Application of the mechanical deflection sensor in blast research

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INTRODUCTION

The anti - vehicular landmines (AVLs) and improvised explosive devices (IEDs) are utilised to affect the mobility of military forces in order to inhibit their operations. These devices disable and destroy vehicles while injuring or killing the occupants.

To enable the development of protection solutions for occupants inside military vehicles, the occupant loading must be thoroughly understood.

MOTIVATION

Currently, the loading of occupants is characterised by measuring the acceleration of the hull plate using accelerometers inside military vehicles. The accelerometers only account for the local effect and does not measure the full profile of the deforming hull plate.

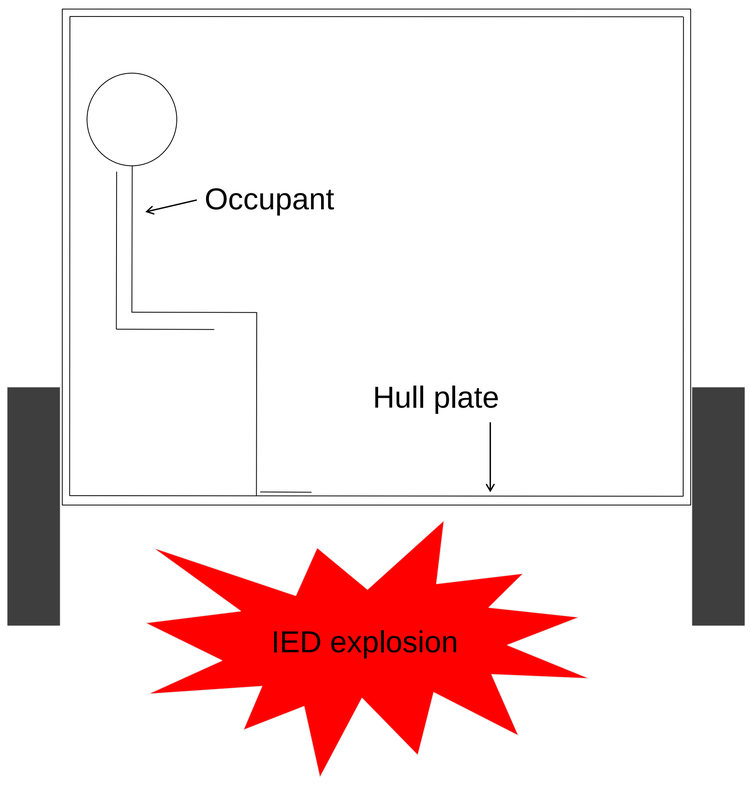
AIM

The aim is to show the capability to measure the positive dynamic deflection of the hull plate using the mechanical deflection sensor (MDS).

TYPICAL VEHICLE RESPONSE

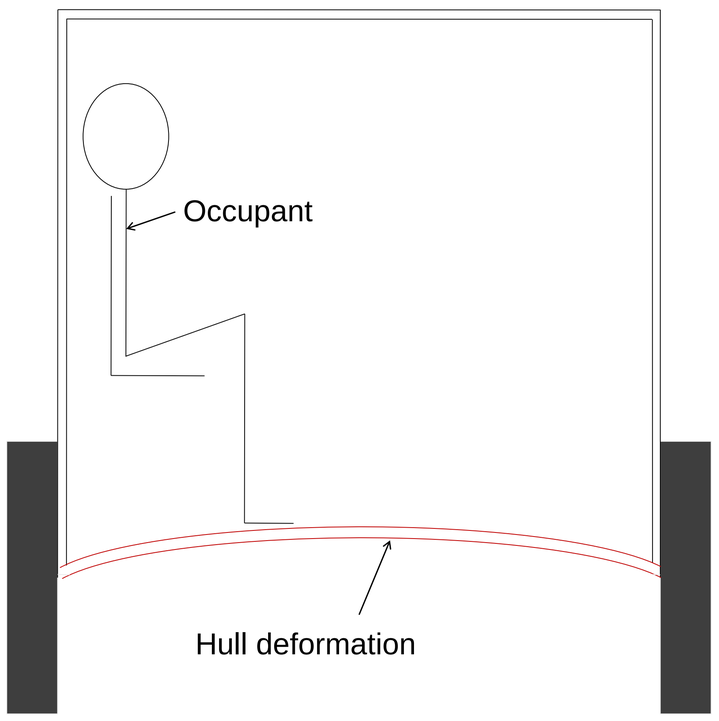
After an AVL or IED has been detonated under a vehicle, a high pressure shock wave is formed and rapidly emitted as shown in Fig. 1. Upon contacting the hull, the shock wave is either deflected or reflected. A vehicle hull absorbs the reflected energy emitted by the shock wave and transmits local accelerations through a vehicle structure.

Figure 1 | IED explosion under the vehicle.



Schematic of the hull plate and occupant after the IED has been detonated under a vehicle. A high pressure shock wave is formed and rapidly emitted as shown in Fig. 1

Figure 2 | **Hull** deformation after IED explosion



The vehicle hull deforms elastically and plastically, depending on the energy transmitted to the vehicle as in Fig. 2. Very high amplitude and short duration axial compressive forces are transmitted through the floorboard to the occupant's feet.

The loading of the occupant is determined by the magnitude and rate of deformation of the hull plate. The hull plate deformation is currently characterised by measuring the acceleration. This method is not sufficient to characterise the complete hull deformation profile, as it only concentrates on local deformation. The complete hull plate deformation time profile must be characterised

MATERIAL AND METHODS

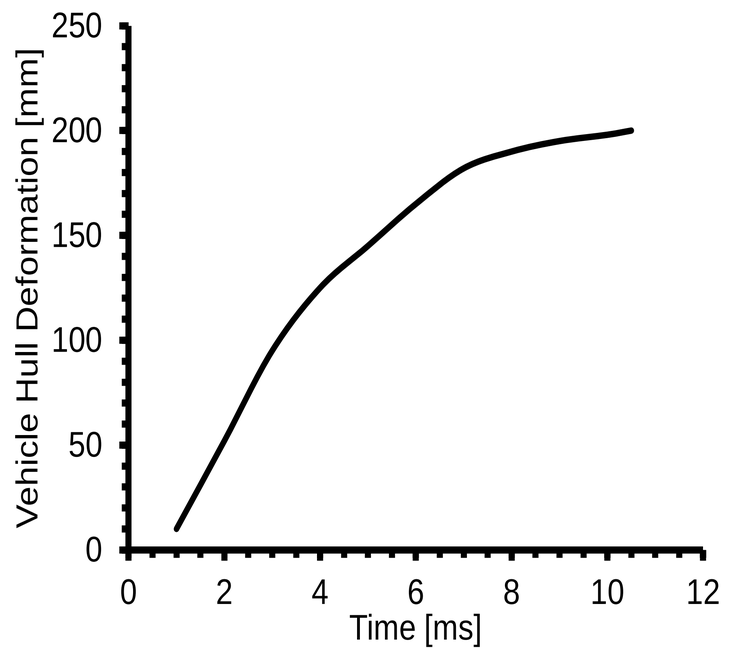
In order to completely characterise the hull plate deformation time profile response, the mechanical deflection sensor (MDS) was developed by the CSIR. The MDS is a specialised tool due to the high sampling rates required to capture data under field conditions.

Figure 3 | Photograph of mechanical deflection sensor

The MDS consists of eight steel rods that are connected to housing as shown in Fig. 3. This housing is made out of teflon material with a PC board enclosed in between the housing. A ribbon cable is connected to the PC board to a data acquisition unit for data capturing. The data collected by the sensor is processed with Matlab™ to produce data that can be interpreted. The MDS measures the hull plate's positive dynamic deformation response over time.

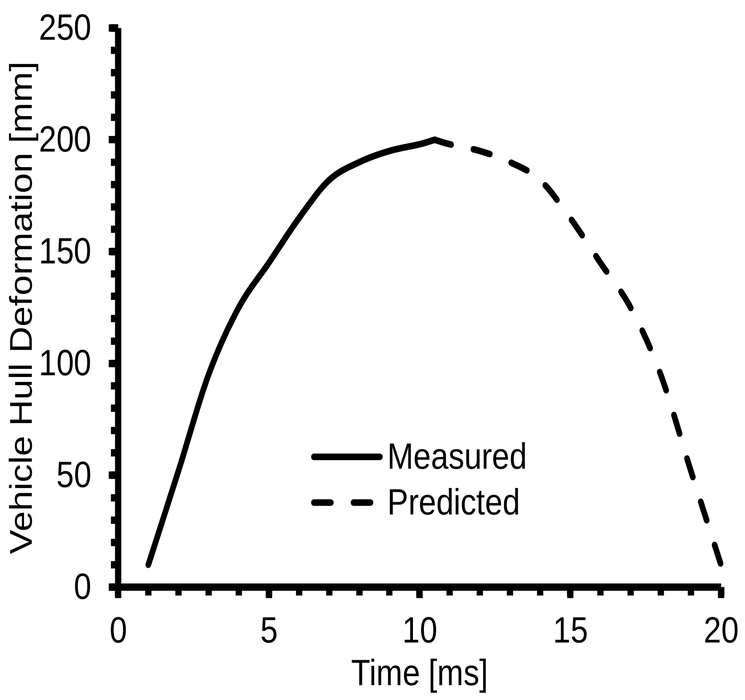
RESULTS AND DISCUSSION

Figure 4 | Positive dynamic deformation of the hull plate.



When the rods are impacted, by the hull during deformation, the positive dynamic deformation of a plate is measured from the response of the steel rods.

Figure 5 | Complete dynamic deformation of the hull plate



From the positive dynamic deformation, the complete profile can be predicted as the general shape of the hull is known.

CONCLUSION

The MDS has the capability to measure the positive dynamic deflection of the hull plate. The complete dynamic deformation profile can be predicted from the initial positive deformation. The prediction of the complete dynamic hull deformation is useful in fully characterising the occupant's response inside a military vehicle.

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