Characterisation of a Mechanical Deflection Sensor

M MIYAMBO AND T PANDELANI
CSIR Defence, Peace, Safety and Security, PO Box 395, Pretoria, South Africa, 0001
Email: mmiyambo@csir.co.za – www.csir.co.za

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INTRODUCTION

The CSIR Defence, Peace, Safety and Security (DPSS) Landwards Science (LS) is conducting research on near-field blast loading effects with respect to blast impulse. As such, the Scientifically Instrumented Impulse Measurement Apparatus (SIIMA) was developed. This instrument measures the force-time duration, which is integrated over time to provide the total measured impulse of a shallow-buried explosive charge near-field blast (Snyman et al, 2006).

The CSIR LS, in conjunction with Conical® to measure the positive dynamic deformation response over time of the vehicle's hull. The MDS captures the response of the centre of the plate by breaking the PC board in the Teflon housing.

APPARATUS AND METHODS

The Mechanical Deflection Sensor

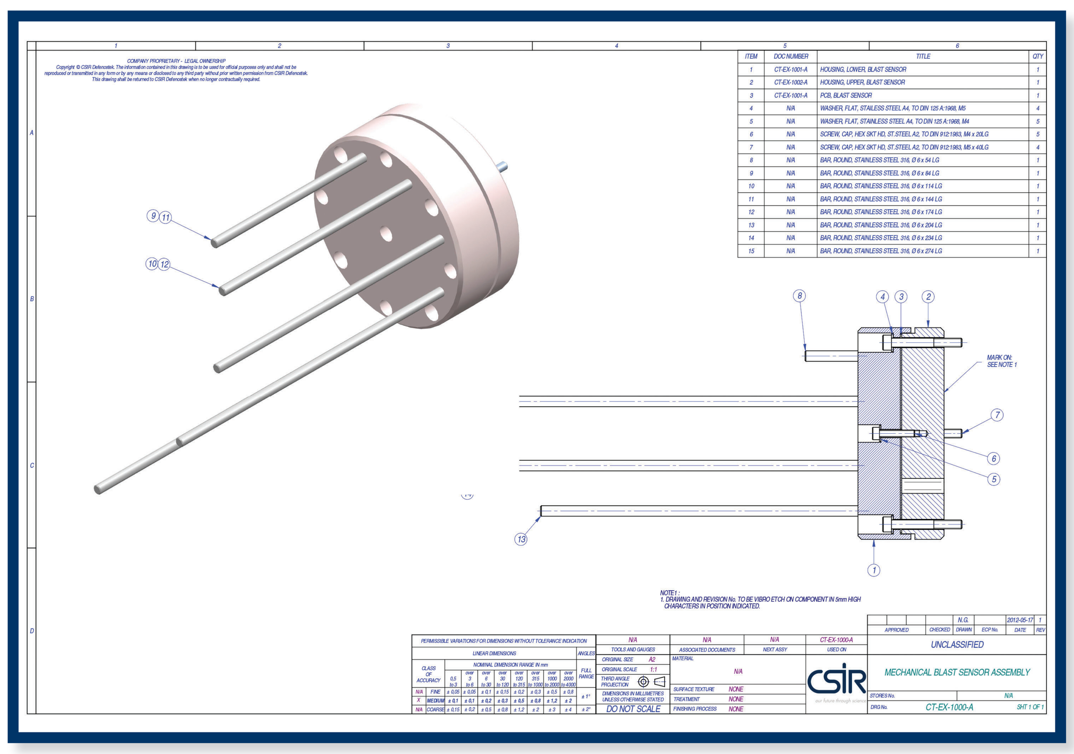

Figure 1: Mechanical Deflection Sensor design

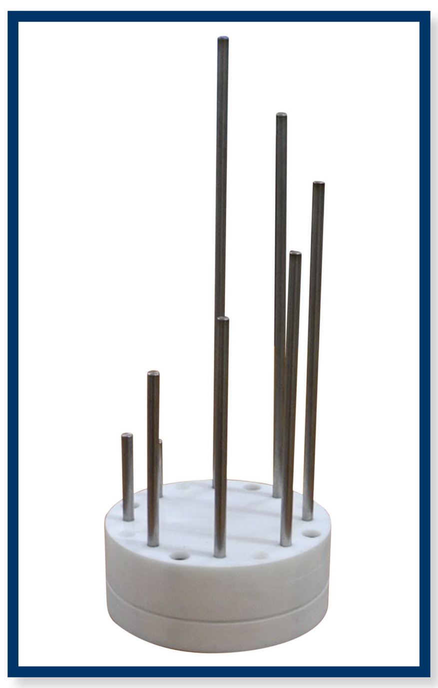

Figure 2: Manufactured Mechanical Deflection Sensor

The MDS consists of eight steel rods that are connected to a housing base. When these rods are impacted, the positive dynamic deformation of a blast plate is measured when the rods move towards the plate's direction of motion, and the data is recorded on the data acquisition unit. **Figure 1** shows the technical drawing of the designed Mechanical Deflection Sensor.

Figure 2 shows the manufactured Mechanical Deflection Sensor.

Application of the Mechanical Deflection Sensor on the Modified Lower Limb Impactor

The Modified Lower Limb Impactor (MLLI) is used to conduct a series of impact tests on the deflection sensor.

The aim of these tests on the deflection sensor is to simulate the positive dynamic deformation, plate impact and the displacement of the measuring rods (**Figure 3**).

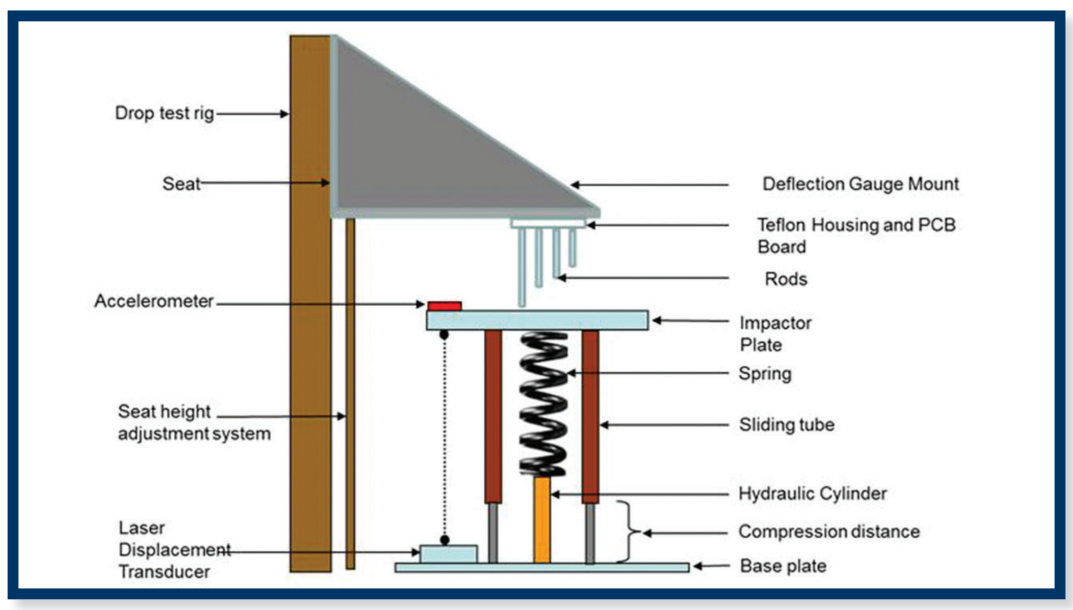

Figure 3: Schematic diagram of the Mechanical Deflection Sensor position

Figure 4 shows the actual setup of the Mechanical Deflection Sensor and Seat Mount.

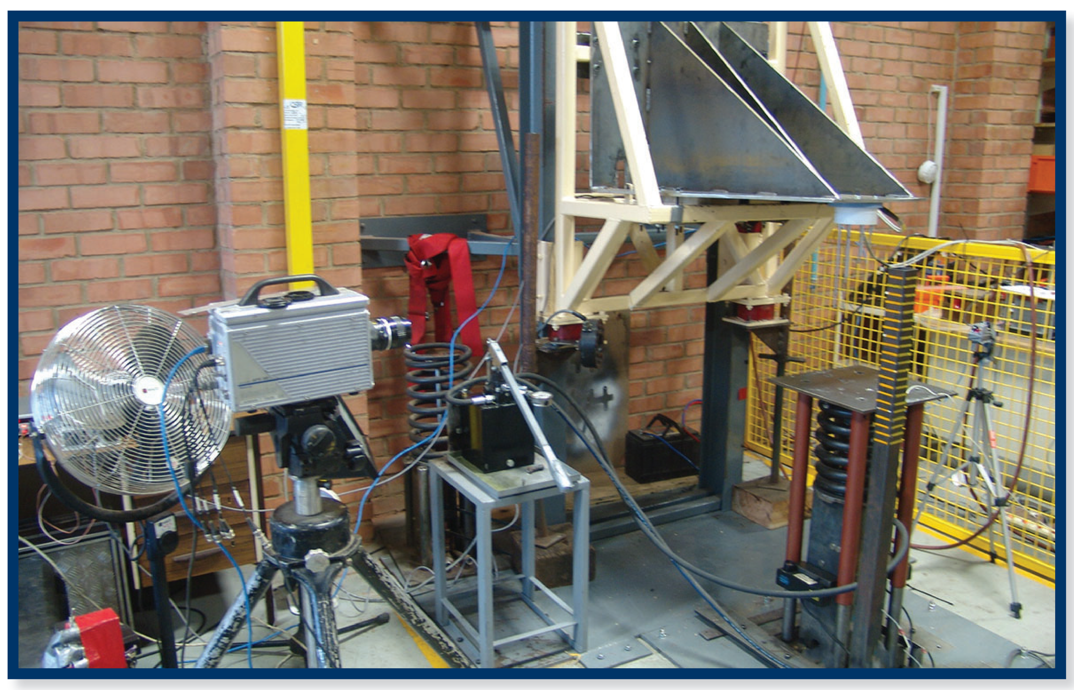

Figure 4: Mechanical Deflection Sensor actual setup

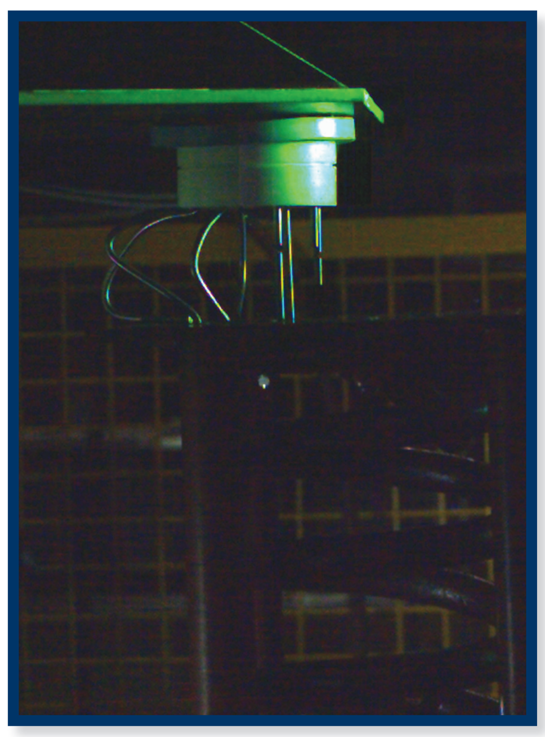

Figure 5: Bending rods of the Mechanical Deflection Sensor

Figure 5 shows a snippet of some of the rods bending due to the impactor plate's load.

Application of the Mechanical Deflection Sensor on the modified SIIMA base plate

Research on near-field blast loading effects with respect to blast impulse will be conducted on thin blast plates using the Deflection Test Jig. The modified SIIMA base plate Deflection Test Jig will be mounted onto the bottom section of SIIMA's moving mass. **Figure 6** shows an isometric sectioned view of the Mechanical Deflection Sensor mounted onto the inner centre of the Deflection Test Jig.

The measured deformation of the blast plate on the Deflection Test Jig when exposed to an explosive charge at scaled shots will be compared to the simulated measurements of the positive dynamic deformation of the MLLI impact tests.

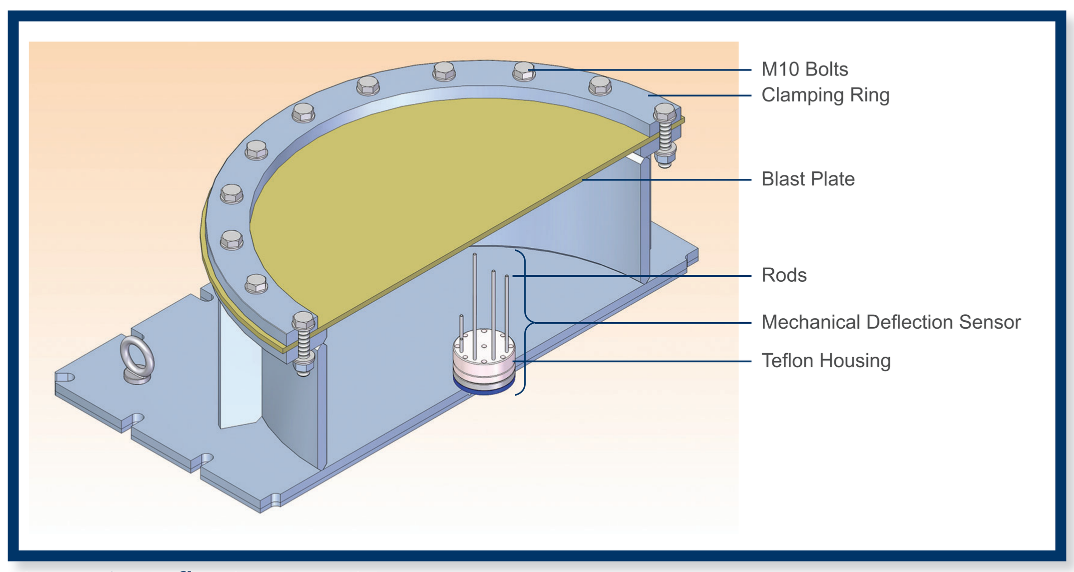

Figure 6: Deflection Test Jig

RESULTS

Figure 7 shows the displacement of the impactor plate measured using the first laser displacement meter.

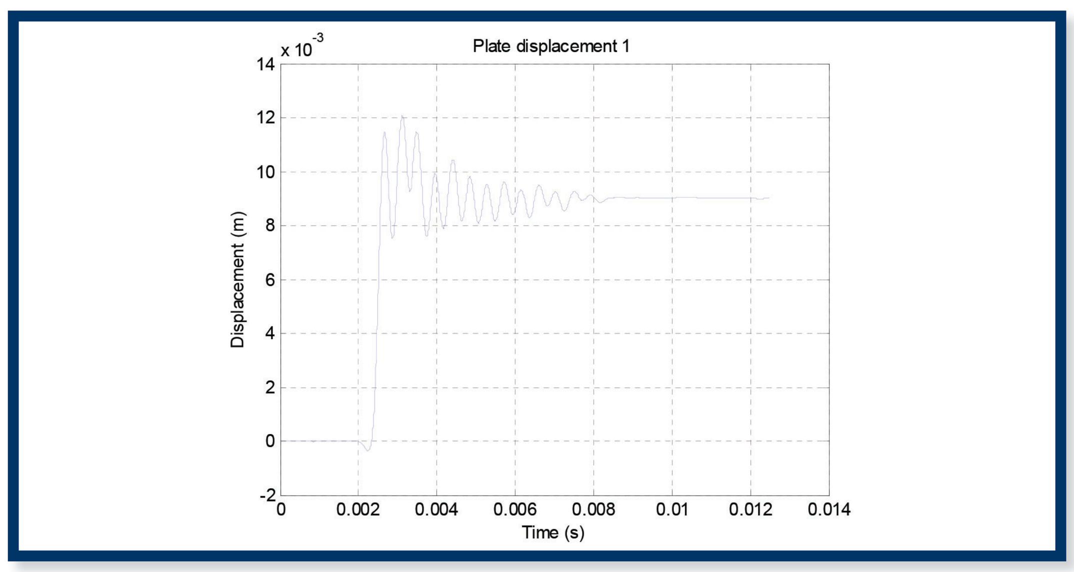

Figure 7: Impactor plate displacement measurement 1

Figure 8 shows the displacement of the impactor plate measured using the second laser displacement meter.

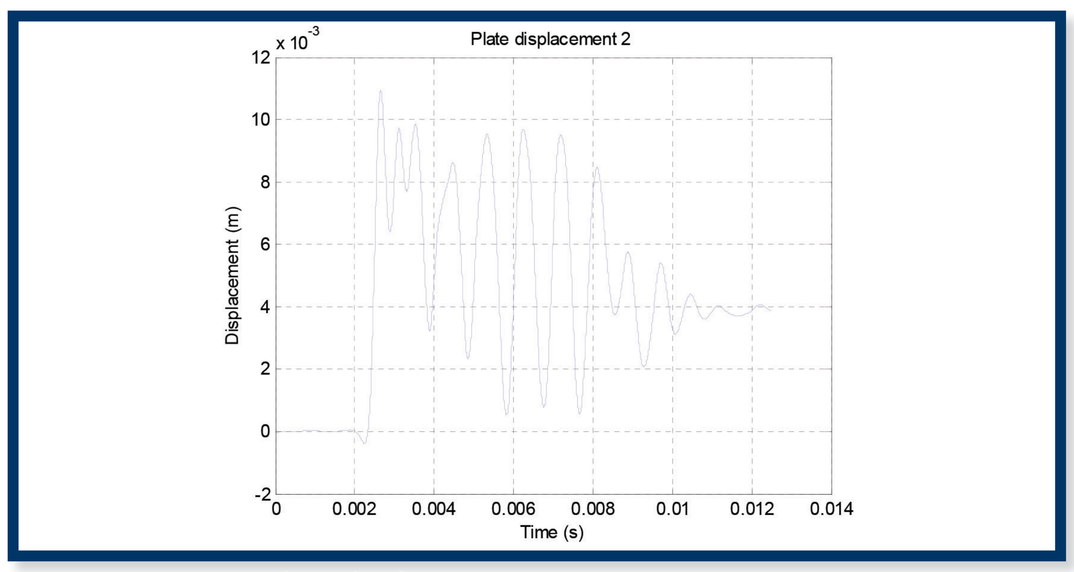

Figure 8: Impactor plate displacement measurement 2

Figure 9 shows the measured impactor plate velocity 1.

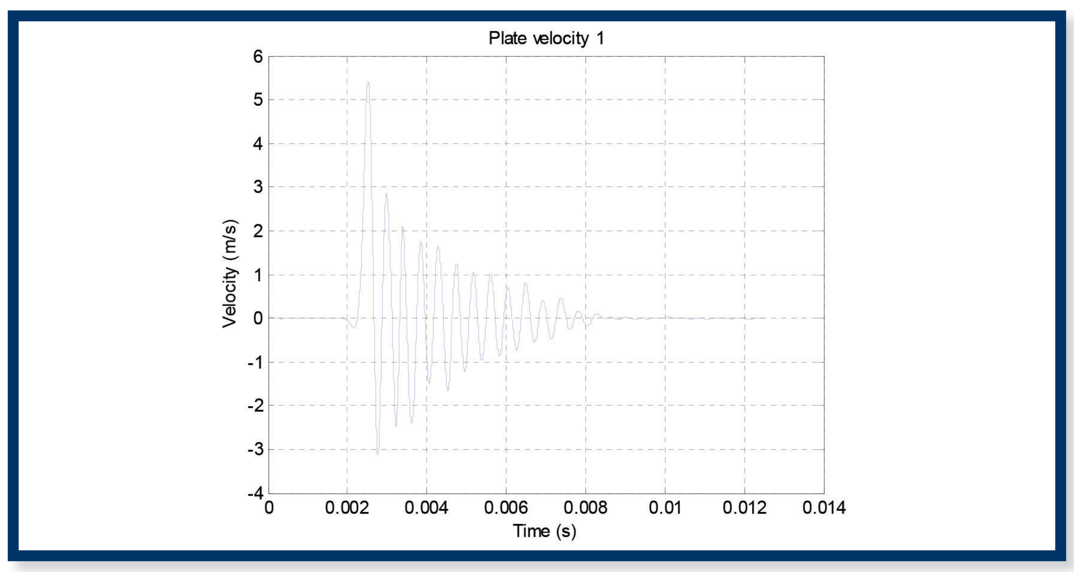

Figure 9: Impactor plate velocity measurement 1

The Mechanical Deflection Sensor (MDS) is used to measure the simulated positive dynamic deformation of a blast plate, when it is impacted by a spring powered Lower Limb Impactor (LLI) plate.

Figure 10 shows the measured impactor plate velocity 2.

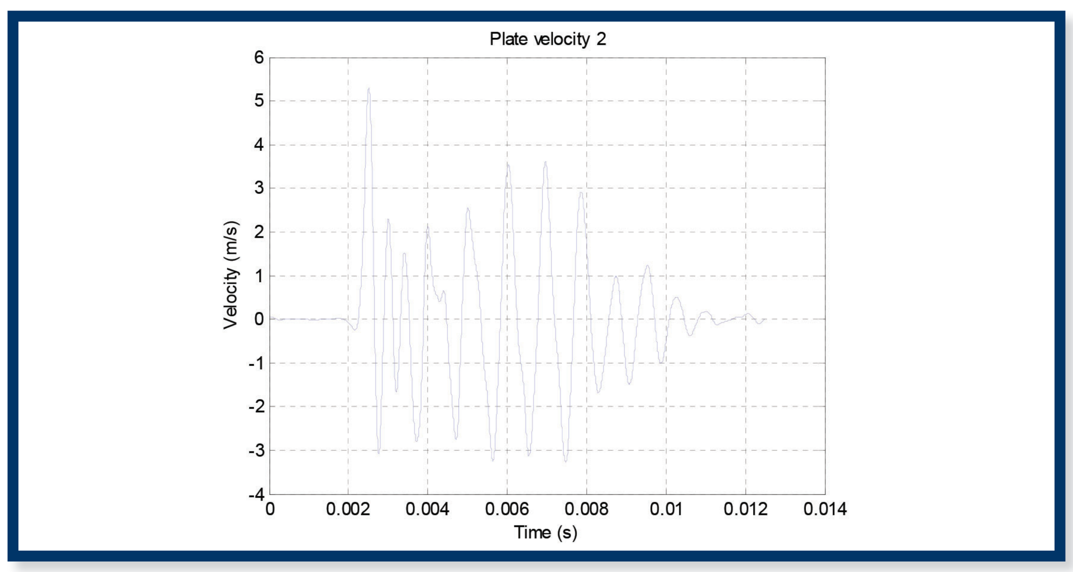

Figure 10: Impactor plate velocity measurement 2

Figure 11 shows the measured deflection of the Mechanical Deflection Sensor due to the impact load of the impactor.

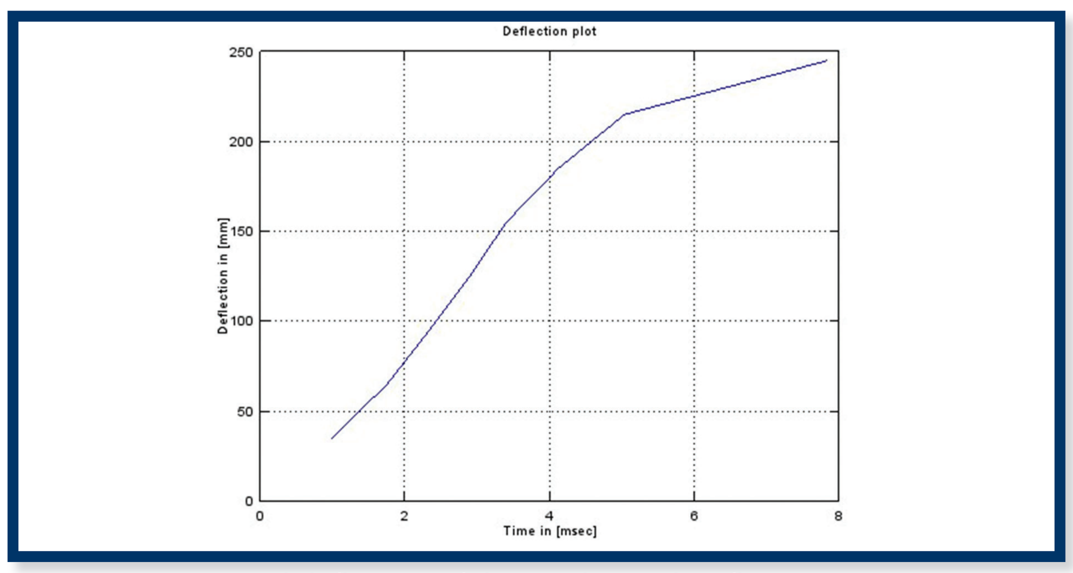

Figure 11: Measured deflection of the Mechanical Deflection Sensor

Figure 9 shows the measured impactor plate velocity 1. Impulse 1 was calculated to be 178.2756 Ns and Impulse 2 was calculated to be 173.8912 Ns.

RECOMMENDATIONS

The impactor plate of the MLLI was compressed to a height of 180 mm before it was released to hit the rods of the MDS. As a result of this compression value, one rod of the MDS was not hit and the deflection on that rod was not obtained (**Figure 5**). The MLLI should be compressed to at least 195 mm, so that the deflection on all the rods can be measured.

CONCLUSION

The execution tests were successful and the expected results of the Mechanical Deflection Sensor were achieved.

ACKNOWLEDGMENTS

David Reinecke (principal mechanical engineer) and Martin Mwila (instrumentation electronics technologist).

REFERENCES

Snyman, I.M. and Reinecke, J.D. 2006. Measuring the impulse from an explosive charge, Ballistics Symposium South Africa, Denel-OTB, Bredasdorp, 15–16 Aug 2006.

Miyambo, M.E. and Pandelani, T. 2012. The Mechanical Deflection Sensor Test Instruction.

Pandelani, T. 2012. SIIMA BAE Test Plate Test Instruction.

Pandelani, T. 2011. HFM Support: Test Instruction: Lower Limb Impactor Testing.

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