Blast characterisation through impulse measurements

INTRODUCTION
- The development of landmine protection solutions for vehicles requires that the threat posed by landmines must be thoroughly understood.
- The close proximity of the exposed bottom section of the vehicles to the landmines (<1000 mm) complicates the analysis.
- To research near-field blast loading effects with respect to blast impulse, the Scientifically Instrumented Impulse Measurement Apparatus (SIIMA) was developed under an Armscor contract.

SIIMA
- SIIMA consists of a frame that is rigidly mounted to a concrete base at the CSIR’s Detonics, Ballistics and Explosives Laboratory (DHEL).
- A moving mass is mounted in the center of the frame.
- The load cells connected to the moving mass measures the force-time duration, which is integrated over time to provide the total measured impulse of a shallow-buried near-field blast.
- SIIMA is currently only used as a comparative measurement as the losses in the spring damper system have not been scientifically quantified.

TM-57 REPLICA MINE VS. 8 kg SURROGATE MINE
Still footage of SIIMA during a typical test

INITIAL RESULTS
- Eighty-six individual tests were executed in this test programme consuming over 645 kg of high explosives.
- A minimum of four tests were executed for each test point to evaluate the repeatability of the experimental design and method.
- All tests with the exception of two varied by no more than 5% from the average impulse value for that test point.

EFFECT OF INCREASING DEPTH OF BURIAL
- An increasing blast impulse trend with increasing depth of burial (DOB) was measured using SIIMA.

COMPUTATIONAL MODELLING
- Computational model predictions were executed using ANSYS AUTODYN.
- The quarter symmetry model consists of:
  - the moving mass section of SIIMA
  - the surrounding air
  - explosive and the soil pit
  - The moving mass is unconstrained and can be accelerated upwards.
  - It is assumed that the blast loading by the gasses is completed within a very short time period.
- The upward total impulse of the moving mass should correspond with the total impulse recorded by SIIMA.

CONCLUSIONS
- The test data have enabled blast loading prediction formulae to be developed.
- These tests have provided a firsthand view into the various parameters that affect blast loading when defined as transferred impulse.
- Predictions can be made using this data for charges closer to as well as further away from the target.
- Several parameters affect anti-vehicular mine blast output and consequently target response.