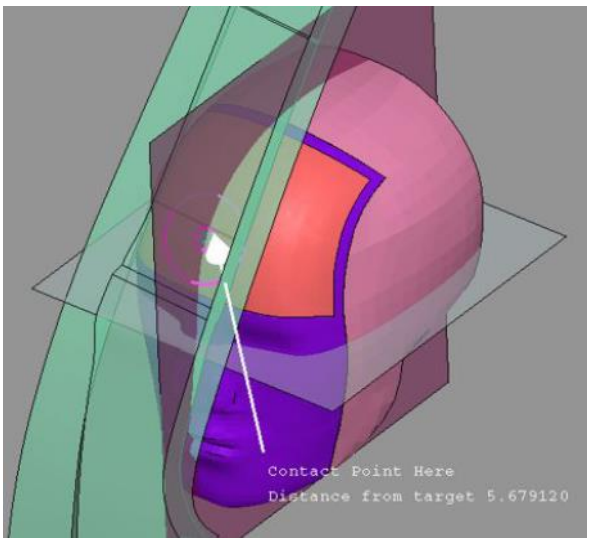
Pre-processing tools for Interior Safety simulation in ANSA



Introduction

Regulations for occupant safety were introduced in the 90s for the enhancement of the occupant protection and the reduction of occupants' injuries and fatalities. Since then, occupant-friendly design influences the styling and the engineering of the vehicle interiors.

Several regulations were introduced for the occupant safety during interior impact. The most prevailing of those are the US Federal Motor Vehicle Safety Standard (FMVSS) 201U and the European Regulation ECE R-21.

The FMVSS 201U specifies the upper interior head impact protection requirements, for a wide range of vehicles, to provide protection when an occupant's head strikes upper interior components, including pillars, side rails, headers, and the roof during a crash. The protocol sets up the protection criteria, and corresponding threshold values, for the impact of a regulated Free Motion Headform (FMH) against specified target locations.

The respective Test Procedure (TP 201U) used for compliance testing includes information regarding the setup, targeting, testing, and data analysis, regardless of the vehicle type.

The targeting procedure, which locates all applicable target points on the upper interior trim of a vehicle, is considered to be one of the most complex and time-consuming testing protocols developed in recent years.

The **ANSA FMVSS 201U Tool** addresses this complexity issue and allows the robust FE model preparation for simulation scenarios according this regulation. The tool offers the functionality for the automatic definition of the impact target points and the positioning of the FMH FE-model on them, as prescribed by the test procedure.

In a respective manner, the **ANSA FMVSS201 / ECE R-21 Tool** accommodates the requirements of the FE-modeling for the simulation of the Test Procedure **TP-201** for the **FMVSS 201** regulation and of the **ECE R-21** regulation, for Occupant Protection in Interior Impact. These regulations set the minimum requirements for vehicle interior components to afford impact protection for occupants.

ANSA FMVSS 201U tool

The ANSA FMVSS 201U tool is used for the identification of target points and the positioning of the FMH for the simulation of the occupant protection in interior impact laboratory test.

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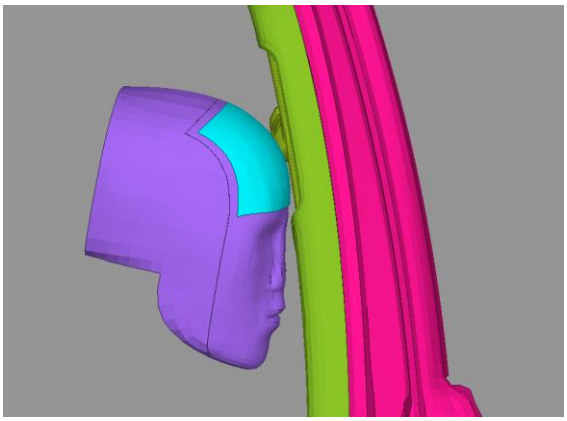


FMH after its positioning on one of the identified points.

The following actions can be performed with this tool, according to TP 201U procedure:

- Identification of the Target Points on the interior components of the vehicle.
- Positioning of the FMH on a selected Target Point of the upper interior of the car (TRIM).
- Calculation of the horizontal approach angle.
- Calculation of the maximum vertical approach angle.

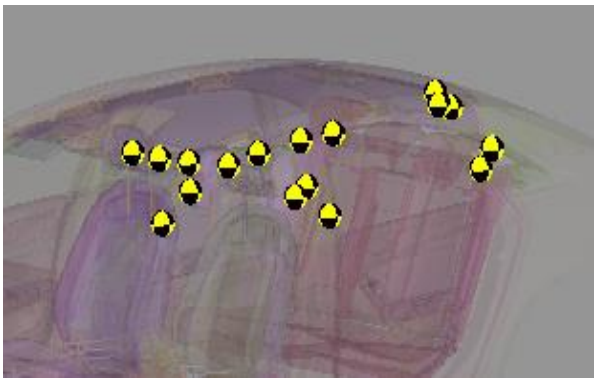
The above operations can be performed both on FE-mesh and unmeshed analytic geometric data.

Target Points Identification on the interior components of the vehicle

The first step to be performed is the Target Points identification on the vehicle's interior.

Target Points on the interior of the model can be identified automatically using the tool's interface, and always in accordance to the requirements of the TP 201U procedure.

Based on the above, ANSA calculates the Target Points where the FMH should be positioned for the test.



All Target Points identified with ANSA according to the TP 201U protocol.

Positioning

After the determination of the Target Points, the next step is the positioning of the FMH on these locations.

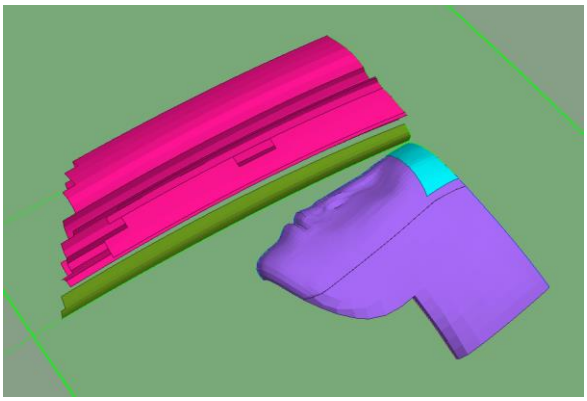
The positioning movement is done according to a local coordinate system defined on the FMH FE-model nodes. The positioning is performed for each one of the identified points separately. For each Impact Point, the Horizontal and Vertical angle limits are respected.

FMH positioning takes into account the following factors in order to find for each one of the impact points the "worst case" for the FMH:

- The angle limits respected during the positioning procedure are either the default values dictated by the TP 201U protocol or may have been automatically calculated within ANSA. In the latter case, the calculation is made during the identification procedure of Target Points and values are transferred for each Impact Point zone respectively.
- ANSA calculates the horizontal angle that leads to the worst HIC value. To do so, an alignment algorithm finds the horizontal angle at which the midsagittal planes of the FMH and the interior trim surface line up.

- Initial contact (using contact algorithm) is performed while moving the FMH from its initial position to the impact point.
- Moving the FMH after Horizontal positioning to Vertical positioning, ANSA rotates the FMH about its local y-axis and adheres to a contact condition with the trim surface by translating the FMH in the local x-z plane. When a second contact is found between the trim surface and the nose or chin of the FMH of the vertical limit is reached, the rebound angle is enforced.
- Vertical impact angle influences the HIC value a lot and thus the correct vertical positioning is very important. It is necessary to set the vertical angle so as to achieve the worst case HIC(d) value.
- ANSA finds the final vertical impact angle while the FMH stays in contact with the impact surface. This ensures that the test will be held with the worst HIC(d) value.
- The user is allowed to perform some alterations for the limit angle values in order to improve the positioning result.
- In cases of very complex interior geometry, where the first contact with the FMH Impact Zone cannot be found, FMVSS tool allows the user to set manually the vertical angle to an allowed value prior to finding first contact with the trim surface.
- During alignment of the horizontal angle in cases where collision between the FMH Impact Zone with other interior trim surfaces happen, ANSA attempts, in the correct order, different alignment angle combinations.
- Many times, due to the geometrical form and complications encountered positioning the FMH the first point of contact between the FMH and the interior trim does not lies on the midsagittal plane of the FMH. For this reason the “out of position” that occurs between these two points is calculated allowing contact based algorithm to output an exact value of the “out of position” that will occur during impact.

Finally FMH is positioned on the identified Target Point according the regulation using contact algorithm for such horizontal and vertical angles resulting to the worst HIC values.



FMH after its positioning on one of the identified points. The positioning can be inspected with the aid of cutting planes.

Manual Operations

The user has the ability to manually manipulate the FMH's final position and get live update of distances and contacts.

These movements are performed incrementally through the Manual Operations tab.

Transformations

The user can convert the final state after positioning for each point to NODE_TRANSFORM keyword in order to use it with Include files.

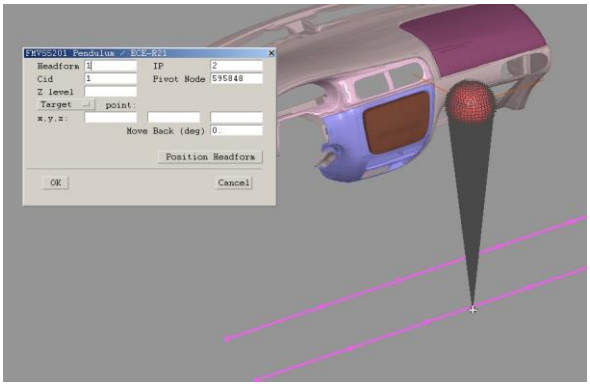
ANSA FMVSS 201 / ECE R-21 Tool

The ANSA FMVSS201 / ECE R-21 Tool is widely used for the fast and proper positioning of the

pendulum model against the FE-model of vehicles' dashboard for the impact simulation.

This tool is used to:

- Position the Pendulum on a selected Target Point
- Automatic position the Pendulum's pivot point on the predefined level set by the user.



FMVSS 201/ECE R-21 tool interface for test device positioning on the dashboard area.

Conclusions - Benefits

ANSA offers unique functionality for the fast and robust modelling of interior safety simulations.

Initially, Target Points are identified automatically in the vehicles interior trim according the TP 201U protocol. Afterwards the FMH is positioned on those Target Points with the aid of contact algorithm. The positioning is performed in two steps, horizontally and vertically leading at that location with the worst HIC(d) value.

This interior safety related functionality, combined with that for pedestrian safety modelling and that the car test dummy seating, positioning and restraining comprise a powerful suite for performing safety simulations modelling.

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