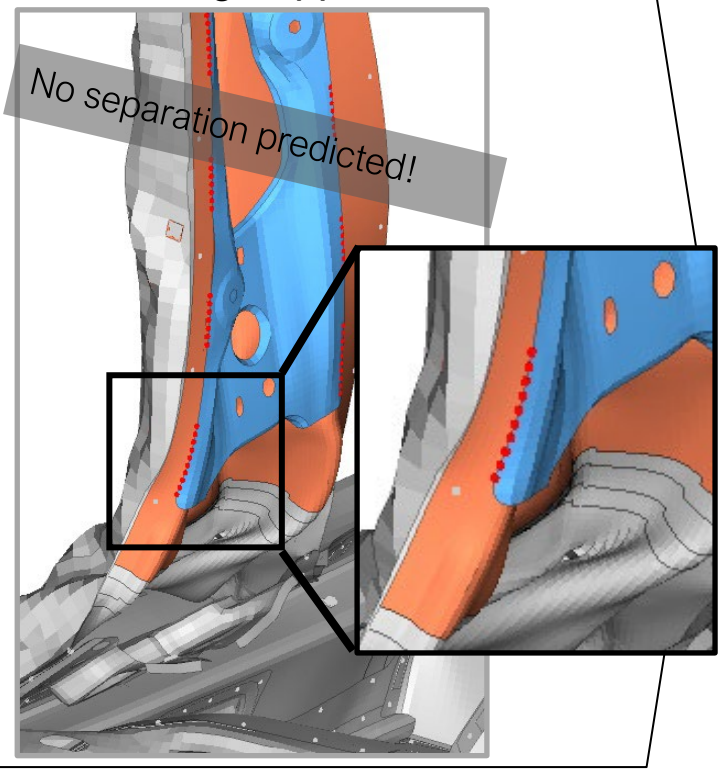
Test Setup



Test results



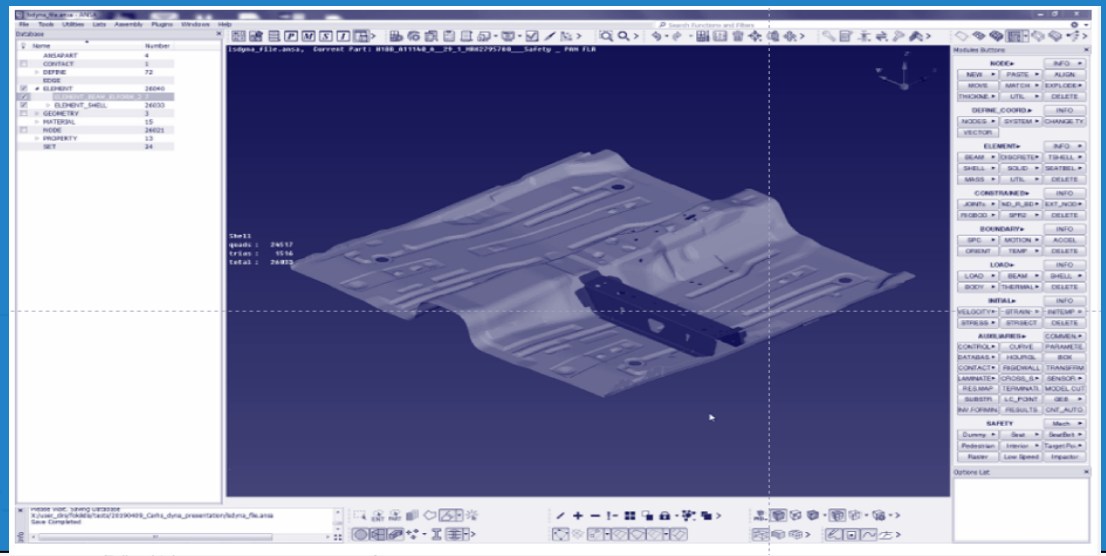
Heritage approach



Virtual Design and digital sign-off require highly predictive approaches

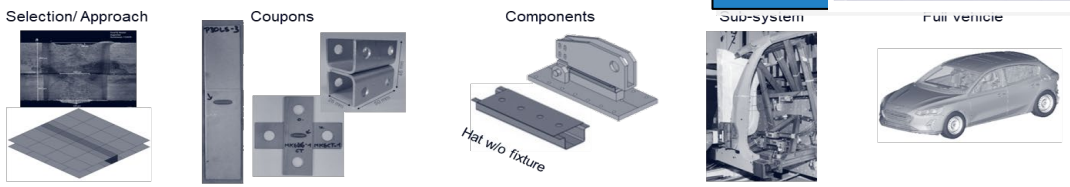
CAE Approach and Implementation

Implementation at Ford
Product Development



Development of a highly
predictive CAE approach

Load case complexity

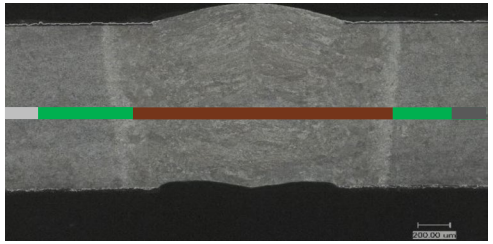


Consideration of user-friendly and effective implementation for model build

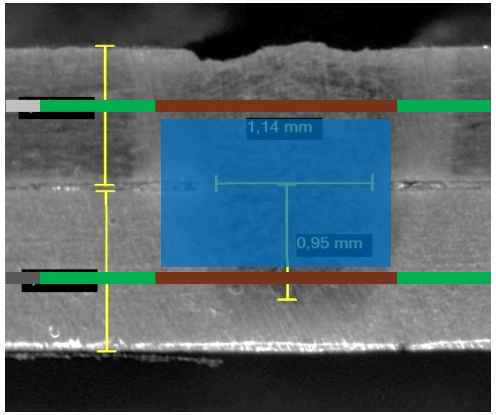
From Physical Line Weld to CAE Approach

- Physical x-sections and CAE line welds

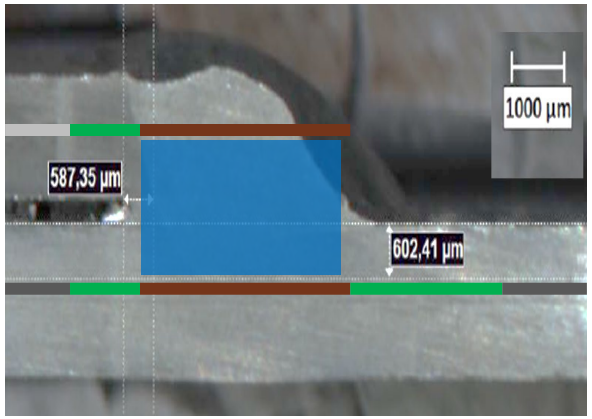
Butt joint



Overlap joint

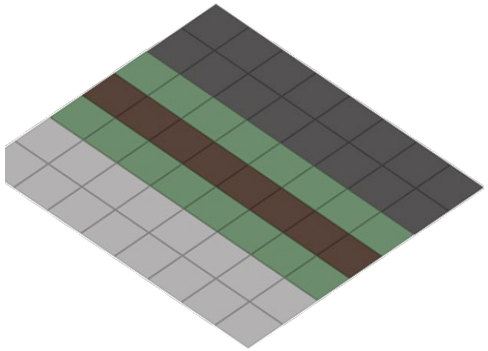


Edge joint

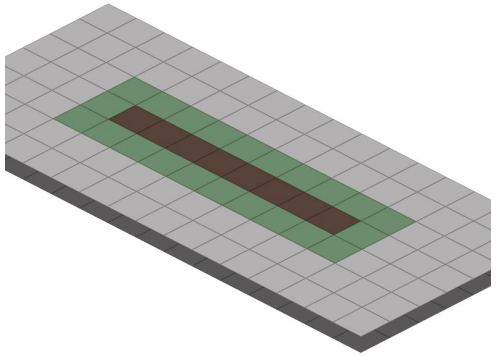


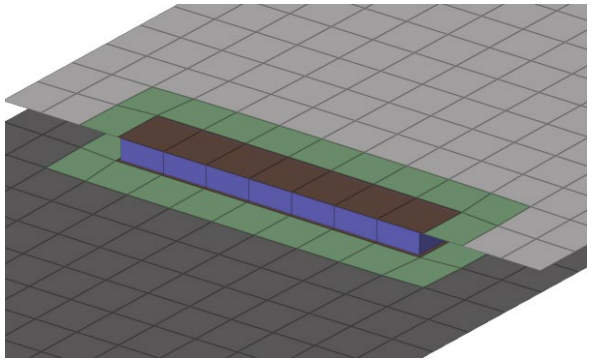
T-joint and Y-joint

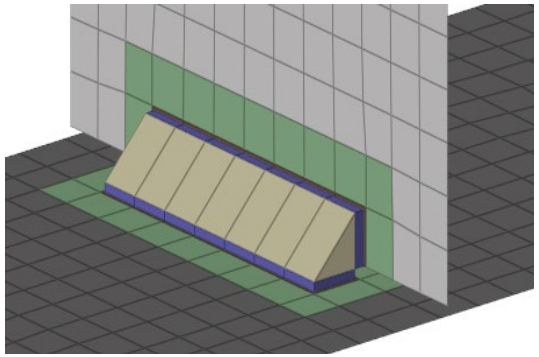
2-D elements only



2-D & 3D elements



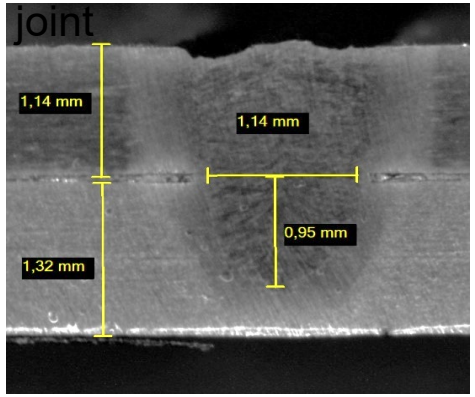




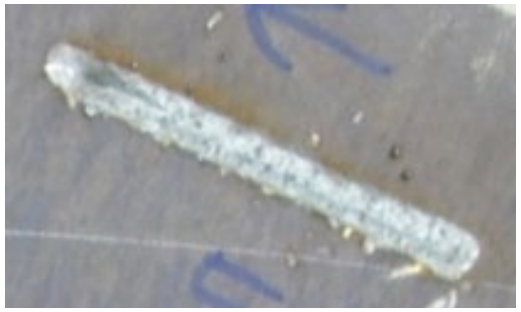
Overlap Connection and CAE Shape

- Different overlap joint geometry and corresponding FE realization of weld line

Overlap joint



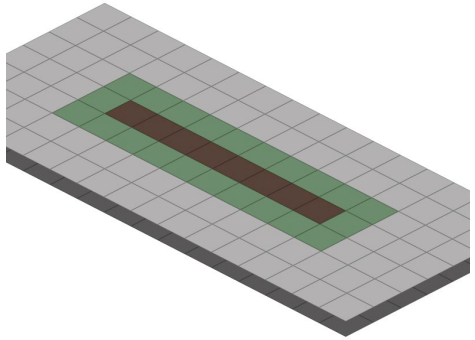
Stitch



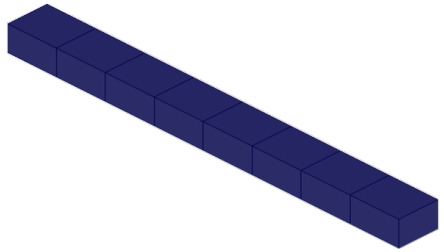
S-shape

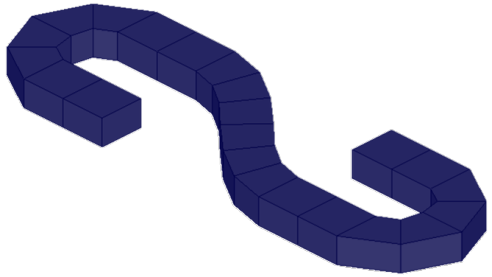
Circle

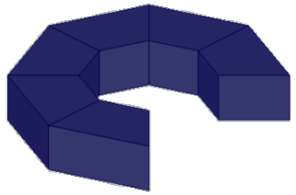
2-D & 3D elements



Geometry design 3D weld line elements



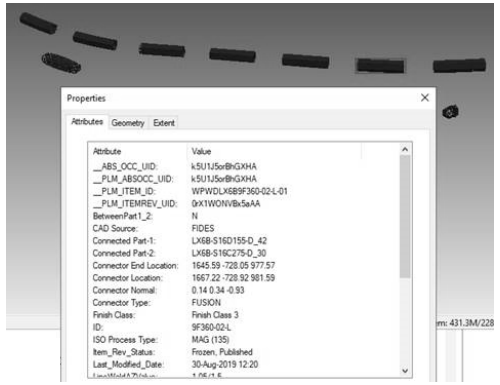




CAD to Automated FE Relization

- Implementation of meshing automation into commercial software tools available at Ford

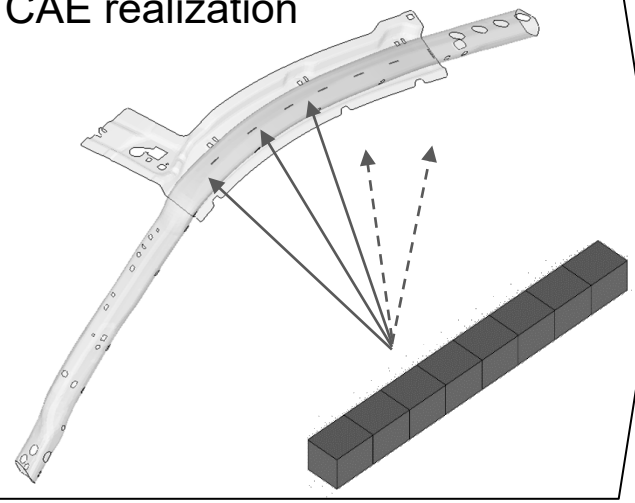
CAD information



BETA SIMULATION SOLUTIONS

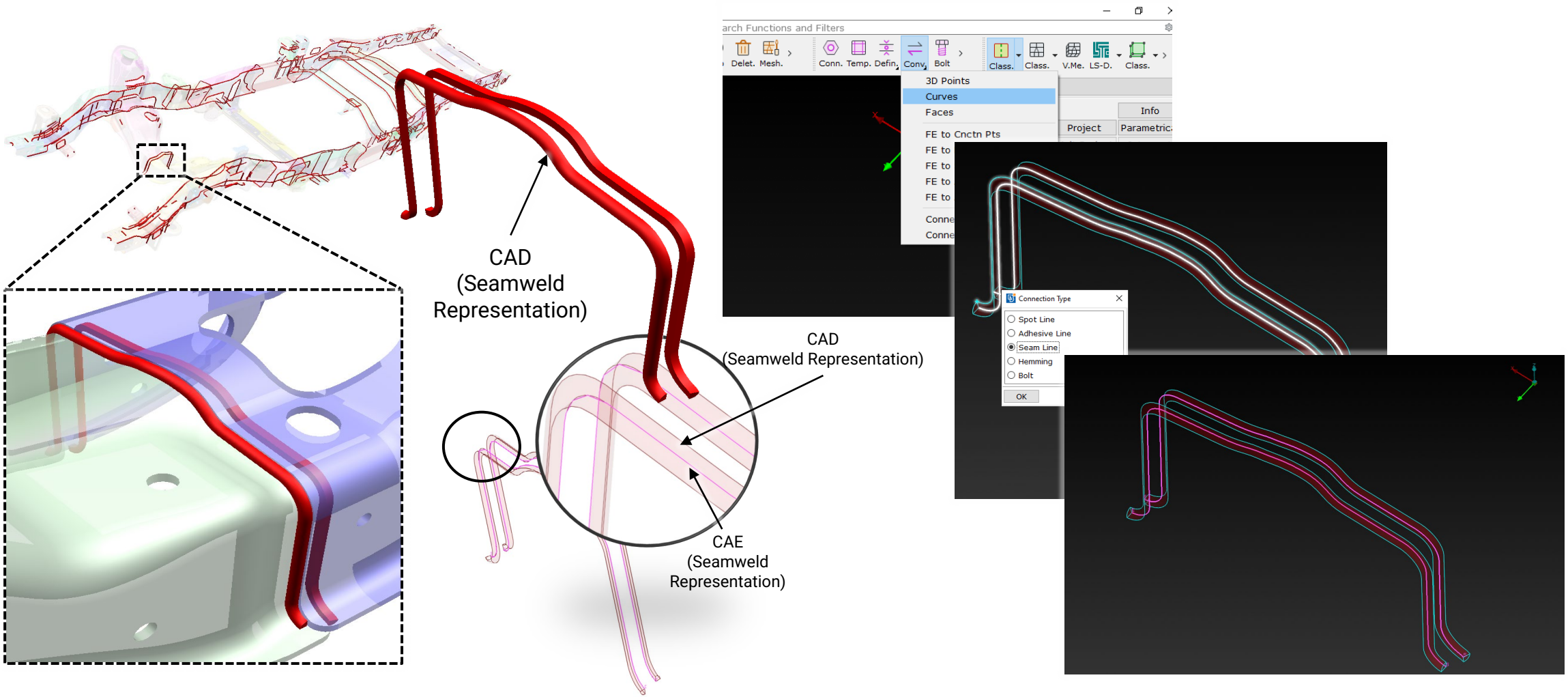
Cooperation → BETA CAE Systems and Ford

CAE realization



Pre – Processing of seamlines in ANSA

From CAD Data to ANSA Seamlines



CAD data can be easily translated to CAE seamline connections

From XML File to ANSA Seamlines

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<connection_list>
  <connection_1d>
    <id> 100024 </id>
    <type>seamweld</type>
    <loc_list>
      <loc> 1078.63545  -31.541872999999995  596.04401 </loc>
      <loc> 1079.1559500000003  -61.535523999999995  596.04401 </loc>
    </loc_l
    <label>
    <info>
    <info>
    <info>
    <info>
  </connect
  <connecti
    <id> 10
    <type>s
    <loc_li
      <loc>
      <loc>
    </loc_l
    <label>
    <info>
    <info>
    <info>
    <info>
  </connect
  <connecti
    <id> 10
    <type>s
    <loc_li
      <loc>
      <loc>
    </loc_l
```

Connection [SeamLine_Type]

Name EDGE_JOINT_GMAW

Main | Misc

ID
100027

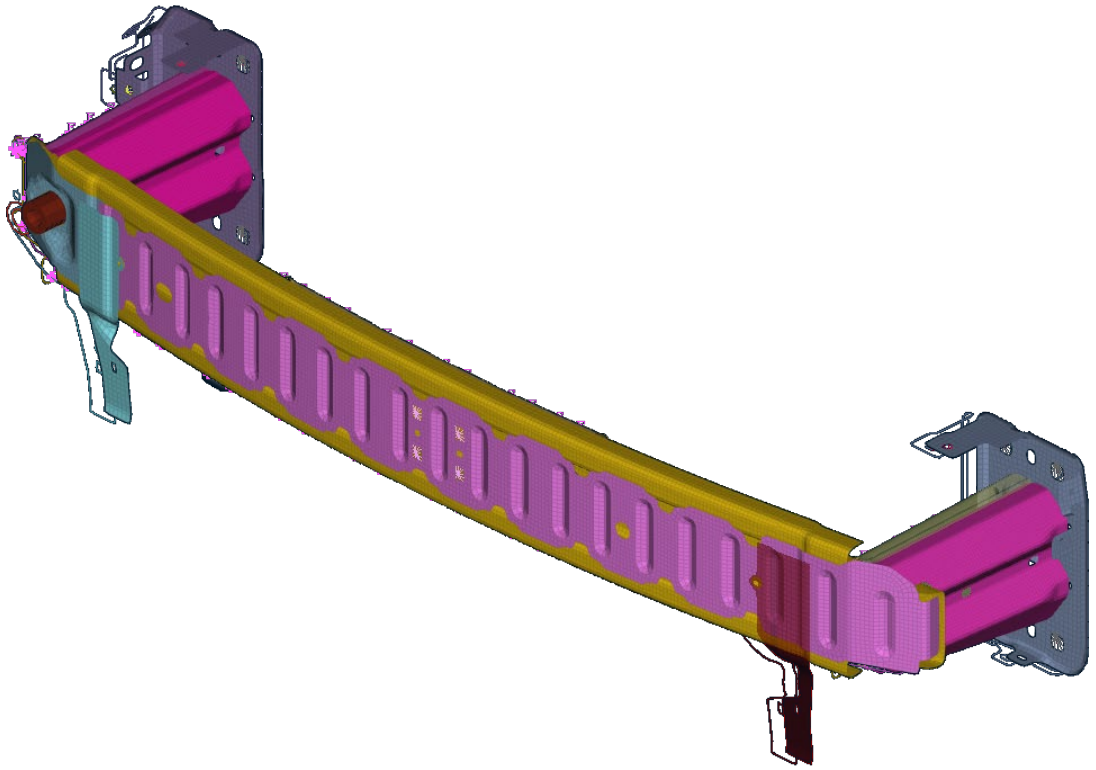
TID	TmplCompliance	W	M1	M2	COG x	COG y	COG z	Length
0		3.74978144	0	0	1088.57817	232.411082	596.04401	29.9980964

Num of Parts	P1	P2	P3	Status	Error Class
2	#421004	#421006			No FE Rep.

User

FE Rep Type: <none>

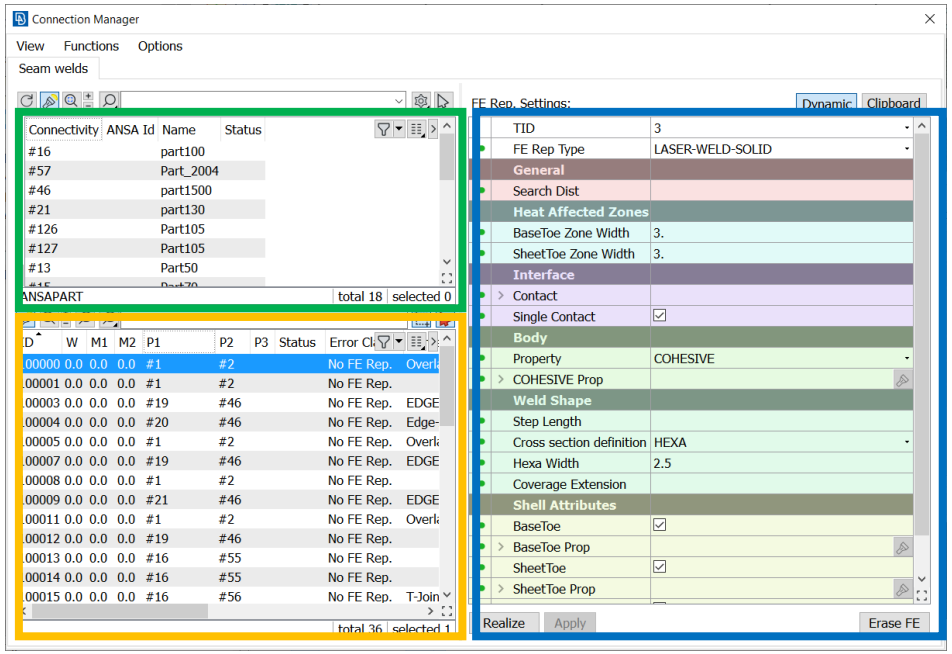
OK | Cancel



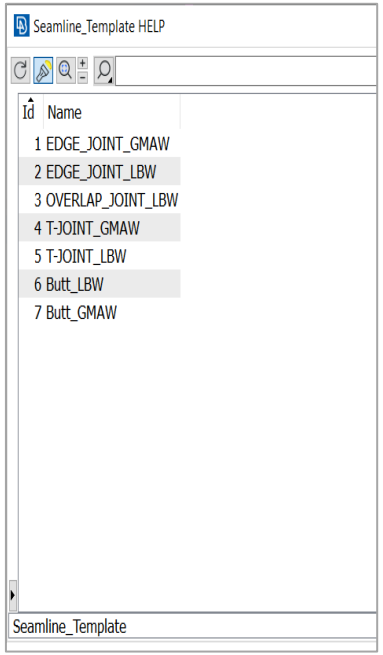
XML file can be read and seamline connections can be created holding all the appropriate info

ANSA Seamline Templates

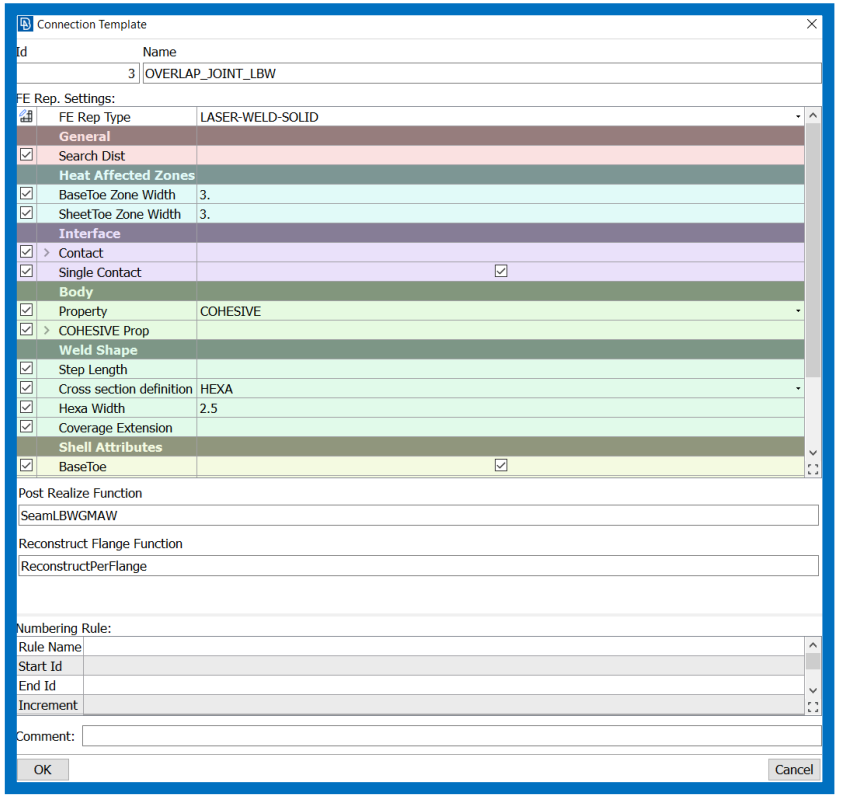
Connection Manager



Templates list

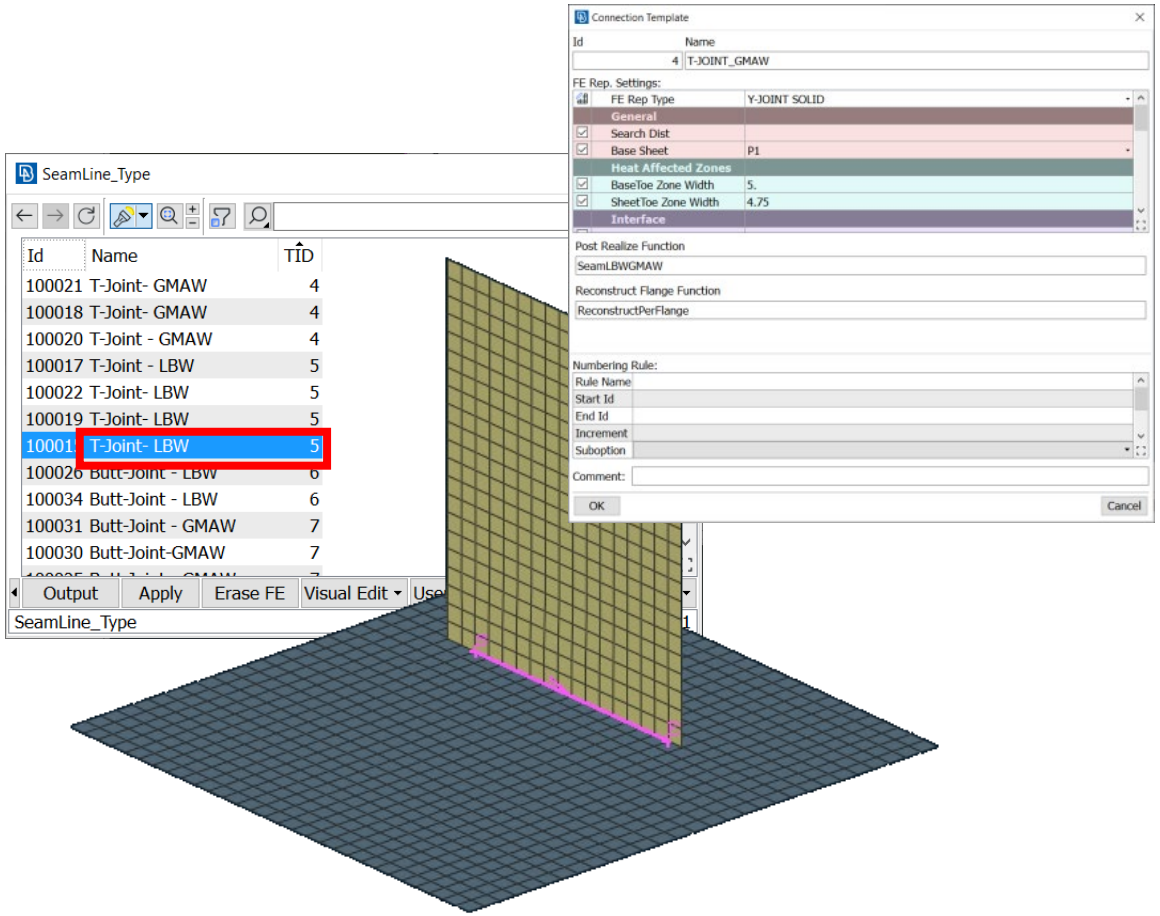


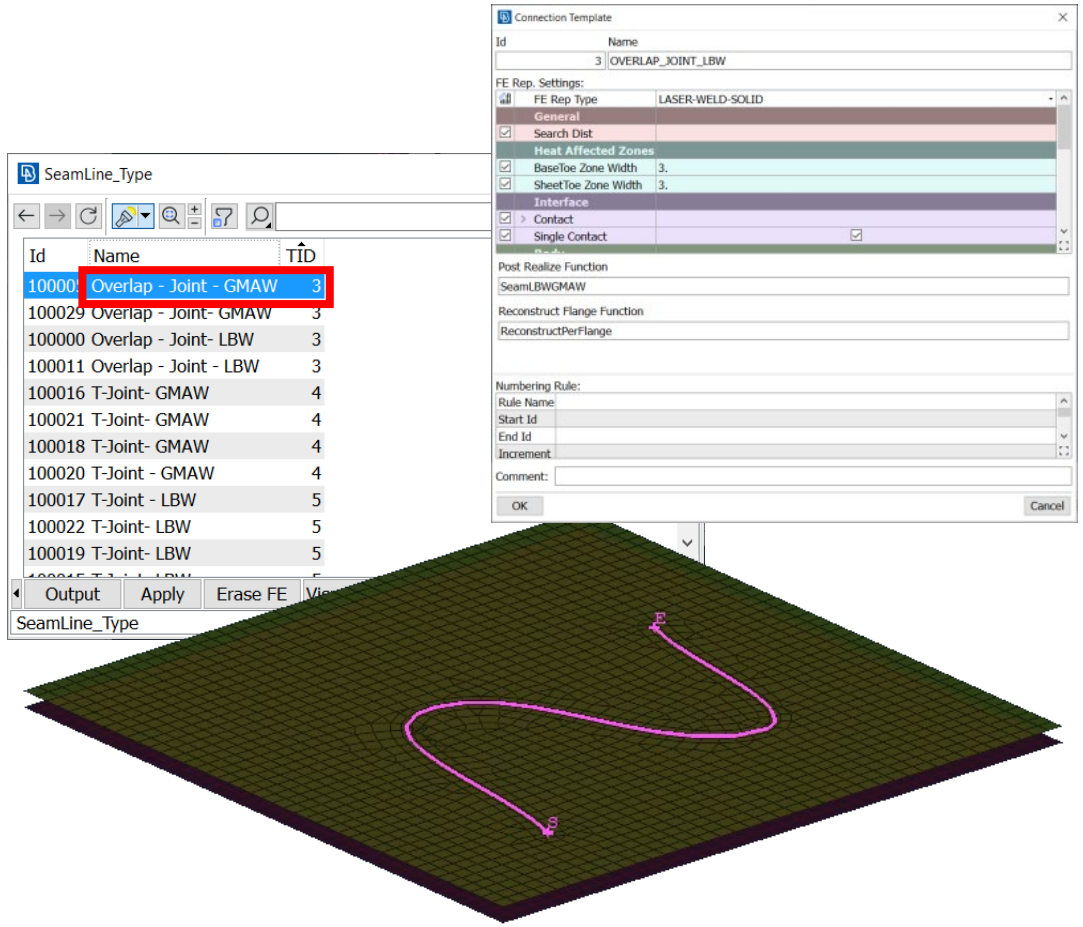
Templates example



FE-Representation settings can be assigned to a template for each seamline type

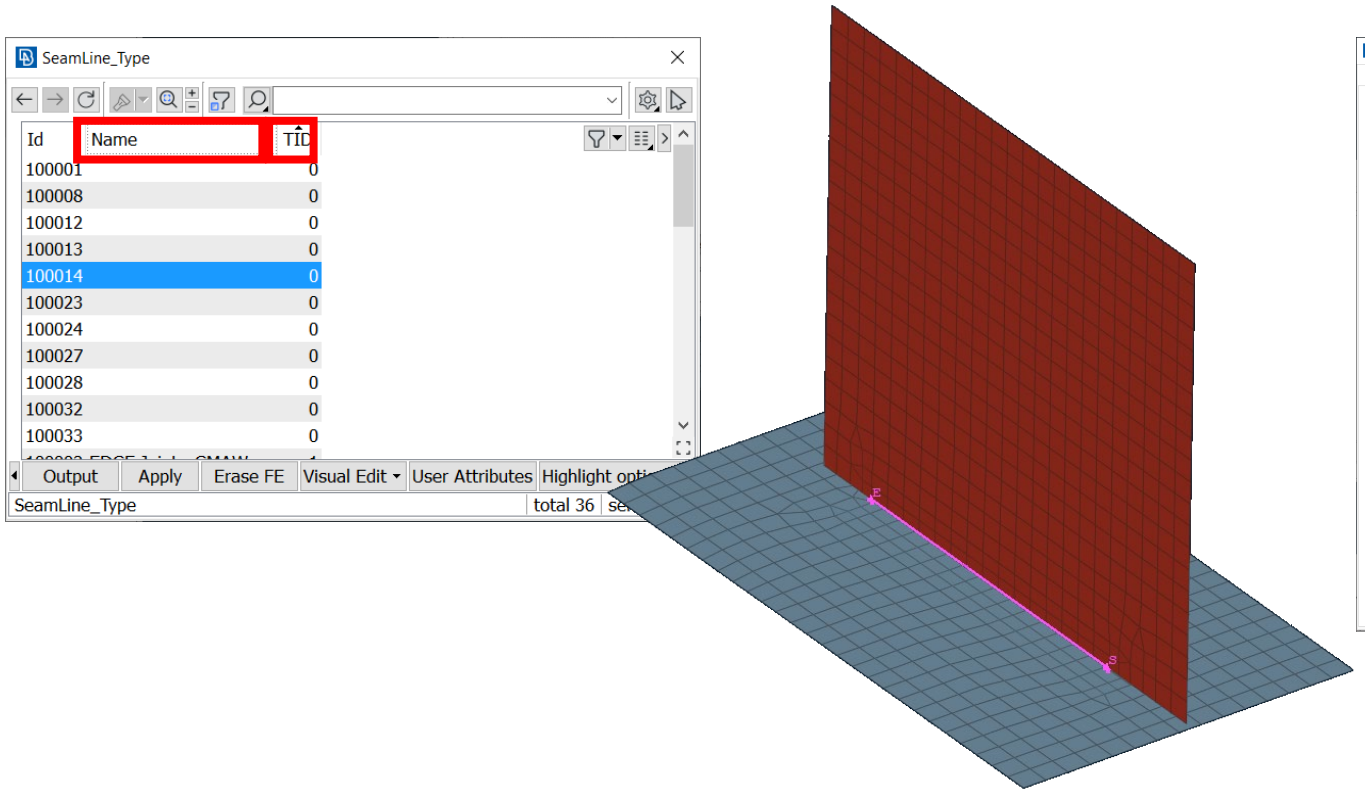
Automated Templates Assignment

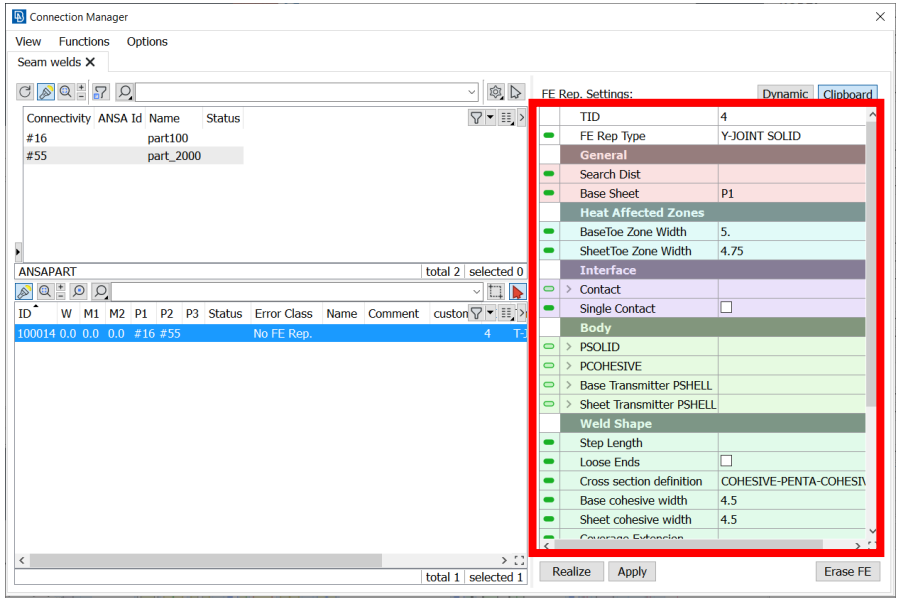




Templates are automatically assigned according to the connection name

Manual Template Selection

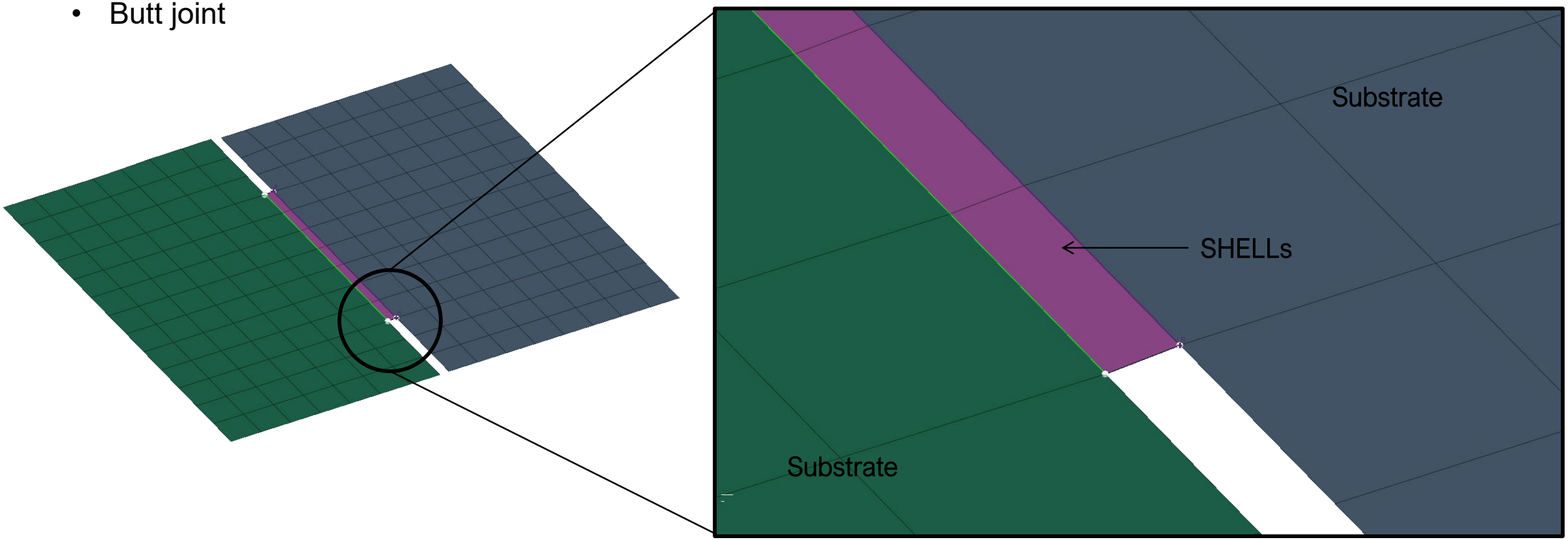




A template can be assigned to a connection at any time during the assembly process

FE-Representations for Seamlines

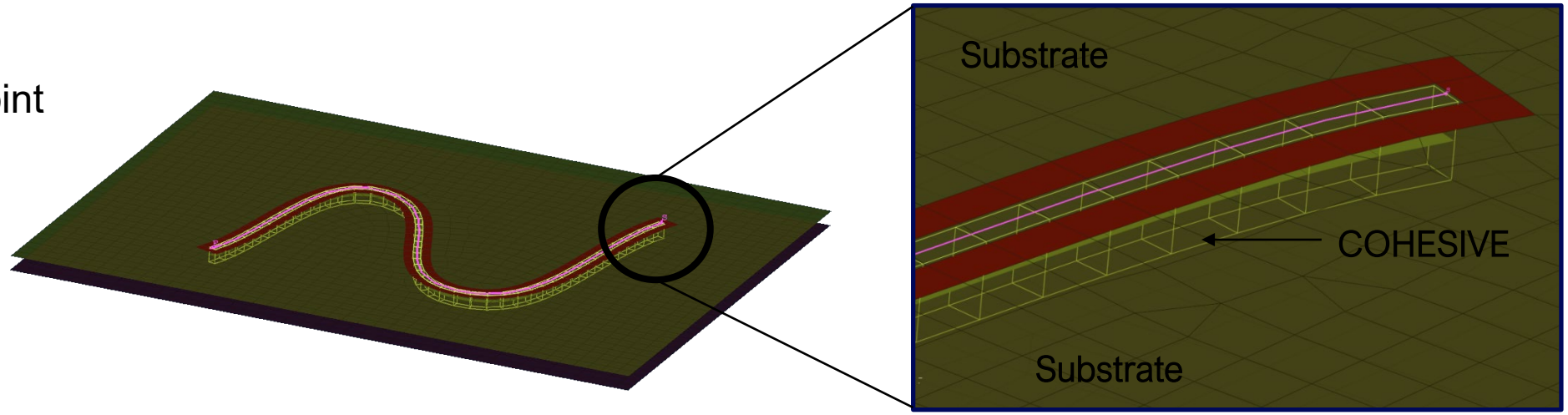
- Butt joint



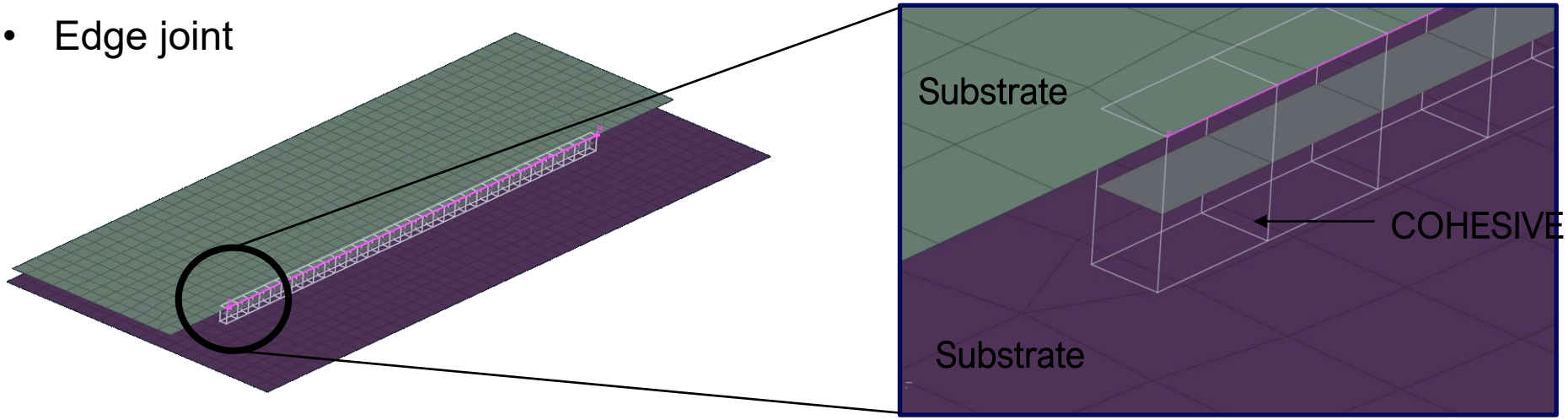
Butt Joint: SHELLs with node to node correspondence

FE-Representations for Seamlines

- Overlap joint



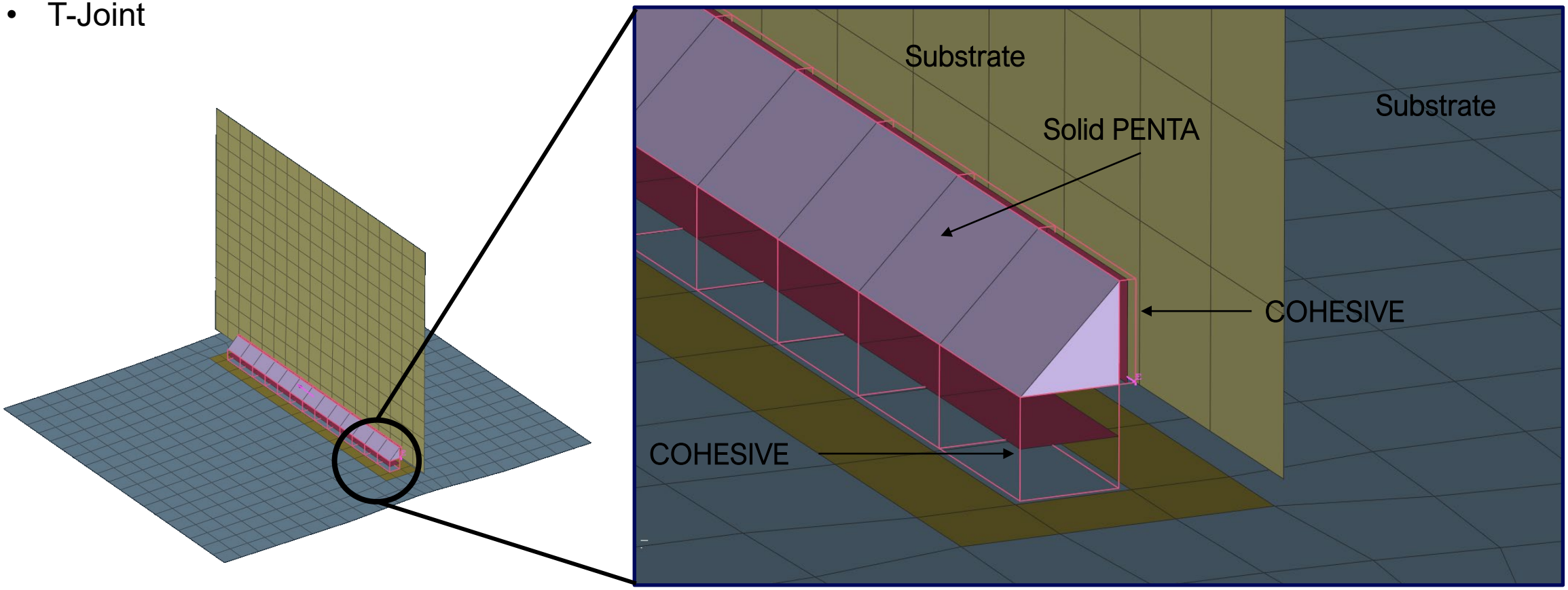
- Edge joint



OVERLAP and EDGE Joints: COHESIVE with TIED contact on the flanges

FE-Representations for Seamlines

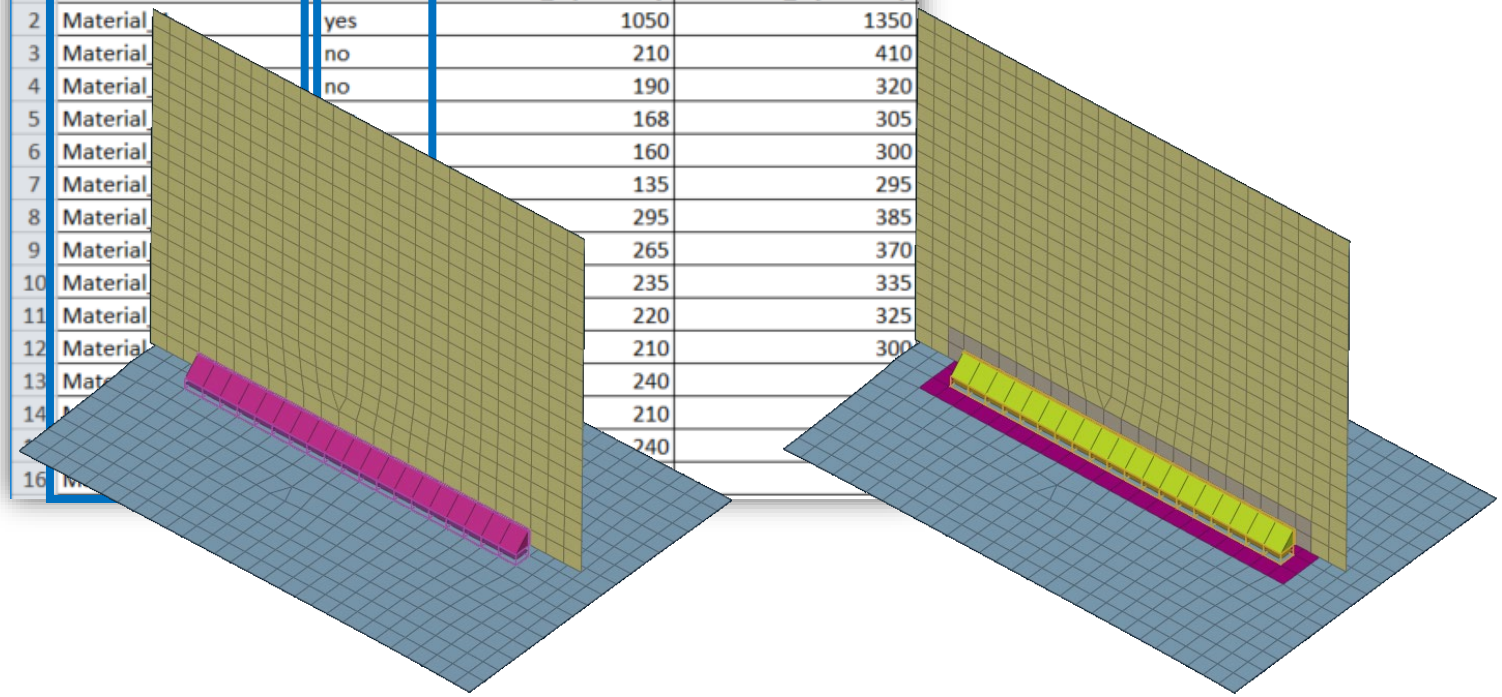
- T-Joint



T-Joint : COHESIVE-PENTA-COHESIVE with TIED contact on the flanges

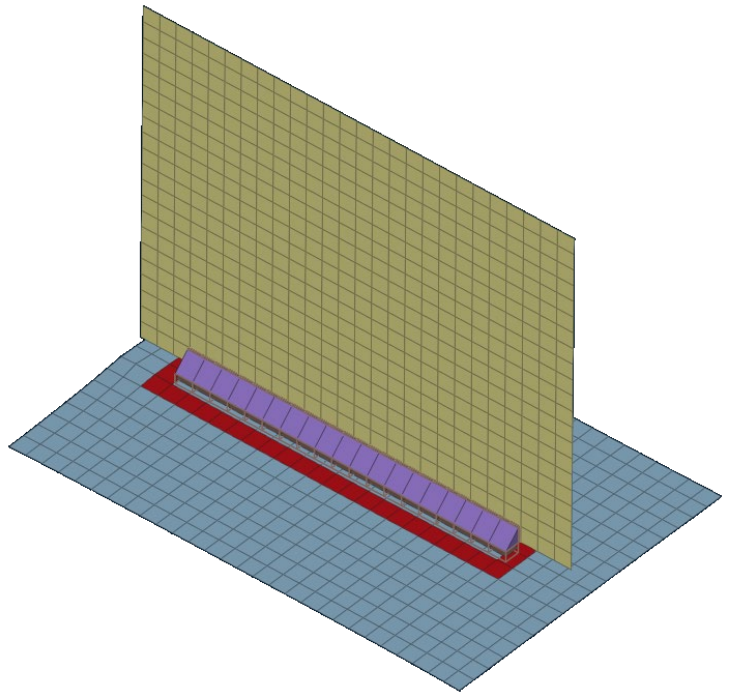
HAZ Assignment

	A	C	D	E
1	#Current	with HAZ	Parameter_1 [N/mm2]	Parameter_2 [N/mm2]
2	Material_	yes	1050	1350
3	Material_	no	210	410
4	Material_	no	190	320
5	Material_		168	305
6	Material_		160	300
7	Material_		135	295
8	Material_		295	385
9	Material_		265	370
10	Material_		235	335
11	Material_		220	325
12	Material_		210	300
13	Mat		240	
14			210	
			240	
16	M			



No HAZ

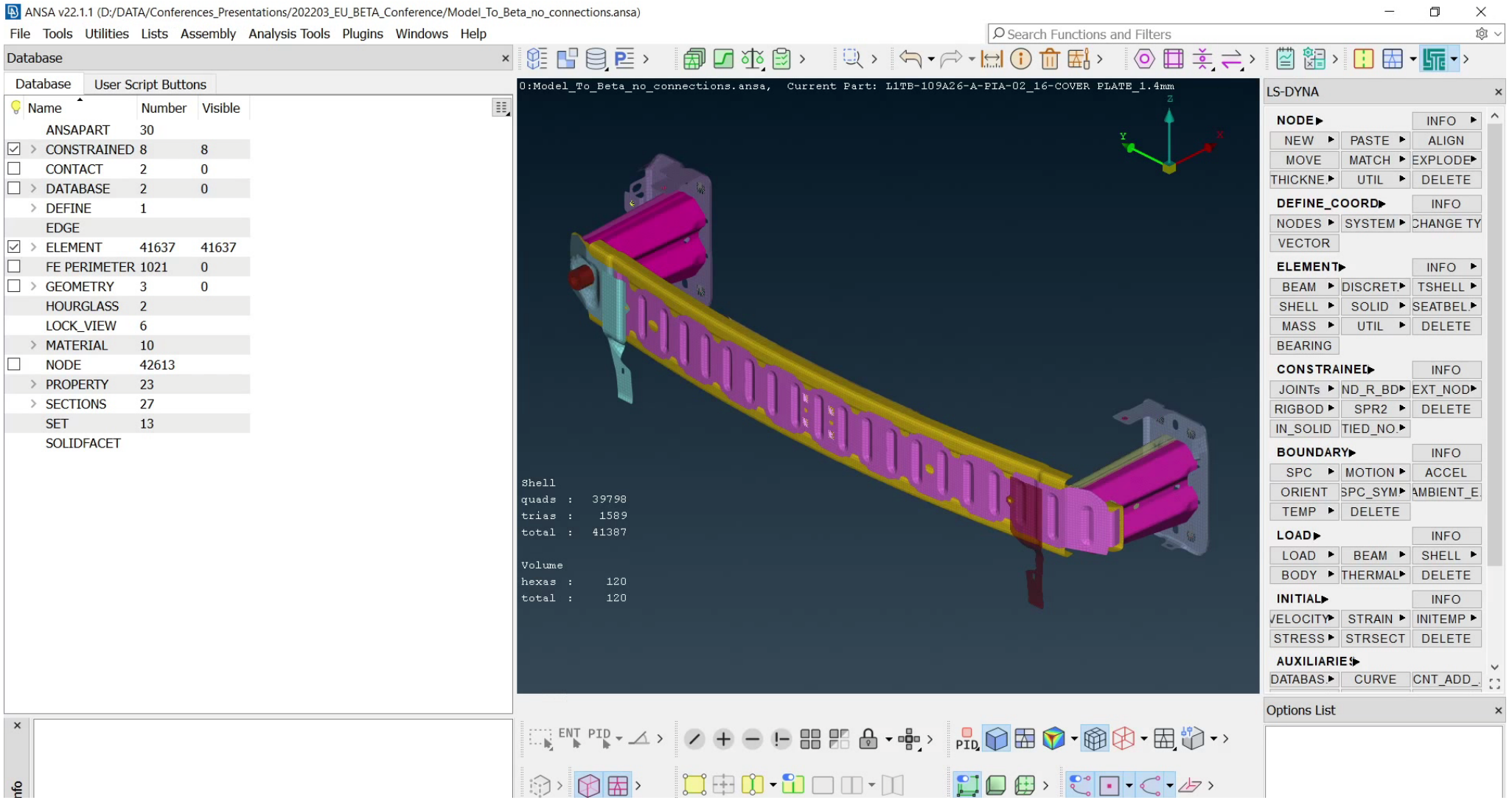
HAZ in both flanges



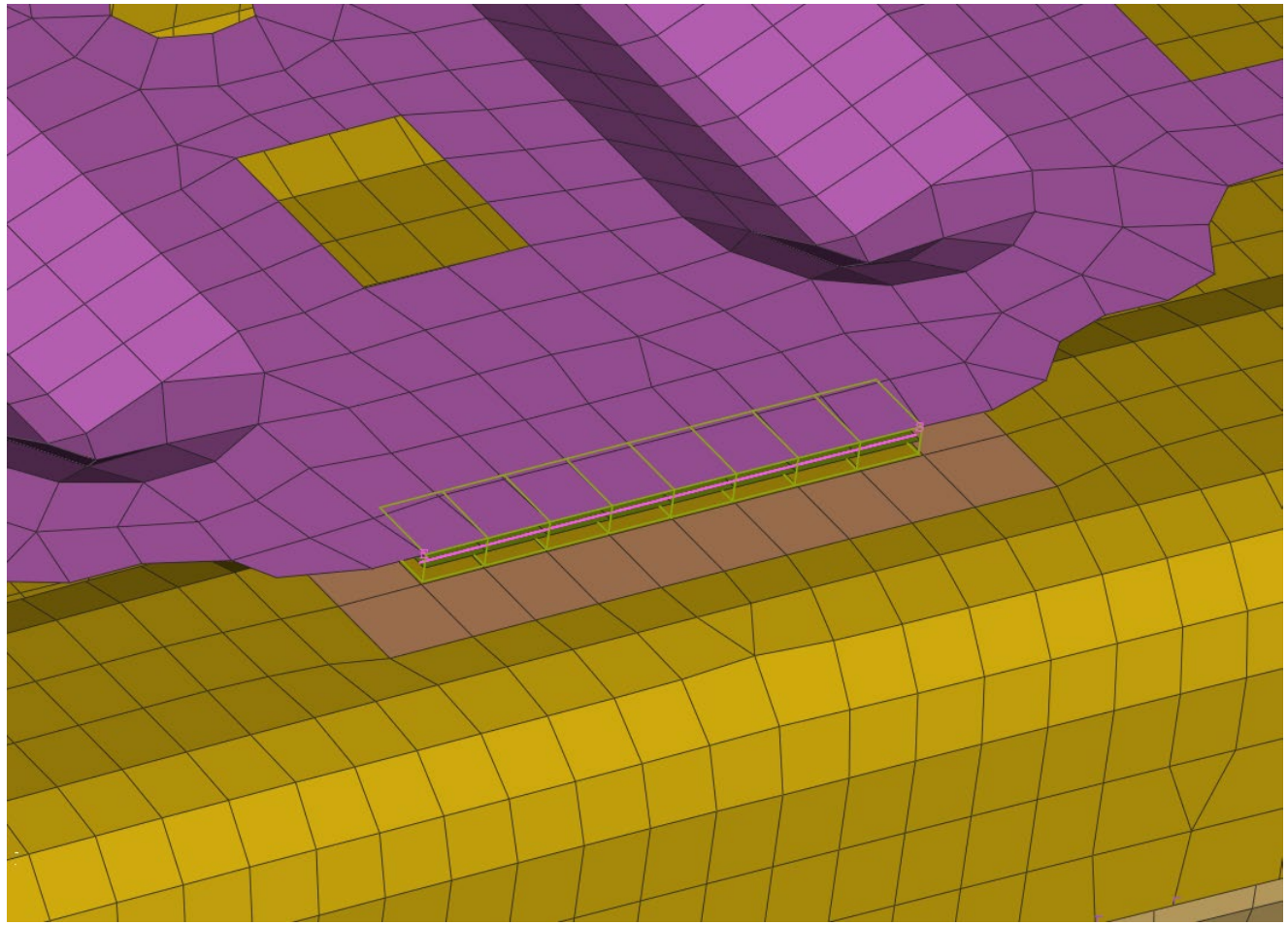
Hybrid

HAZ assignment is individual and based on a material list and automatically created

Connection Creation: Video

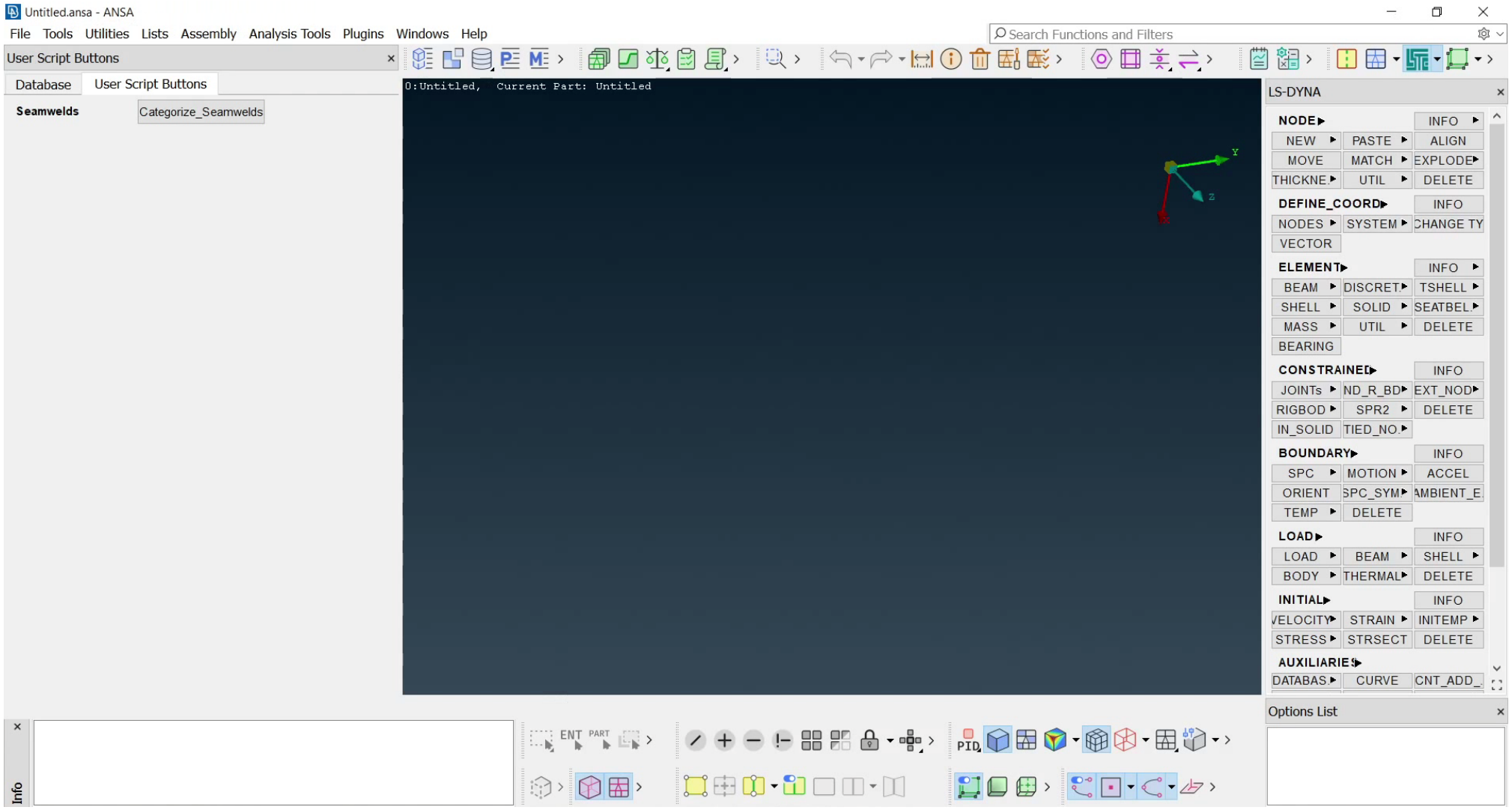


Heritage Model Treatment



Transform a line connected model to a solid connected one

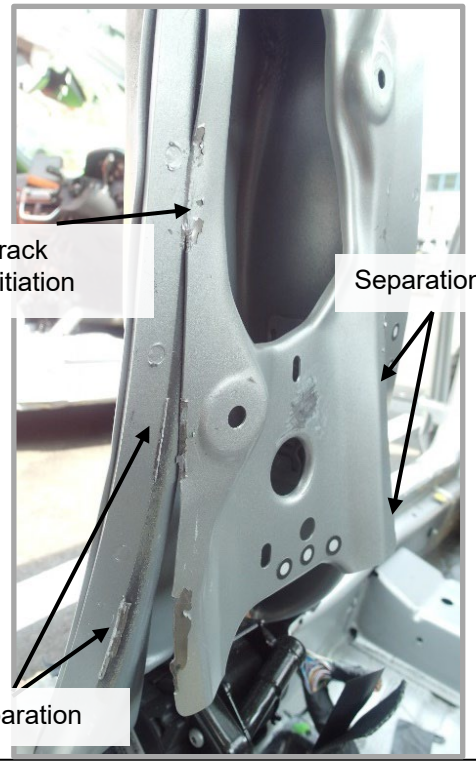
Heritage Model Treatment: Video



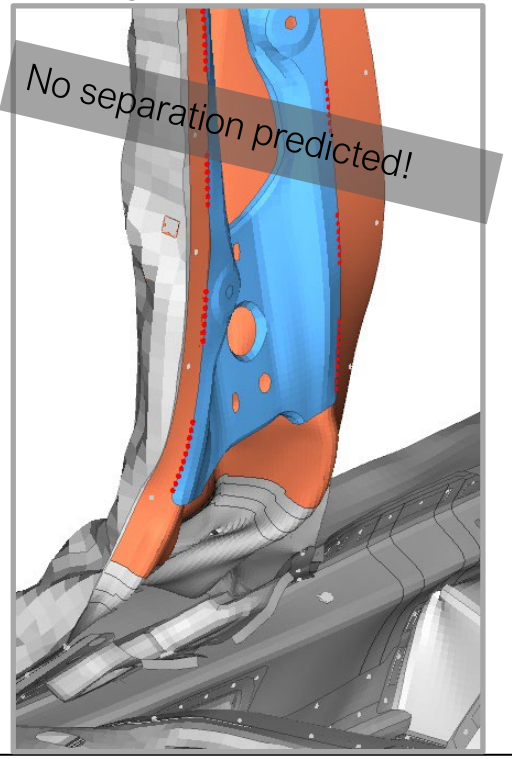
Application Example of New Approach

- Comparison of deformation between prototype test and CAE

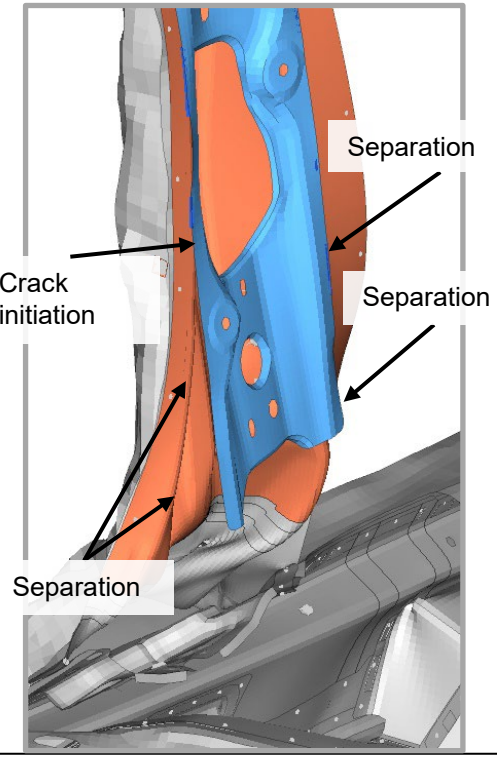
Test setup and results



Heritage approach



New LBW approach



→ New predictive LBW approach automated for PD

Conclusion and Outlook

Implementation of a new mesh dependent and independent line weld modeling approach enabled by:

- **Automated assembly process** for seamlines including HAZ creation based on ANSA templates
- **Treatment of unconnected and heritage line connected models** with the new approach
- **User-friendly interactive and scripted “on the fly”** line weld processing covered

THANK YOU!