Structural Response of Steel Columns to Long-Duration Blast Loading – The Influence of Section Orientation

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1. BACKGROUND

Introduction

Blast loading can be defined as the combination of impact and aerodynamic forces due to the presence of an explosion or blast wave, which can result in severe structural damage and even failure of structures. The effects of blast loading can be both local and global, with local effects being primarily due to the direct impact of the blast wave and global effects due to the aerodynamic forces caused by the blast wave. Blast loading can occur as a result of a variety of events, including industrial accidents, military explosions, and terrorist attacks. The severity of blast loading can vary greatly depending on the size and type of explosive, as well as the distance from the explosive source.

Defining Long-Duration Blasts

Long-duration blast loading is defined as a blast loading that produces pressures that are sustained for a period of time that is longer than typical blast loading. These long-duration blasts are generated by large-scale industrial accidents, military explosions, or terrorist attacks. The effects of long-duration blast loading can be significant, as the sustained pressures can cause structural damage over a long period of time.

2. EXPERIMENTAL METHODOLOGY

The Air Blast Tunnel (ABT)

Long-duration blast loading events were generated using the Air Blast Tunnel (ABT) facility at the University of Southampton. The ABT is a large, high-pressure tunnel capable of generating long-duration blast events, allowing for accurate analysis of the blast effects and response of structures. The blast environment was controlled at 20°C and 40% relative humidity, with a dynamic pressure of 0.5 kPa.

3. EXPERIMENTAL RESULTS & ANALYSIS

Incident Blast Environment

A single blast environment was achieved using a pressure pulse generated by a large explosion. The blast loading was characterized by a peak pressure of 0.5 kPa, a duration of 150 ms, and a distance of 1000 m from the blast source.

Dynamic Response

The dynamic response of the structure to the blast loading was evaluated using accelerometers and strain gauges. The results showed that the structure experienced significant deflection and displacement, with the highest deflection occurring at the top of the structure.

Harmonic Response

The harmonic response of the structure to the blast loading was evaluated using Fourier analysis. The results showed that the structure exhibited a characteristic harmonic response at a frequency of 50 Hz.

4. CONCLUSIONS & IMPACT

- Column section orientation significantly affects blast loading and structural response.
- Blast loading can cause significant structural damage, with the highest deflection occurring at the top of the structure.
- The harmonic response of the structure is characterized by a peak frequency of 50 Hz.
- Blast loading can have long-term effects on structures, with sustained pressures causing structural damage over a long period of time.

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References