Seismic design for suspended ceilings

Suspended ceilings fared poorly in recent earthquakes. In response, the relevant standard was revised, and there are stringent design and installation requirements to prevent collapse in a 1-in-500-year event.

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AMENDMENTS TO NZS 1170.5:2004 *Structural design actions - Part 5: Earthquake actions - New Zealand* came into effect in September 2016. These changes have a significant influence on the design and installation of all suspended ceilings.

NZS 1170.5:2004 is the design actions standard cited by Verification Method B1/VM1 to New Zealand Building Code clause B1 *Structure*. Following this standard means an installed ceiling complies with the Building Code and will help safeguard people from injury or fatalities caused by structural failure.

Confusion with previous standard

Before the amendment, there was confusion around seismic design requirements for ceilings, particularly selecting the appropriate part category to apply. This was especially a problem with tile and grid suspended ceilings.

Some argued that ceilings made up of parts that weighed less than 10 kg and that were less than 3 m above floor level could be classified as part category P7. P7 only requires design to a serviceability limit state.

By considering only the weight and fall height of individual components, rather than the total weight of the ceiling system, ceilings were not designed for much larger ultimate limit state events.

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Serviceability or ultimate limit state?

Serviceability limit state requires design for no or minimal damage during a 1-in-25-year earthquake, whereas ultimate limit state requires design to a level to prevent collapse during a 1-in-500-year event. For buildings of a higher importance level, ➤

the requirement increases to a 1-in-2,500-year event. Clearly, the choice between serviceability and ultimate limit states has an enormous effect on the resulting seismic design.

Supporting commentary in the updated standard acknowledges the previous vagueness. '[Designing suspended ceilings to serviceability limit state] is not the intent of the standard and it is recognised that some of the previous standard and commentary provisions may have contributed to this by not having been expressed clearly enough.'

Threshold now 7.5 kg for whole ceiling system

The new standard lowers the weight threshold for ultimate limit state design to 7.5 kg and makes it clear that the total weight of the ceiling system needs to be considered - tiles, grid, luminaires and any other supported services.

It is no longer possible to define ceilings as P7 (and requiring design to serviceability design state) simply because the weight of the individual components is below 7.5 kg - the overall system needs to be considered for the design.

Given the performance of suspended ceilings in earthquakes over the past 7 years, these clarifications are required. Collapsing ceilings can injure occupants and interfere with evacuation and reoccupation of a building.

What are part categories?

A system is assigned a part category according to its potential to cause death or injury or its importance for the continued functioning of the building or if the consequential damage is high.

Part categories P1, P2 and P3 apply where the system represents a hazard to human life. The ultimate limit state is used for their design.

A part is considered a hazard to human life if it:

Design all future suspended ceilings for ultimate limit state events.

- weighs 7.5 kg or more, regardless of from what height it falls
- can fall more than 3 m, regardless of weight.

Clearly, a suspended ceiling system as a whole is not exempt and needs to be designed to ultimate limit state.

Design right

Most reputable New Zealand ceiling grid manufacturers and suppliers will have a seismic calculator to assist with seismic restraint requirements or will be able to assist with a compliant ceiling design.

Many building consent authorities are now also requiring producer statements from a qualified professional to sign off on a design. Sign-off after completion is also needed.

Design ceilings for ultimate limit state events

The most important requirement is to design all future ceilings for ultimate limit state events. This applies to everyone - architects, designers, contractors and installers - for both consented and non-consented work.