2.2 Gauge Points

Gauge points are located at 1.2, 2.0, 3.0, 4.0 and 5.0m from the centre of blast in case-1 and case-2 respectively to measure the pressure at these points.

2.3 Detonation

A detonation point is located at the canter of explosive (0, 0, 0) to start the explosion at time zero.

2.4 Mesh

One degree quadrilateral element has been used to model the wedge. Since accuracy of the results is highly dependent on mesh therefore mesh sizes 0.5, 1.0, 2.0, 4.0 and 8.0 of meshes have been used in case-1 and case-2.

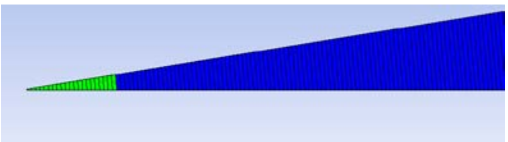


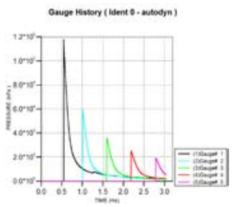
Figure 2: Mesh Model

3. Result and Discussion

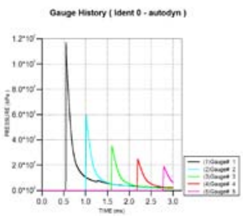
Case-1**:** Table -4, shows the blast pressure, due to blast of 10kg of TNT in water. AUTODYN spherical symmetric analysis with shock EOS of water results are compared with analytical equation given by Cole. Different element sizes are used in AUTODYN model to study the mesh convergence.

Table 4: Overpressure in AUTODYN with Shock EOS and Cole

Maximum Pressure (MPa) at different Standoffs (mm)					
Mesh sizes in millimeter	1.2	2.0	3.0	4.0	5.0
0.5mm	117.5	59.75	35.88	25.12	19.18
1.0mm	116.75	59.2	35.34	24.83	18.80
2.0mm	115.71	58.23	34.56	24.07	18.24
4.0mm	113.53	56.46	33.24	22.95	17.30
8.0mm	110.31	53.76	31.21	21.38	15.99
Analytical solution	100.17	56.24	35.57	27.87	19.97



Element size=0.5mm



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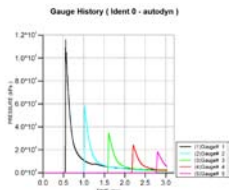
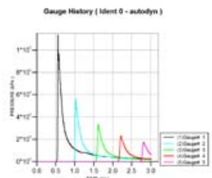
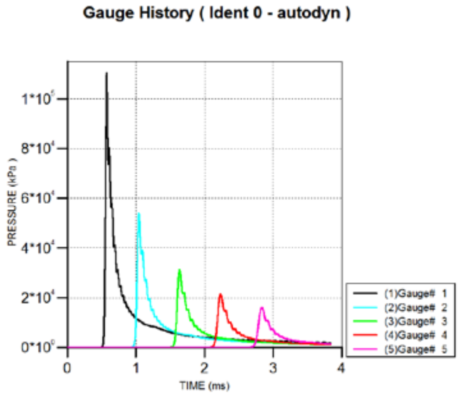


Element size=2.0mm



Element size=4.0mm



Element size=8.0mm

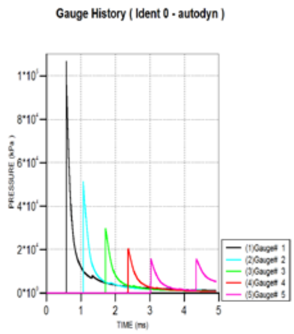
Figure 4: Overpressure vs. time graph for different element sizes at different standoffs in AUTODYN using Shock EOS

Figure 4 shows the overpressure-time histories for different element sizes used in AUTODYN model. The AUTODYN pressure profile at a particular standoff is exactly matching with theoretical graph given by Cole in Figure 1. This result shows that as mesh is refined, overpressure value come closure to analytical equation result. With most refined mesh i.e. element size 0.5mm at the farthest point (5.0mm), difference in AUTODYN result and analytical result is 0.8%. Case-2: The same analysis is repeated for Polynomial EOS of water and its results are compared with Cole's analytical formula results. Table 4 summaries the result for same.

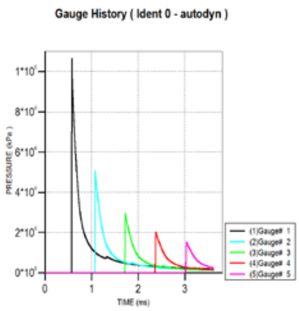
Table 5: Overpressure in AUTODYN with polynomial EOS and Cole

Maximum Pressure (MPa) at different Standoffs (mm)					
Mesh sizes in millimetre	1.2	2.0	3.0	4.0	5.0
0.5mm	106.6	51.0	29.62	20.52	15.68
1.0mm	106.27	50.66	29.31	20.23	15.28
2.0mm	105.07	50.03	28.77	19.76	14.86
4.0mm	103.0	48.85	27.91	19.03	14.24
8.0mm	100.0	46.84	26.50	17.96	13.36
Analytical solution	100.18	56.24	35.577	27.87	19.97

The simulation result depends on mesh size. With most refined mesh the pressure value at the farthest point vary 17% with analytical value. Figure 5 shows the overpressure-time histories for different mesh sizes of AUTODYN model. The simulation result depends on mesh size. With most refined mesh the pressure value at the farthest point vary 17% with analytical value. Figure 5 shows the overpressure-time histories for different mesh sizes of AUTODYN model.



Element size=0.5mm



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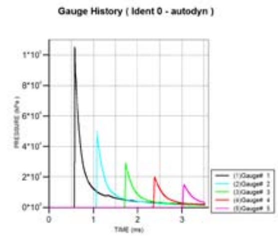

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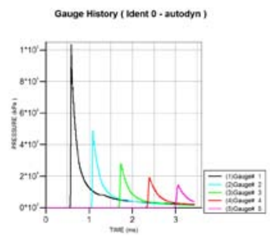
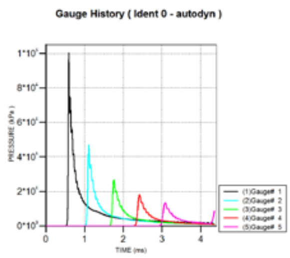


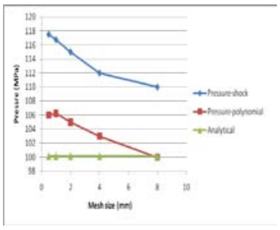
Element size=4.0mm



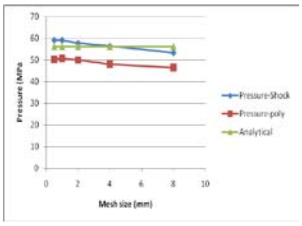
Element size=8.0mm

Figure 5: Overpressure vs. time graph for different element sizes at different standoffs in AUTODYN using Polynomial EOS

Figure 6 shows the comparision of pressure with Shock and Polynomial EOS and Cole's aalytical results for each element size at diferent stand off points. There is 7% of overprediction in simulation result at the neareast stanoff distance



Stand off=1.2mm



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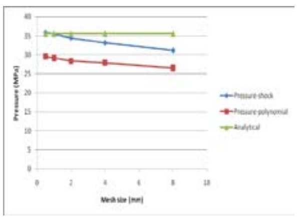
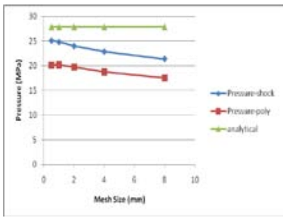
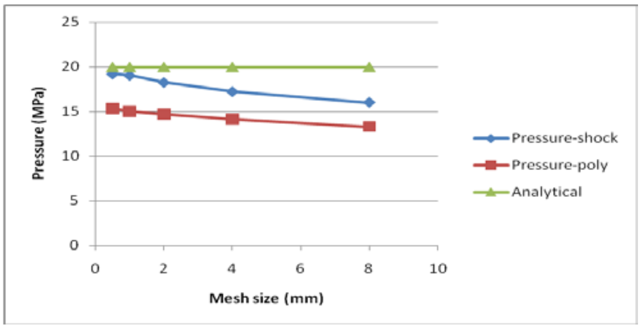


Stand off=3.0mm



Stand off=4.0mm



Stand off=5.0mm

Figure 6: Overpressure vs. element size graph for different Stand offs

Figure 7 shows the pressure vs. stand-off graph for most refined mesh (0.5mm). The Analytical result is compared with AUTODYN results. There is 7% of over prediction of pressure for most refined mesh when pressure is measured near to blast (1.2m)

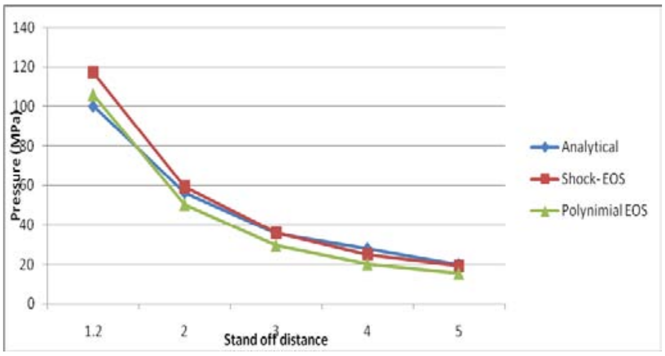


Figure 7: Overpressure vs. stand offs graph for a particular element size

4. Conclusion

In this paper, the explosion phenomenon and blast wave propagation in water are successfully simulated and the blast wave parameter (over pressure) is calculated using ANSYS/AUTODYN program. The two Equation of state of water is used for results comparison & validation point of view. Maximum overpressure which is calculated in ANSYS/AUTODYN is compared with the analytical equation presented by Cole. Simulation studies show that AUTODYN results match very well with analytical equation.

However, the accuracy of simulation is dependent on mesh size; with refined mesh over pressure results obtained is closure to reference results Equation of State of water also influences the maximum values. The values derived with shock EOS agree better to Cole's equation than these derived with polynomial EOS. The general recommendation is to use impulse (integral of pressure over time) for postprocessing instead of pressure values

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