Energy Absorbing Connectors for Blast Resistant Design

Charles Oswald, Marlon Bazan

Protection Engineering Consultants, San Antonio, TX, USA

Contact: coswald@protection-consultants.com

Abstract

Structural components are typically designed to resist blast loads with rigid connections. An innovative approach for blast design is to support blast-loaded cladding components on a building with energy absorbing connections (EACs), which deform as they resist the dynamic reaction load from the component. The EACs and the structural component both deform dynamically to absorb the energy applied by the blast load. The EACs can limit the peak dynamic reaction load transmitted into the supporting structure and reduce the damage to the supported component compared to a traditional rigid support if they are designed optimally, as a system accounting for their interactive responses. This paper will discuss static and dynamic testing that has been conducted on steel and aluminium honeycomb EACs and a simplified dynamic design approach for the EACs and the supported component.

Keywords: energy absorbing connections, blast loads

1 Introduction

This paper discusses the ongoing development of energy absorbing connectors (EACs) for building facades, specifically precast and curtain wall façades, on buildings subject to blast loads from possible terrorist attacks. These types of façades are usually placed outside the building floor slabs with a typical offset dimension of 2 inches. The EACs will be placed between the façade and the floor slabs in an increased lateral offset distance equal to the EAC height (i.e. dimension of EAC in the direction it deflects) of 4 to 6 inches, so that the EACs act as flexible connections for the façade components. The façade response to blast load will initially put the EAC in compression (i.e. reducing its height), and then rebound of the façade components will put the EAC into tension. The EACs will be attached to the façade and floor slab with positive connections that resist inward and outward lateral movement of the façade. A concept for installing EACs in a building is shown in Figure 1.

The EACs absorb energy from the applied blast load by yielding ductilely as they respond to the dynamic reaction load applied by the supported façade component with a controlled, nearly constant, resisting load out to a large strain. The absorbed energy is equal to the EAC yield load multiplied by its deflection. The blast-loaded façade component supported by the EACs is also designed to yield in flexure and absorb energy, so that both the EACs and supported component are designed as a system to absorb the energy applied by the blast load. If this system is optimized, the façade component can be designed with a lower strength than if it had traditional rigid supports, since it does not need to resist all the applied blast energy. Also, the yield load of the EACs can be designed to transmit a lower maximum reaction load into the supporting structure than a rigid connection. This advantage of EACs can be most important

https://doi.org/10.2749/vancouver.2017.0462
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