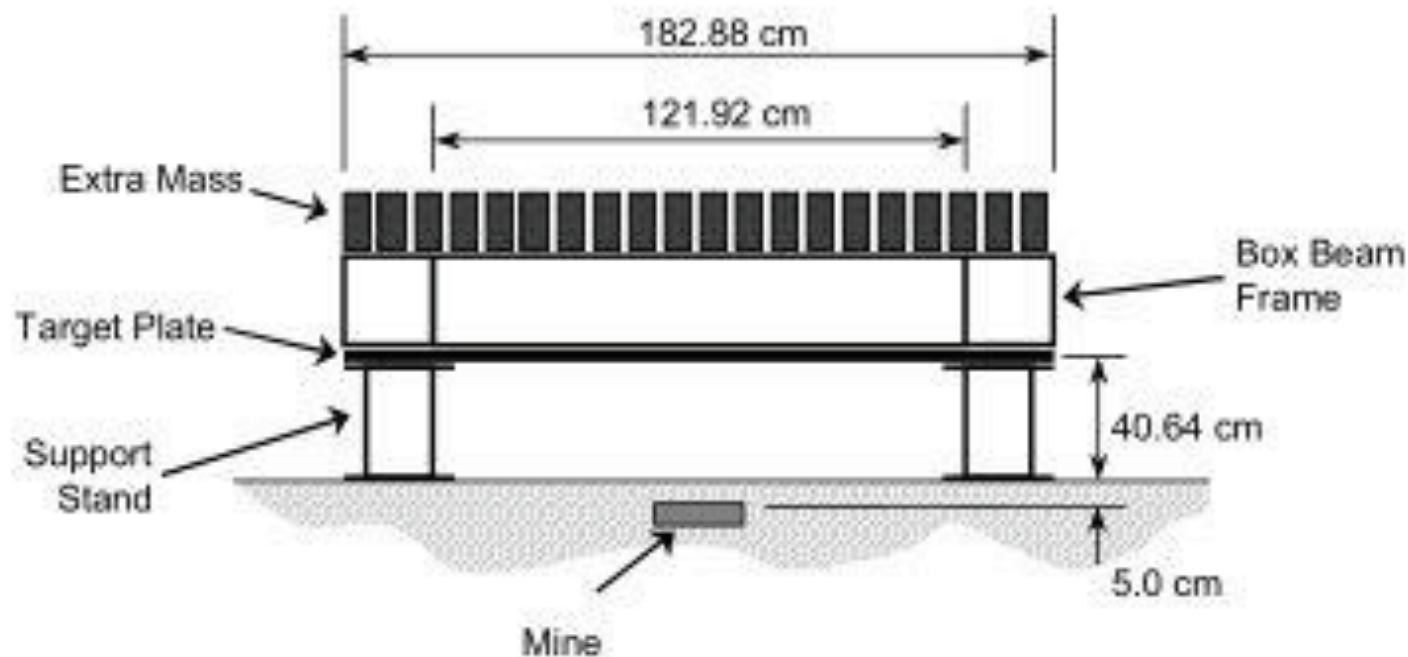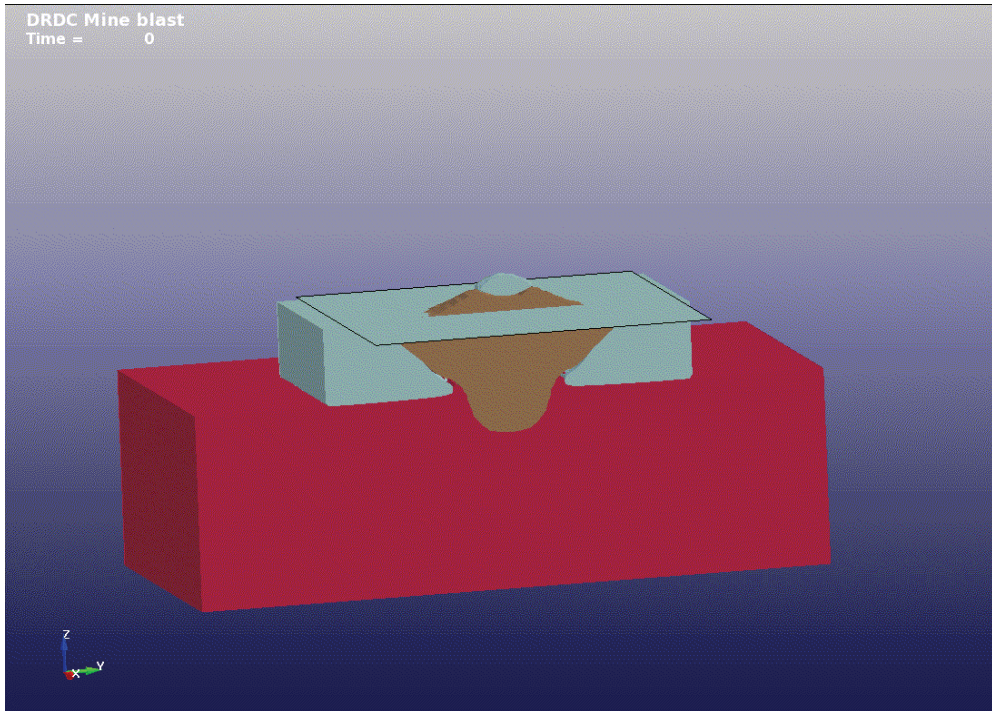# Application: Explosion – Model Description

- Blast mine on plate; Model dimensions and material properties from "Validation of a Loading Model for Simulating Blast Mine Effects on Armoured Vehicles", Williams et al, 7th International LS-DYNA Users Conference; DRDC (Defence R&D Canada)
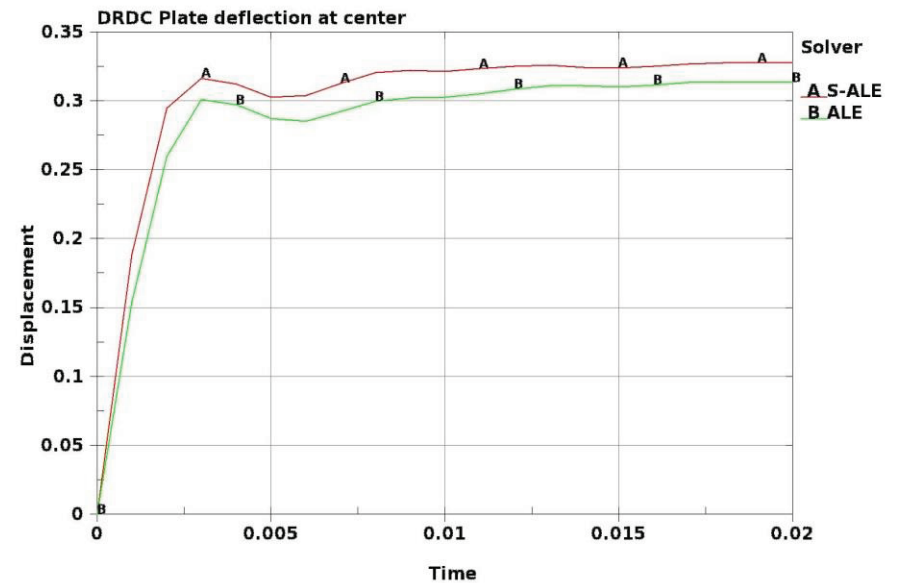

- S-ALE mesh spans from (-1.714, -1.714, -1.0) to (1.714, 1.714, 1.321) modeled by 1,339,200 (120x120x93) elements.

Application: Explosion – Simulation

20ms simulation time
1.3 million S-ALE elements
MPP 48 cpus

S-ALE: 1 hrs 47 mins
ALE: 4 hrs 28 mins

Application: Explosion – Model Setup 1

*ALE_STRUCTURED_MESH					
MSHID	PID	NBID	EBID		
1	999	5000001	5000001		
CPIDX	CPIDY	CPIDZ	NID0	LCSID	
1001	1001	1003			

MSHID: Mesh ID (for future use)

PID: Part ID assigned to the mesh
NO NEED to define *PART card

NBID: Starting Node ID

EBID: Starting Element ID

NID0: Origin Node ID

LCSID: Local Coordinate System ID

*ALE_STRUCTURED_MESH_CONTROL_POINTS		
1001		
	1	-1.714290
	121	1.714290

*ALE_STRUCTURED_MESH_CONTROL_POINTS		
1003		
	1	-1.000000
	32	-0.131200
	37	0.000000
	94	1.321190

Application: Explosion – Model Setup 2

*ALE_MULTI-MATERIAL_GROUP

PID	PTYPE
3000	1
1000	1
2000	1
2001	1

1 to 1 ⟷

*PART

PID	SECID	MID	EOSID	HGID
3000	3000	3001	3001	3000
1000	1000	1001	1000	1000
2000	2000	2000	2000	2000
2001	2000	2000	2000	2000

PID	MATERIAL	AMMG
3000	HE	1
1000	SOIL	2
2000	AIR B$_{elow}$	3
2001	AIR A$_{bove}$	4

- *SECTION should always be 11. Same SECID OK.

- *HOURGLASS form and coefficient should always be 1 and 1.0e-6. Same HGID OK.

- PIDs not used elsewhere. Only to be put into *ALE_MULTI-MATERIAL_GROUP card.

Application: Explosion – Model Setup 3

*INITIAL_VOLUME_FRACTION_GEOMETRY							
SID	IDTYP	BAMMG					
999	1	4					
TYPE	FILLOPT	FAMMG				"5 = BOX"	
5	0	3					
X0	Y0	Z0	X1	Y1	Z1		
-1.0	-1.0	0.0	1.0	1.0	0.39404		
TYPE	FILLOPT	FAMMG				"3 = PLANE"	
3	0	2					
X0	Y0	Z0	NX	NY	NZ		
0.0	0.0	0.0	0.0	0.0	-1.0		
TYPE	FILLOPT	FAMMG				"4 = CYLINDER"	
4	0	1					
X0	Y0	Z0	NX	NY	NZ	R1	R2
0.0	0.0	-0.1312	0.0	0.0	-0.05080	0.12	0.12

1. All to "AIR Above"; 2. Inside box to "AIR below";
3. Below plane to "SOIL"; 4. Inside Cylinder to "HE"

Application: Explosion – Model Setup FSI

Couple plate to air below

*CONSTRAINED_LAGRANGE_IN_SOLID							
SLAVE	MASTER	SSTYP	MSTYP	NQUAD	CTYPE	DIREC	MCOUP
5000	999	1	1	2	4	2	-33
START	END	PFAC	FRIC	FRCMIN	NORM	NORMT	DAMP
		-54		0.3			
CQ	HMIN	HMAX	ILEAK	PLEAK			
			2	0.1			

Couple plate to HE and soil

*CONSTRAINED_LAGRANGE_IN_SOLID							
SLAVE	MASTER	SSTYP	MSTYP	NQUAD	CTYPE	DIREC	MCOUP
5000	999	1	1	2	4	2	-12
START	END	PFAC	FRIC	FRCMIN	NORM	NORMT	DAMP
		-55		0.3			
CQ	HMIN	HMAX	ILEAK	PLEAK			
			2	0.1			

Application: Explosion – Model Setup MISC

*CONTROL_ALE							
DCT	NADV	METHOD	AFAC	BFAC	CFAC	DFAC	EFAC
	1	1					
START	END	AAFAC	VFACT	PRIT	EBC	PREF	NSIDEBC
						101325.0	

Define NODESET SEGSET using *SET_"?"_GENERAL

*SET_SEGMENT_GENERAL							
SID							
1							
OPTION	MSHID	-X	X	-Y	Y	-Z	Z
SALEFAC	1	1	1				

*BOUNDARY_NON_REFLECTING		
SSID	AD	AS
1	0.0	0.0
2	0.0	0.0
3	0.0	0.0

Another newly added option in SET_?_GENERAL SALECPT: It is to define a box with (xmin,ymin,zmin) to (xmax,ymax,zmax) in Control point nodal index. Nodes/Segments/Solids inside the box are included.

Application: Explosion – MPP Performance

NCPU	48	96	192	384
Total Time	6422	3580	2290	1440
S-ALE	4110	2120	1232	610
FSI	242	202	233	303

Slope=0.72

MPP Scalability on Total Time

Slope=0.92

MPP Scalability on S-ALE