S-ALE Recent Development

Progressive Mesh Spacing

25 nodes along each direction located in [0.0, 0.2]; first 7 elements [0.0,0.066666] increasing element length; 10 equally-spaced elements; last 7 elements increasing element length [0.1333333, 0.2].

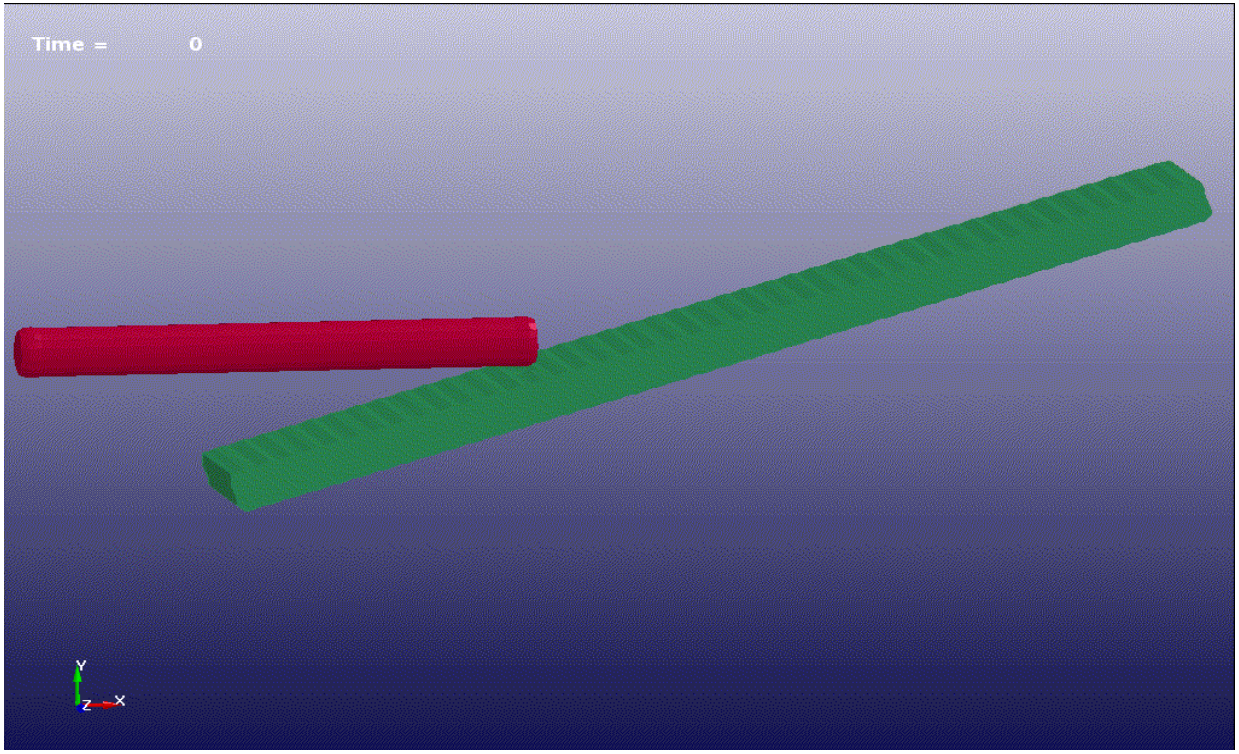
Progressive Mesh Spacing

*ALE_STRUCTURED_MESH					
MSHID	PID	NBID	EBID		
1	1	200001	200001		
CPIDX	CPIDY	CPIDZ	NID0	LCSID	
1001	1001	1001	1	234	

*ALE_STRUCTURED_MESH_CONTROL_POINTS		
1001		
NO	X	Ratio
1	0.0	-0.10
8	0.066666666	0.00
18	0.133333333	0.10
25	0.2	

Ratio > 0 increasing
Ratio < 0 decreasing
abs(ratio): from the smallest element, each element size increased by abs(ratio)

*IVFG – Tilted Box



A long rod projectile impacting an oblique steel plate (Fugelso & Taylor 1978).

- Steel plate is tilted box not aligning with global coordinates. Before we have to generate a Lagrange box using shell elements and then use PART/SEG option in *IVFG to convert material inside box to steel.
- Newly added LCSID (Local Coordinate System ID) for Box option. R9 release or dev version later than 107422.

*IVFG – Tilted Box (Before)

*INITIAL_VOLUME_FRACTION_GEOMETRY							
SID	IDTYP	BAMMG	NTRACE				
11	1	2					
TYPE	FILLOPT	FAMMG	VELX	VELY		"1=PART/SEGSET"	
1	1	3	-61.631	208.06			
PID	IDTYP						
101	1						
TYPE	FILLOPT	FAMMG	VELX			"4=Cone/Cylinder"	
4	0	1	1289				
X0	Y0	Z0	X1	Y1	Z1	R1	R2
-103.0	0.0	0.0	-26.33	0.0	0.0	3.835	3.835

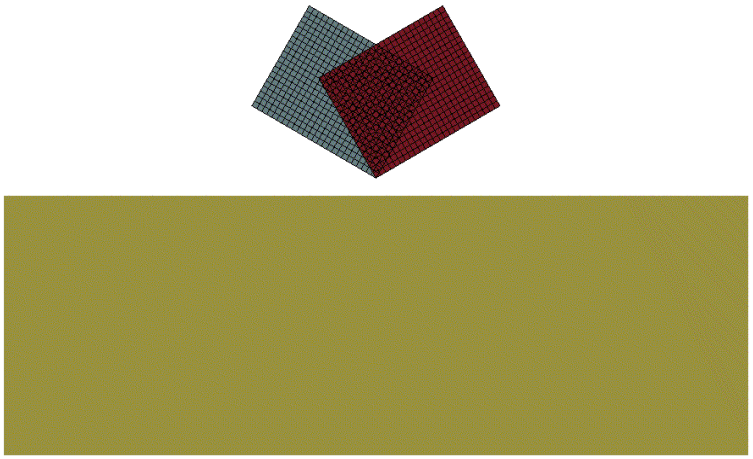
1. First set all elements in PART 11 to vacuum (AMMG2)
2. Next switch vacuum (AMMG2) inside LAG part 101 to plate (AMMG3)
3. Finally switch vacuum (AMMG2) inside a cylinder to rod (AMMG1)

*IVFG – Tilted Box with LCSID

*INITIAL_VOLUME_FRACTION_GEOMETRY							
SID	IDTYP	BAMMG	NTRACE				
11	1	2					
TYPE	FILLOPT	FAMMG	VELX	VELY		“5=BOX”	
5	0	3	-61.631	208.06			
X0	Y0	Z0	X1	Y1	Z1	LCSID	
-71.0026	-24.3693	-29.0000	70.0438	24.0854	29.0000	1	
TYPE	FILLOPT	FAMMG	VELX			“4=Cone/Cylinder”	
4	0	1	1289				
X0	Y0	Z0	X1	Y1	Z1	R1	R2
-103.0	0.0	0.0	-26.33	0.0	0.0	3.835	3.835

1. First set all elements in PART 11 to vacuum (AMMG2)
2. Next switch vacuum (AMMG2) inside a tilted box to plate (AMMG3)
3. Finally switch vacuum (AMMG2) inside a cylinder to rod (AMMG1)

*IVFG – Cylinder/Sphere Volume Corrections



Blast mine on two boxes; Three multi-materials in S-ALE mesh: HE, Soil and Air. HE is a cylinder 4mm long with radius=5.5cm.

- Volume fraction generated by *INITIAL_VOLUME_FRACTION_GEOMETRY card. For elements not fully enclosed in the cylinder/sphere, NxNxN sampling cells are constructed. If the center of a sub-cell lies in the cylinder/sphere, the volume of the cell is added to “volume inside”.
- This algorithm leads to numerical errors in calculating material volume. → wrong material mass. For HE this error is not negligible.
- A correction algorithm is added in IVFG to cure this numerical error. In R9 release or Dev version later than 107883.

*IVFG – Cylinder/Sphere Volume Corrections

1. All to “Soil”; 2. Inside the cylinder h=4cm, r=5.5cm and buried 5cm under soil to “HE”; 3. Above the plane (z=45cm) to “Air”

*INITIAL_VOLUME_FRACTION_GEOMETRY							
SID	IDTYP	BAMMG	NTRACE				
101	1	2					
TYPE	FILLOPT	FAMMG				“4 = Cone/Cylinder”	
4	0	1					
X0	Y0	Z0	X1	Y1	Z1	R1	R2
0.0	0.0	36.0	0.0	0.0	40.0	5.5	5.5
TYPE	FILLOPT	FAMMG				“1 = PART/PSET”	
3	0	3					
X0	Y0	Z0	XCOS	YCOS	ZCOS		
-3.5	-3.5	45.0	0	0	1		

HE mass = pi*5.5^2*(40-36)*1.63 = 619.6172
Without volume correction = 617.9374 (error=2.7e-3)
With volume correction = 619.6163 (error=1.45e-6)

ALE Keyword Conversion

*ALE_STRUCTURED_MESH					
MSHID	PID	NBID	EBID		
1	5	100001	100001		
CPIDX	CPIDY	CPIDZ	NID0	LCSID	
Leave BLANK this Line					

1. Convert a rectilinear ALE mesh to S-ALE mesh
   - Automatically find the three axes and generate local coordinate system
   - Generate three CONTROL_POINTS by stripping from ALE element coordinates.
   - Convert *SET_NODE/SEGMENT/SOLID to use the S-ALE node/element numbering.
2. Map an existing initial volume fraction file to a new file using S-ALE element numbering.

ALE Keyword Conversion

1. Add *ALE_STRUCTURED_MESH card (second line blank) into a ALE keyword.
2. Run the modified ALE keyword for 1 cycle.
3. The generated keywords will be in the ascii file “saleconvrt.inc”.
   - *ALE_STRUCTURED_MESH
   - *ALE_STRUCTURED_MESH_CONTROL_POINTS
   - *DEFINE_COORDINATE_SYSTEM_NODES and *NODE
   - *INITIAL_VOLUME_FRACTION_NALEGP
   - *SET_NODE/SET_SOLID/SET_SEGMENT
4. Delete the corresponding ALE keywords in the original input and include this “saleconvrt.inc’ file and run the S-ALE analysis.

Dev Version 109219 or later

Thank You