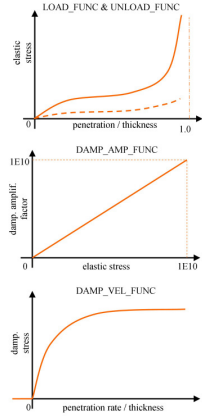


	Additional Information
<p>CONTROL_ANALYSIS.TIME</p> <ul style="list-style-type: none"> Integration method: EULER Time step: $\leq 1.10^{-5}$ for facet dummy models (FE models like airbags may require smaller time steps) Avoid sub-cycling between MB & FE models, if needed USE_FE_TIME_STEP=ON, contact interaction between FE models and/or GF can reduce FE time step 	
<p>FACET SURFACE DEFINITION</p> <ul style="list-style-type: none"> A facet surface is a fully supported PART under FE_MODEL referring to PROPERTY.MEM MEM3 MEM4 and MATERIAL.NULL. Facet surface compliance is represented by allowing finite penetrations of nodes contacting the surface (NOT by deformation of the surface). Let element thickness represent physical thickness of compliant surface : <ul style="list-style-type: none"> uniform surface thickness → use THICK under PROPERTY.MEM MEM3 MEM4. non-uniform surface thickness → use THICK under ELEMENT.TRIAD3 QUAD4 (this overrules thickness definition under PROPERTY.MEM MEM3 MEM4) Use MATERIAL.NULL with DENSITY_NULL=0.0 (physical mass lumped in supporting rigid bodies): <ul style="list-style-type: none"> surfaces considered rigid in contact → define CONTACT_E and CONTACT_NU (used in penalty- or adaptive-based contacts with FE models like airbags) surfaces considered compliant in contact → refer to characteristic with CONTACT_CHAR (used in characteristic-based contact with other facet surfaces or FE models) All nodes must be supported in all (translational) DOFs. Facet surfaces can only show deformation when supported to either deformable bodies or multiple rigid bodies. 	<p>Reference manual - appendix I - section 2.1 and 2.2</p>
<p>MESHING GUIDELINES</p> <ul style="list-style-type: none"> Both ELEMENT.TRIAD3 and ELEMENT.QUAD4 can be used to mesh facet surfaces. MADYMO facet dummy models have an average element size of 10-15 mm. Recommended element size vehicle components interacting with dummy models → 10-15 mm. Existing FE models (in MADYMO or other codes) are good basis for facet surface models: <ul style="list-style-type: none"> smaller elements → no real problems, though CPU costs will increase. larger elements → model responses may be less accurate. Meshing tips to avoid contact problems with facet surfaces : <ul style="list-style-type: none"> close openings in surface where possible avoid (unrealistically) sharp edges in the mesh make sure mesh connectivity is correct (remove duplicate nodes) make sure all element normals point outwards (towards other contacting structure) Predefined facet dummy contact groups are all closed volumes with element normals pointing outwards. 	<p>Reference manual - appendix I - sections 1.2 & 1.3</p>
<p>SURFACE COMPLIANCE DEFINITION (CHARACTERISTIC.CONTACT)</p> <ul style="list-style-type: none"> Use CONTACT_MODEL=STRESS : <ul style="list-style-type: none"> sensitive to contact area and (varying) thickness of the facet surface. LOAD_FUNC and UNLOAD_FUNC are defined in engineering stress vs. engineering strain (strain = penetration / element thickness). Define element (or part) thickness equal to thickness of physical compliant layer: <ul style="list-style-type: none"> Range of X-axis in LOAD_FUNC and UNLOAD_FUNC → 0.0 to 1.0. X = 1.0 equals 100% compaction of compliant layer. Damping is defined as a physical representation of rate dependency in surface material compliance. Use DAMP_AMP_FUNC in combination with either a DAMP_COEF or a DAMP_VEL_FUNC. It is advised to always include some damping in the characteristic to damp out noisy vibrations in contact forces. Rate dependency can also be modelled using the RATE.* elements under MATERIAL.NULL Contact characteristics can best be derived from either material test data or FE material models Some facet contact modelling issues to keep in mind : <ul style="list-style-type: none"> additional contact stiffness due to “pocketing” effects is not represented. (pocketing occurs when a stiff and edged structure is pushed in softer surface) contact area calculation becomes less accurate as area gets smaller w.r.t. to slave element size. Defining CONTACT_CHAR under MATERIAL.NULL (instead of GROUP.FE) allows use of different contact characteristics in one GROUP.FE → larger contact groups and less contact definitions. 	<p>Reference manual - appendix I - sections 2.2 & 2.3</p> 

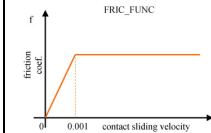
Additional Information

CONTACT DEFINITION (CONTACT.FE_FE + child elements)

- CONTACT_METHOD.* options :
 - Use CONTACT_METHOD.NODE_TO_SURFACE_CHAR for contacts involving compliant facet surfaces. Use SMOOTH_MASTER_THICK=ON to help reduce high frequency vibrations in contact forces. If contact with edges of master surface is inevitable, RELEDG=ON and FACE_TYPE=FRONT may be used as workaround solutions. Do not use GAP_TYPE.*.
 - Use CONTACT_METHOD.NODE_TO_SURFACE|SURFACE_TO_SURFACE for “non-deformable” facet surfaces contacting FE surfaces (e.g. airbags).
- CONTACT_FORCE.* options :
 - Use CONTACT_FORCE.CHAR for contacts involving compliant facet surfaces:
 - CONTACT_TYPE=MASTER|SLAVE → referring to the (most) compliant surface.
 - CONTACT_TYPE=COMBINED → use only if both surface compliances are really relevant.
 - this option can cause significant increase of CPU costs
 - too deep nodal penetrations result in inaccurate solutions.
 - For contacts between “non-deformable” facet surfaces and FE surfaces (e.g. airbags) use CONTACT_FORCE.PENALTY|ADAPTIVE.
 - Use FRIC_FUNC to refer to friction function (friction coefficient as function of relative velocity)
 - Avoid noise due to static friction → always start function at (0,0)
 - Option to model direction- and penetration-dependent friction to model “belt pocketing” effects in dummy-belt contacts.
- INITIAL_TYPE.* options :
 - Use INITIAL_TYPE.CHECK to identify undesired initial nodal penetrations (check reprint file).
 - Use INITIAL_TYPE.MASTER to apply initial contact forces to desired initial nodal penetrations.
 - Make sure that contact surface normals point towards each other when using INITIAL_TYPE.*
- MASTER / SLAVE selection - general guidelines (in order of priority):
 - Surface edges in contact → choose this surface as slave
 - Curved surfaces with large nodal penetrations → choose most curved surface as slave
 - Significant difference in element size → choose finer meshed surface as slave
- MASTER / SLAVE selection - dummy specific guidelines:
 - For some facet dummy models, guidelines concerning master and slave surface selection are given in the model manual. These guidelines may overrule the guidelines given above.
- MASTER / SLAVE selection - guidelines for facet dummy - belt / airbag / seat contacts:
 - FE belts should always be chosen as slave surface
 - Airbags are generally chosen as slave surface, but sometimes choosing master can help avoiding contact problems with sharp edges (e.g. dummy nose)
 - Facet seat foam surfaces are generally chosen as master surface
 - FE seat foam surfaces are generally chosen as slave surface

Reference manual - appendix I - sections 1.2 & 1.3

Reference manual - appendix I - sections 1.2 & 1.3 section 3.1



Application manual - section 2.7

Reference manual - appendix I - sections 1.2 & 1.3

Theory manual - section 9.3

Reference manual - appendix I - sections 1.2 & 1.3

Model Manual - sections 3 of chapters

Reference manual - appendix I - sections 3.1 & 3.2

CHECK YOUR OUTPUT

- Request sufficient output to avoid having to run the model again if some data is missing.
- Reprint file : Check in reprint file (*.rep) for initial penetrations in contacts (if undesired, try removing them, if desired make sure INITIAL_TYPE.MASTER is used). Check for extrapolation warnings in contact characteristics (bottoming out stiff enough?)
- Kinematics : Study model kinematics (*.kn3) for missing contacts or non-realistic contact behaviour.
- Contact forces : Check contact forces (*.cntfrc) to see if contacts are handled correctly, eg.:
 - contact forces back to zero after contact has passed in kinematics?
 - contact directions in line with expectations from kinematics / reality?
- Energy : Define energy balance output per system and/or for the complete model. Check for drifts in total energy of the system or complete model (*.energy). Also check for spikes or discontinuities in energy output signals. These phenomena may point to local model instabilities.
- Time history files Use EXTENDED_SAMPLING in relevant output to avoid aliasing effects.