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Design and Analysis of Vehicle Mine Blast Using AUTODYN

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Abstract: Anti-vehicular (AV) mines are capable of disabling a heavy vehicle, or completely destroying a lighter vehicle. The most common form of AV mine is the blast mine, which uses a large amount of explosive to directly damage the target. In a conventional military setting, landmines are used as a defensive force-multiplier and to restrict the movements of the opposing force. They are relatively cheap to purchase and easy to acquire, hence landmines are also potent weapons in the insurgents' armamentarium. The stand-off nature of its design has allowed insurgents to cause significant injuries to security forces in current conflicts with little personal risk. As a result, AV mines and improvised explosive devices (IEDs) have become the most common cause of death and injury to Coalition and local security forces operation.

A number of different strategies are required to mitigate the blast effects of an explosion. Primary blast effects can be reduced by increasing the standoff distance between the seat of the explosion and the crew compartment. Enhancement of armour on the base of the vehicle, as well as improvements in personal protection can prevent penetration of fragments. Mitigating tertiary effects can be achieved by altering the vehicle geometry and structure, increasing vehicle mass, as well as developing new strategies to reduce the transfer of the impulse through the vehicle to the occupants. Protection from thermal injury can be provided by incorporating fire resistant materials into the vehicle and in personal clothing. The challenge for the vehicle designer is the incorporation of these protective measures within an operationally effective platform.

Keywords: High explosive (TNT), co-ordinate of vehicle, occupant safety, blast analysis, mine blast.

I. INTRODUCTION

The need for better and more widely available blasters' training has long been recognized in the blasting community. The Mine Safety and Health Administration (MSHA) of the Department of Labor requires health and safety training for blasters. In 1980, the Office of Surface Mining Reclamation and Enforcement (OSM), Department of the Interior, promulgated regulations for the certification of blasters in the area of environmental protection. These regulations are certain to have a positive influence on the level of training and competence of blasters. They will, however, present a problem to the mining industry. This manual is designed to fulfill that need. It is appropriate that the Bureau of Mines prepare such a manual. Since its inception, the Bureau has been involved in all aspects of explosives and blasting research including productivity, health and safety, and environment, and has provided extensive technical assistance to industry and regulatory a guidance in the promotion of good blasting practices. This manual serves two basic functions. The first is to provide a source of individual study for the practical blaster. There are literally tens of thousands of people involved in blasting at mines in the country and there are not enough formal training courses available to reach the majority of them. The second function is to provide guidance to industry, consultants, and academic institutions in the preparation of practical training courses on blasting.

The manual has been broken down into a series of discrete topics to facilitate self-study and the preparation of training modules. Each section stands on its own.

Each student or instructor can utilize only those sections that suit his or her needs. An attempt has been made to provide concise, yet comprehensive coverage of the broad field of blasting technology. Although liberal use has been made of both Bureau and non-Bureau literature in preparation of this manual, none of the topics are dealt with in the depth that would be provided by a textbook or by a publication dealing with a specific topic. Each section is supplemented by references that can be used to pursue a more in-depth study. These references are limited to practical items that are of direct value to the blaster in the field. Theory is included only where it is essential to the understanding of a concept. Where methods of accomplishing specific tasks are recommended, these should not be considered the only satisfactory methods. In many instances there is more than one safe, effective way to accomplish a specific blasting task. None of the material in this manual is intended to replace manufacturers' recommendations on the use of the products involved. It is strongly recommended that the individual manufacturer be consulted on the proper use of specific products

II. LITERATURE SURVEY

In order to evaluate the damage to a vehicle and its occupants resulting from a landmine blast impulse and to determine the vulnerability of the vehicle, finite element analysis has been widely used recently. In comparison with the ALE method, the IIM method is more convenient for simulating a shallow-buried-mine blast impact on a target plate; this means that it is unnecessary to construct larger soil and air domains, which saves modelling time. The computation time for the IIM method is only about 0.4% of that for the ALE method, which greatly improves the efficiency. Therefore, application of the IIM method to simulate and predict the response of an armoured vehicle for a shallow-buried-mine blast impulse has proved to be highly accurate and successful.

A commonly used model to describe structural materials subjected to large deformation, high strain rate and adiabatic temperature softening model. The model is based on von Mises plasticity, where the yield stress is scaled depending on the state of equivalent plastic strain, strain rate and temperature.

A. Designs

We have modified two types of designs

1) *Blast Design:* Blast design is not a precise science. Because of the widely varying nature of rock, geologic structure, and explosives, it is impossible to set down a series of equations which will enable the blaster to design the ideal blast without some field testing. Tradeoffs must frequently be made in designing the best blast for a given situation. This fundamental concept of blast design. These concepts are useful as a first approximation for blast design and also in troubleshooting the cause of a bad blast.

a) *Models Of Material:* The material models used in this work for modelling the blast loading and the subsequent structural response are briefly described.

b) *Air:* Air has been modeled using a perfect gas form of EoS.

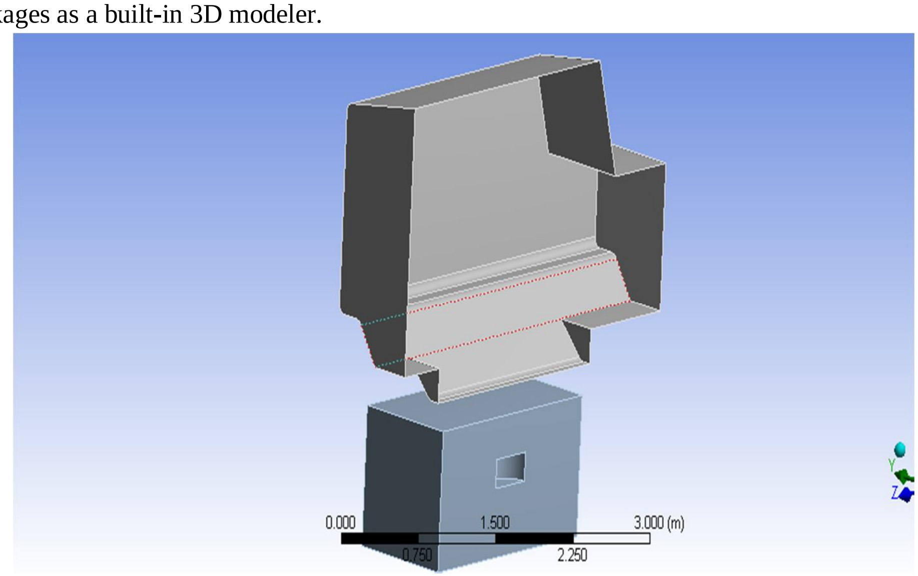
c) *High Explosive (TNT):* Trinitrotoluene or more specifically 2,4,6-trinitrotoluene, is a chemical compound with the formula $C_6H_2(NO_2)_3CH_3$. This is occasionally used as a reagent in chemical synthesis, but it is best known as an explosive material with convenient handling properties. The explosive yield of TNT is considered to be the standard comparative convention of bombs and the destructiveness of explosives. In chemistry, TNT is used to generate charge transfer salts

2) *Vehicle Model Design:* We have modified a vehicle by using Space Claim.

B. Space Claim

Space Claim is a solid modeling CAD (computer-aided design) software that runs on Microsoft Windows and developed by Space Claim Corporation. The company is headquartered in Concord, Massachusetts.

Space Claim Corporation was founded in 2005 to develop 3D solid modeling software for mechanical engineering. Its first CAD application was launched in 2007 and used an approach to solid modeling where design concepts are created by pulling, moving, filling, combining, and reusing 3D shapes. It was acquired by Ansys in May 2014, Inc, and was integrated in subsequent versions of Ansys Simulation packages as a built-in 3D modeler.



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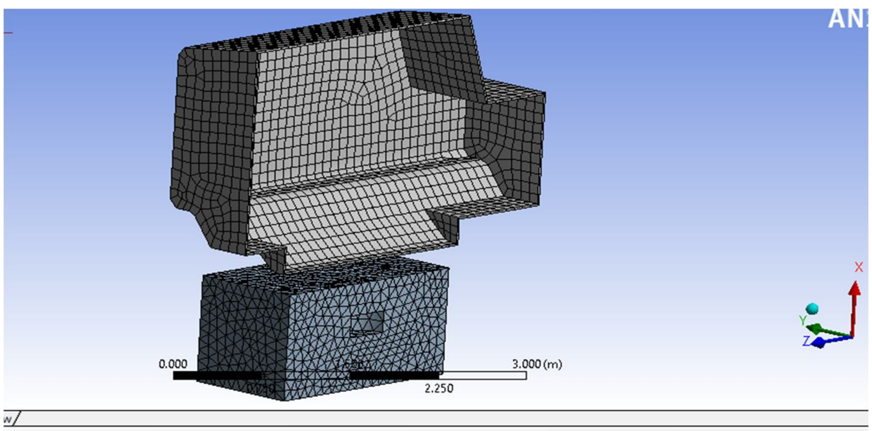
C. Finite Element Method

The finite element method (FEM) is a numerical technique for solving problems which are described by partial differential equations or can be formulated as functional minimization. A domain of interest is represented as an assembly of finite elements. Approximating functions in finite elements are determined in terms of nodal values of a physical field which is sought. A continuous physical problem is transformed into a discretized finite element problem with unknown nodal values. For a linear problem a system of linear algebraic equations should be solved. Values inside finite elements can be recovered using nodal values.

Transient Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, furniture, attire, soil strata, prostheses and biological tissue. Structural analysis employs the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The results of the analysis are used to verify a structure's fitness for use, often precluding physical tests. Structural analysis is thus a key part of the engineering design of structures.

Static analysis is used to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. ... The kinds of loading that can be applied in a static analysis include: Externally applied forces and pressures.

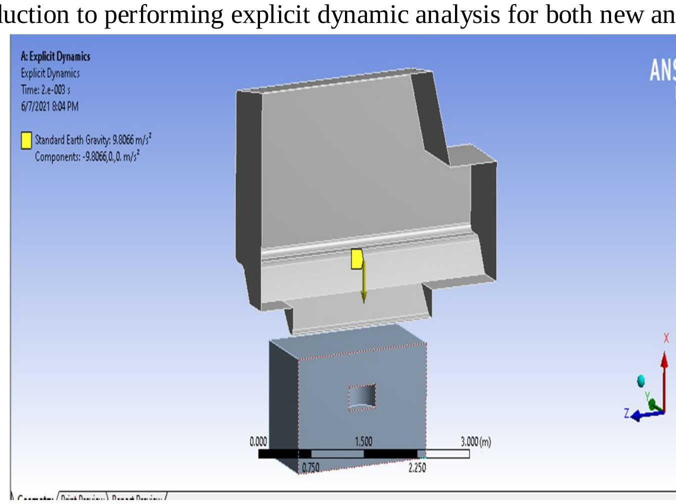


Mesh geometry of modeled vehicle

D. Explicit Dynamics

With the implementation of an explicit solver in ANSYS Workbench there is another advanced analysis type available in this versatile user interface. The phrase “Explicit” refers to a type of time integration used to perform dynamic simulations. Explicit methods are more accurate and efficient for simulations involving shock wave propagation, large deformations and strains, non-linear material behavior, complex contact, fragmentation and non-linear buckling.

This course will serve as an introduction to performing explicit dynamic analysis for both new and experienced users.



E. Anysis Autodyn

In today’s operations, explosive blasts are just as much about precision control as brute force. For efficiency, miners must use enough explosives to fragment and move as much material as possible—but the amount of explosive energy is constrained by budgets and limits on blast vibrations. If timed correctly, shock waves reinforce and amplify one another to produce maximum fragmentation and movement of rock, ore, coal and other materials

With so many variables, mining operators must determine the right detonation delay, often through trial and error. Even after months of experimentation, many companies settle on a delay that gets the job done satisfactorily rather than finding the optimal delay. The largest supplier of explosives in the industry, Orica, is studying precise-delay timing, using Ansys Autodyn nonlinear explicit dynamics software for risk assessments of explosives manufacturing, to give the mining industry a better alternative.

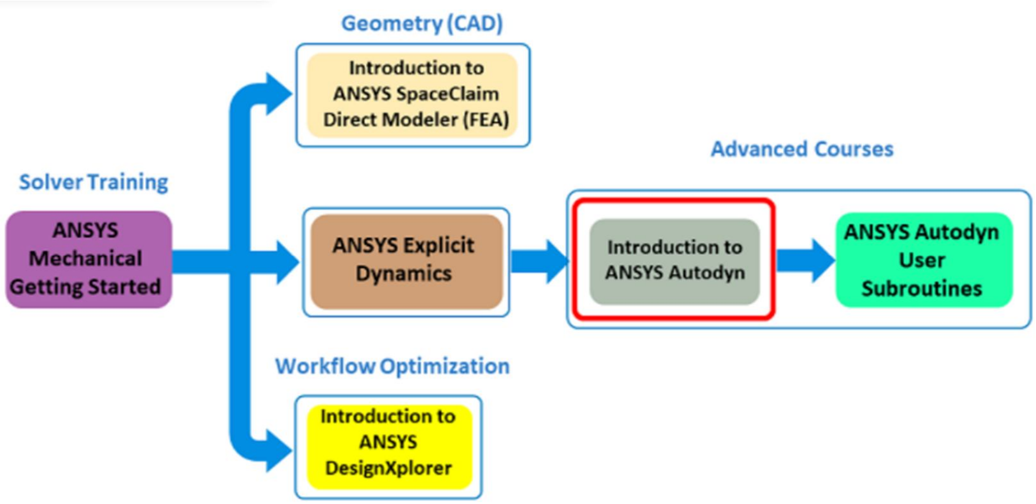
Choose the Autodyn solver most appropriate for simulating large material deformation, fluid/gas flows, blast conditions, and fragmentation of brittle materials.

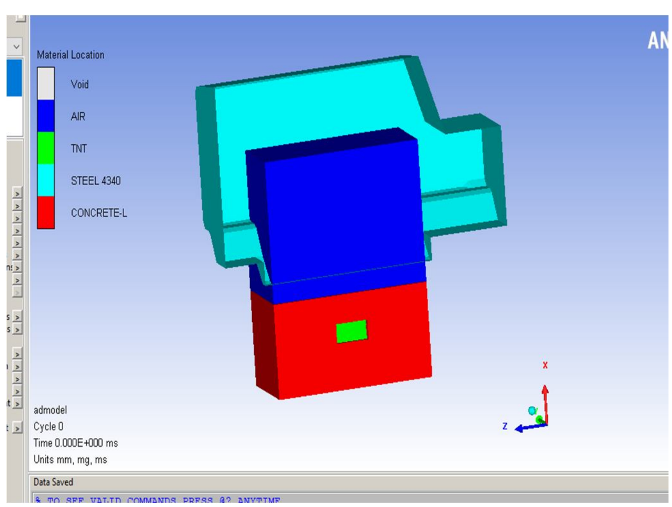
Use the Euler Solver in Autodyn along with various forms of coupling with the Lagrangian solver to model the complex interactions existing when structures are subjected to blast events in both liquid and gaseous environments.

Use the Autodyn Graphical User Interface to access the full capabilities of the Autodyn solvers that may not be fully exposed in the Workbench Mechanical user interface.

Apply an established workflow for creating and solving models, to include part creation, meshing and filling parts with materials, setting up interactions and erosion controls, establishing boundary and initial conditions, solution controls and review of results.

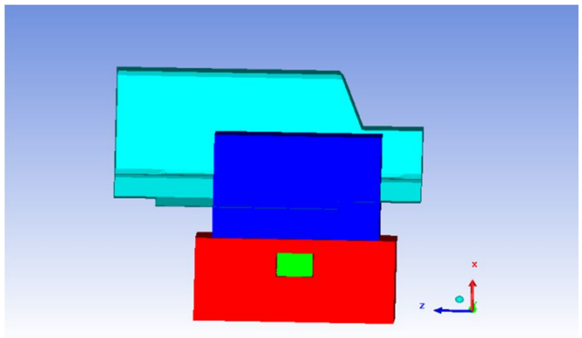
Select from a vast library of material models and understand the material requirements needed based upon the state (solid/liquid/gas) and characteristics of a material (reactivity, porosity, ductility, pressure dependency, etc.) Use Autodyn within the Workbench Environment to take advantage of efficient model setup afforded by Ansys Mechanical





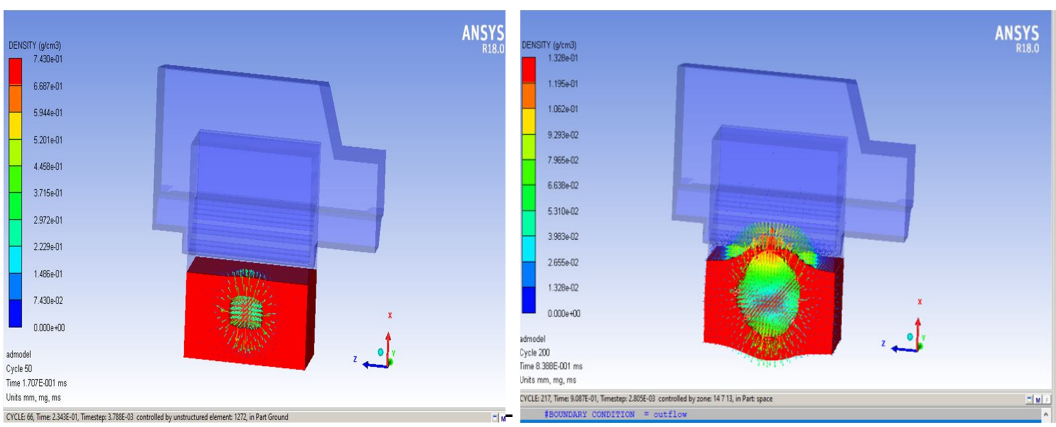
F. After Changing Co-Ordinate Of Vehicle

Set Vertical vehicle offset = 200 mm,
Horizontal vehicle offset = 600 mm,
To change the shape of the vehicle deflector shield set hull angle = 160 degrees.
Charge Weight = 160 Kg.
Charge Height To Diameter = 0.75.
Charge Depth = 200 mm.
Ground Range = 1200 mm.

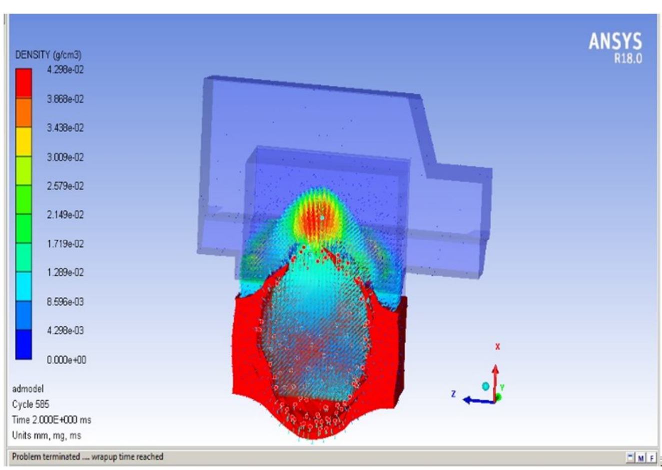


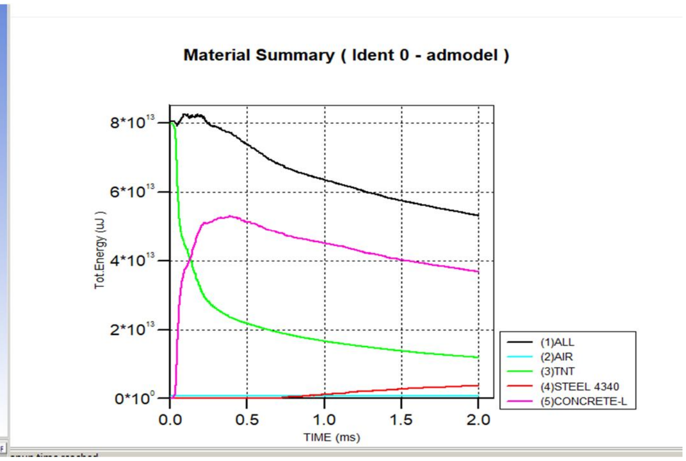
III. RESULTS

A. Standard Dimensions of Vehicle



B. Graph





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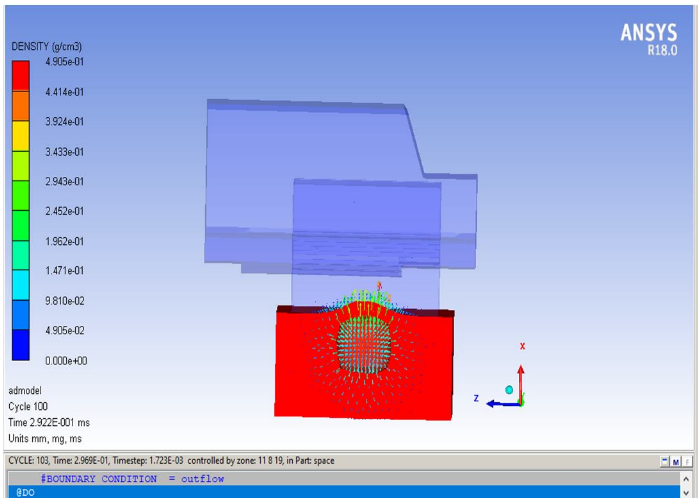
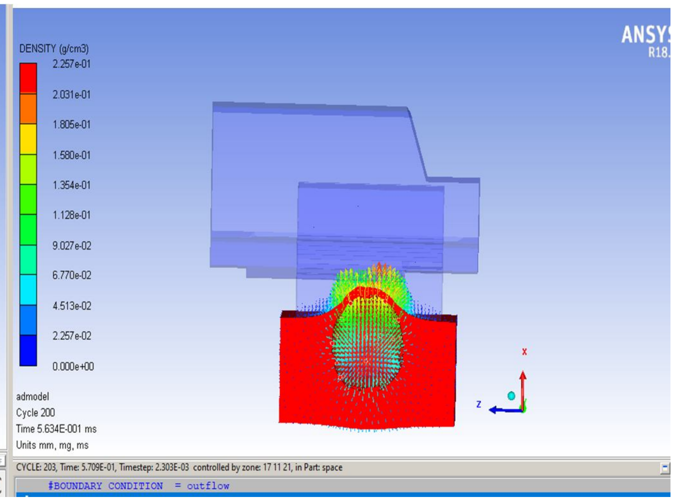
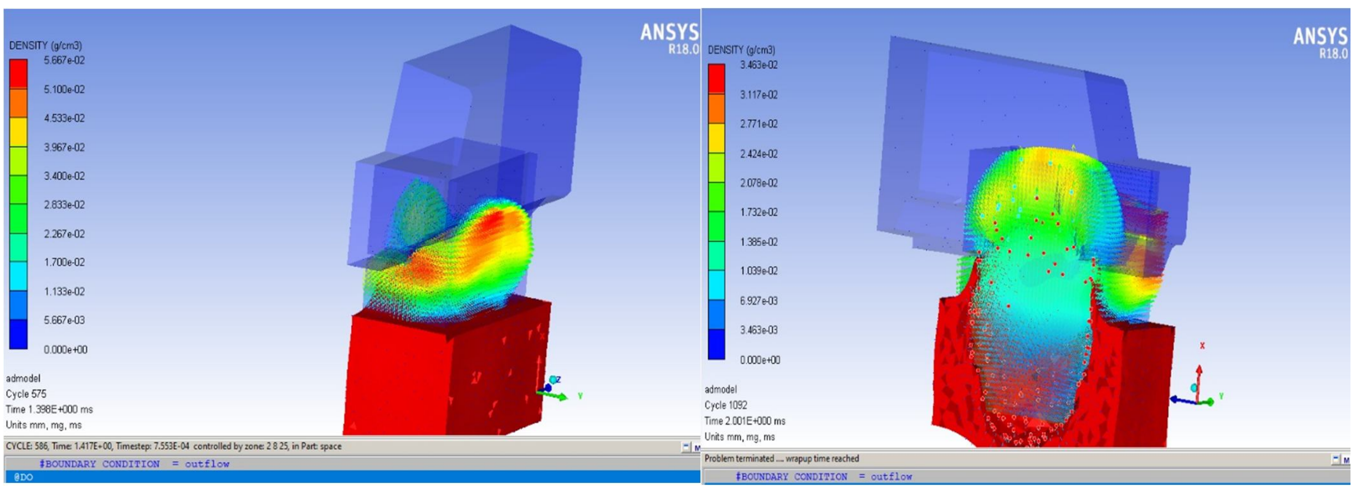
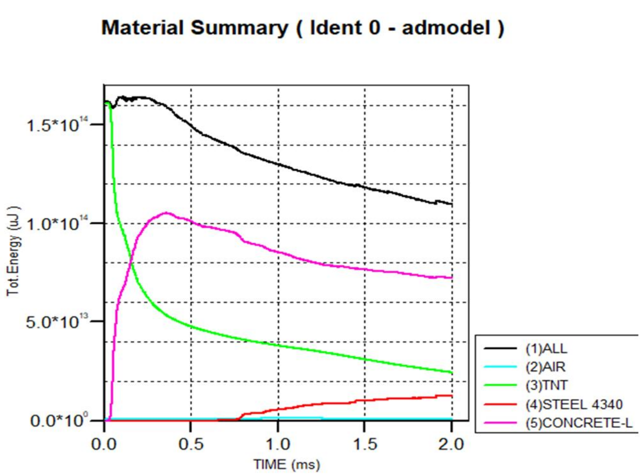
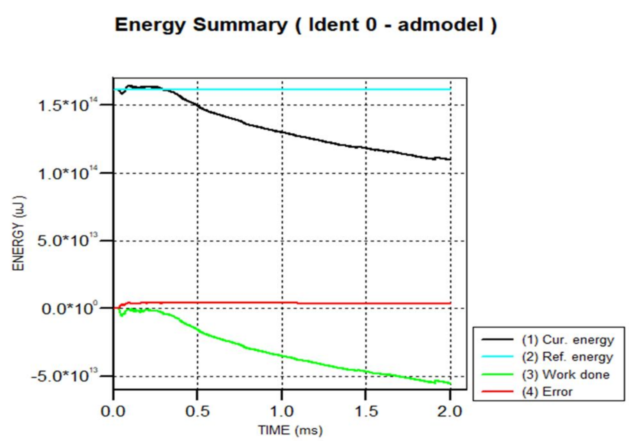
IV. MODIFIED THE CO-ORDINATION OF VEHICLE



A. Graphs





V. CONCLUSION

The development of mine protection strategies is multifaceted and requires a collaborative approach between engineers, scientists and clinicians to fully understand the interaction of the blast with the vehicle and its relationship to human injury. Physical protection remains only one element in the attempt to reduce injury. Improvements in mine detection, countermeasures and tactics are equally important in preventing injury and enabling security forces to move unhindered within a high mine threat environment. There is no way that a vehicle can be fully mine-proofed. If the insurgent is able to plant enough explosive, any vehicle can be penetrated. However, by applying mine protection principles and tactics it is possible to increase the insurgents logistical and operational problems to the point where the tactic of mining vehicles is of limited value, other than in exceptional circumstances.

REFERENCES

[1] Dannatt R. A perspective on the nature of future conflict. In: Chatham House, editor. London: Chatham House; 2009.
[2] Baker W, Cox P, Westine P, Kulesz J, Strehlow R. Loading from Blast Waves. In: Baker W, Cox P, Westine P, Kulesz J, Strehlow R, editors. Explosion Hazards and Evaluation. Amsterdam: Elsevier; 1983.
[3] Tremblay J, Bergeron DM, Gonzalez R. KTA 1-29: Protection of Soft-Skinned Vehicle Occupants from Landmine Effects. In: Program TTCP, editor. Val-Belair, Canada: Defence Research Establishment Valcartier, Quebec, Canada;1998.
[4] Grujicic M, Pandurangan B, Zhao CL, Cheeseman B. A Computational Investigation of Various Water-induced Explosion Mitigation Mechanisms. Multidiscipline Modeling in Materials and Structures. 2007;3[2]:185-212.
[5] Bergeron DM, Tremblay JE, editors. 16th International MABS Symposium; Sept 2000; Oxford, UK.
[6] Tipler P, Mosca G. Physics for Scientists and Engineers. 6th ed. New York: WH Freeman; 2007.
[7] Grujicic M, Pandurangan B, Qiao R et al. Parameterization of the porous-material model for sand with different levels of water saturation. Soil Dynamics and Earthquake Engineering. 2008; 28:20-35.
[8] Mellor SG, Cooper GJ. Analysis of 828 servicemen killed or injured by explosion in Northern Ireland 1970-84: the Hostile Action Casualty System.Br J Surg. 1989;76[10]:1006-10.
[9] Champion HR, Holcomb JB, Young LA. Injuries from explosions: physics, biophysics, pathology, and required research focus. J Trauma. 2009 ;66[5]:1468-77
[10] Morrison J, Mahoney P, Hodgetts T. Shaped Charges and Explosively Formed Penetrators: Background for Clinicians. JR Army Med Corps2007;153[3]:184-7.