Refurbishing, Strengthening and Retrofitting Façades to Increase Seismic Resistance

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Abstract

Recent events have shown that existing, older buildings often lack sufficient seismic resistance. Façade collapse is particularly concerning as falling components can cause personal injury and block escape and emergency access routes. The 2020 earthquakes in Croatia highlighted these issues and caused considerable damage to thousands of buildings, a high proportion of which were either old or poorly preserved and located in Zagreb's historic centre. Due to the cultural importance of historic buildings, when restoring or improving the static load-bearing capacity, suitable and aesthetically sympathetic repair methods should be used. This paper presents methods for the repair of existing façades which can be used to preserve the historic building fabric and strengthen the façade structure with the aim of meeting seismic design requirements. An alternative to large shake table tests is described, the technical background is explained and test results are presented.

Keywords: seismic retrofitting, façade systems; non-structural elements, testing methods, heritage.

1 Introduction

The most obvious function of a building façade is to enhance the appearance of a building, however it also protects the inner structure and occupants from adverse weather such as wind and rain. In addition to this, a façade can improve the physical properties of a building by providing an open cavity space for ventilation and an insulation layer for thermal benefits.

An integral part of this construction are the façade fixings which are required to transfer loads back to the structure – both the dead load from the façade itself and any imposed loads such as wind or seismically-induced loads. It is important that the fixings transfer the load back safely and efficiently and in such a manner as to maintain the clear cavity between external and internal leaves. Where 'heavy' façades are concerned i.e. façades with a dead load of more than 100kg/m^2 (brickwork or natural stone for example), the façade fixings are required to transfer high point loads back to the structure, sometimes over large distances between the outer and inner layers.

Façades and façade fixings are classified as non-load bearing components in the current seismic design standards [2]. Defined as masses without any inherent stiffness and attached to the load bearing structure, static equivalent horizontal loads acting in the most unfavourable direction can be used to design for the seismic load case.

Earthquakes often inflict minor damage, such as hairline cracking, to building façades but the