

BLAST RESPONSE OF STRUCTURES AND ITS MITIGATION USING ADVANCED LIGHTWEIGHT MATERIALS

by

**MANMOHAN DASS GOEL
DEPARTMENT OF CIVIL ENGINEERING**

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In the loving memory of beloved

Nana-Nani-ji

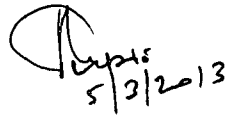
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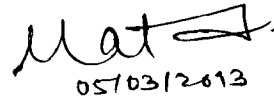
This is to certify that the thesis entitled, “**BLAST RESPONSE OF STRUCTURES AND ITS MITIGATION USING ADVANCED LIGHTWEIGHT MATERIALS**” being submitted by **Mr. Manmohan Dass Goel** to the Indian Institute of Technology Delhi for the award of the degree of **DOCTOR OF PHILOSOPHY** is a record of the bonafide research work carried out by him. He worked under our supervision for the submission of thesis, which to our knowledge has reached the requisite standard as demonstrated by excellent international publications in journals and conferences. Further, the contents of his research work, in full or in parts, have not been submitted to any other institute or university for the award of any degree or diploma to the best of our knowledge and belief.



Dr. Anil K. Gupta

Former Director

CSIR - Advanced Materials and Processes
Research Institute (AMPRI)
Hoshangabad Road, Near Habibganj Naka
Bhopal - 462 064, Madhya Pradesh
India



Dr. Vasant A. Matsagar

Associate Professor

Department of Civil Engineering
Indian Institute of Technology (IIT) Delhi
Hauz Khas, New Delhi - 110 016
India

Fakultät für Luft- und Raumfahrttechnik
Institut für Mechanik (LRT 4)

Univ.-Prof. Dr.-Ing. Steffen Marburg
Technische Dynamik

Universität der Bundeswehr München · 85577 Neubiberg · Germany

der Bundeswehr
Universität  **München**

Telefon: +49 89 6004-4676
Sekretariat: " -2383
Telefax: +49 89 6004-2386
E-Mail: steffen.marburg@unibw.de

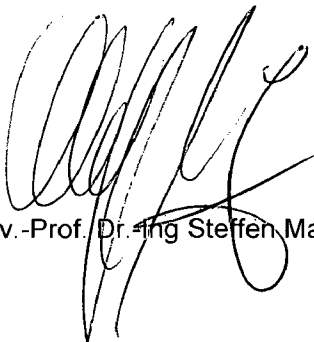
Confirmation Certificate of Doctoral Research Completion

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To whom it may concern,

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The research work carried out by him under my supervision achieved high quality as demonstrated by excellent international publications in journals and at conferences. As one of his co-supervisors, it is approved by the undersigned for awarding Doctor of Philosophy (PhD) at the Indian Institute of Technology (IIT) Delhi. Further, the contents of his research work, in full or in parts, have not been submitted to any other institute or university for the award of any degree or diploma to the best of my knowledge and belief.



Univ.-Prof. Dr.-Ing. Steffen Marburg

Universität der Bundeswehr München
Fakultät für Luft- und Raumfahrttechnik
Institut für Mechanik
Univ.-Prof. Dr.-Ing. Steffen Marburg
85577 Neubiberg

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अखण्डमण्डलाकारं व्याप्तं येन चराचरम् ।
तत्पदं दर्शितं येन तस्मै श्रीगुरवे नमः ॥

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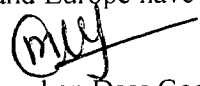
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-Manmohan Dass Goel

ABSTRACT

In the recent years due to increased fanatic activities, structures are exposed to threats from blast induced loads. Several such incidences have taken place around the world causing serious threat to life and property. Therefore, in addition to the strategically important and heritage structures, even public structures, important commercial buildings and complexes are required to be designed for blast resistance. Lightweight materials have shown their potential in energy management particularly under crash and impact. Therefore, it is essential to investigate the response of structures subjected to blast and to study their response using lightweight materials.

An explosion in air releases energy rapidly which generates a pressure wave of finite amplitude. This energy moves forward in air with a front and physical properties of air cause the front to shock up or steepens as it progresses further. This shock front moves supersonically with discontinuity in pressure, density and particle velocity across the front and results in the formation of a blast wave. After the explosion occurs, the ambient pressure increases almost instantaneously and begins to decay exponentially. An ideal blast wave representation and its characteristics are functions of the distance to the center of the charge and the time which governs the loading experienced by the structure exposed to the blast.

Herein, the conventional materials, sand and steel are studied for their comparative response under blast. The two varieties of foams, namely polymeric and metal foams, have diverse applications and have been explored in the present investigation for their effectiveness in blast response mitigation. To use metal foam efficiently in such applications, their characterization in terms of dynamic properties is carried out at higher strain rates using split Hopkinson pressure bar (SHPB). Experimentally investigated deformation behavior of aluminum foam at different strain rates ranging from quasi-static to high strain rates is reported for their strain rate sensitivity. Response of stiffened sandwich structures is then studied in terms of peak central point displacement against different blast loading.

In order to develop an effective protection/ mitigation system against blast, it is important to understand the mechanism of interaction of shock waves with materials used for this purpose. The shock attenuation/ or enhancement capability of low density metal foam is studied experimentally by exposing it to shock wave loading. The experimental results provided understanding of the performance and mechanisms of shock attenuation/ enhancement for metal foam under shock loading.

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