

CROSS Safety Report

Alterations to spine wall and joists result in structural issues

This month's report details the structural damage in a listed building after alterations that involved moving a spine wall and notching timber joists.

Reporter's submission

The reporter, an experienced structural engineer, explains that they were asked to advise on structural movement in a multiple storey listed historic building that had been converted into residential apartments.

The building had a traditional arrangement with long-span continuous timber joists spanning from front to back at each floor and a central spine wall providing support to the floors and the wall above.

The issue arose after alterations were made to a first-floor flat. According to the reporter, the architect's design involved moving the loadbearing spine wall by around 300mm and notching timber floor joists by approx. 75mm to accommodate a soil pipe for a new bathroom (Figure 1).

The reporter highlights that the project's structural engineer designed steel plates to reinforce the joists at the notches. However, the engineer did not carry out an overall check of the joists for the increased bending

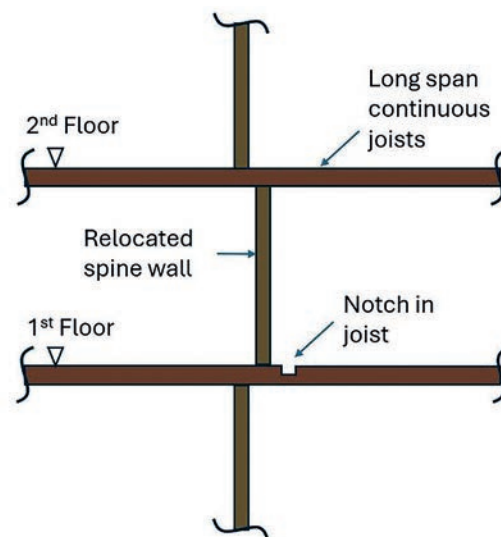
moments, nor did they calculate deflections or verify the adequacy of the screws connecting the plates to the joists.

The floor was opened up in several places, the reporter continues, and it was found that the steel plates were missing at those locations (Figure 2).

Following the works, the reporter states the first- and second-floor joists deflected. This caused doors in the upper-ground-floor flat to jam and cracks to appear at the second-, third-, and fourth-floor levels. The reporter's calculations indicated that the joists could be overstressed locally at the notches by factors of up to two.

As far as the reporter is aware, the situation remains unresolved.

The full CROSS Safety Report, including links to guidance mentioned, is available on the CROSS website (report ID: 1511) at www.cross-safety.org/uk/safety-information/cross-safety-report/alterations-spine-wall-and-joists-result-1511.



➤ FIGURE 1: Indicative cross-section showing relocated spine wall and notched joist



➤ FIGURE 2: Soil pipe passing through notched and unreinforced floor joist

Key learning outcomes

For civil and structural design engineers:

- ➔ Establish and assess the whole building load path before undertaking any alterations or design
- ➔ The relocation of loadbearing spine walls is a significant structural intervention which requires oversight from suitably qualified and experienced personnel during design and execution
- ➔ Steel plate strengthening to notched timber joists is likely to require the plate to extend well beyond the notch, and fixings in over-sized holes will not engage until the joist has deflected
- ➔ Advise the client of the significance of any structural intervention and the need for inspection during the construction phase



THE DESIGN OF ALTERATIONS TO EXISTING BUILDINGS SHOULD BE COLLABORATIVE, WITH ALL PARTIES WORKING WITHIN THE CONSTRAINTS OF THE STRUCTURE

Expert Panel comments

The works described by the reporter are major structural interventions to the building. Moving a loadbearing spine wall and notching continuous timber joists are significant changes that require thorough design, verification and implementation, and the observed structural movement indicates clear shortcomings in these areas.

Relocating the spine wall alters load paths and increases both bending and shear demands on the joists. Capacity should be established not only at the notch but also at the supports and across the span. There should be an overall understanding of how the structure carries load to ground before substantial alterations proceed.

Where joists are notched, any strengthening must be properly designed and verified, including the fixings. Plates that do not have adequately designed screw connections, or that are not installed,

provide no effective reinforcement. In aged timber, variability in knots, shakes and twists demands conservative design and site checking, and any plates should extend well beyond the notch to be effective. Fixings within clearance holes will not carry load until the joist has deflected.

Primary structural interventions in existing buildings should be accompanied by regular inspections by the structural engineer. Deviations on site can compromise performance and the Expert Panel stresses the importance of verifying that proposals are implemented as designed, although it notes the inadequacy of the original design in this case described by the reporter.

Short-term stability or minor movement is not a guarantee of long-term performance in timber. Allowable timber stresses over short durations can be much higher than long-term values, so early indications of

movement should be regarded as warning signs of potentially worse outcomes if left unresolved. Additional steelwork may be required to restore adequate capacity.

The design of alterations to existing buildings should be collaborative, with all parties working within the constraints of the structure. The Expert Panel emphasises the need for suitably qualified and experienced structural engineers and contractors, and for the structural engineer to challenge proposals that do not align with the behaviour of the existing fabric.

A recurring theme of CROSS Safety Reports is the need for a clear understanding of the overall structural behaviour of a building, rather than focusing on isolated elements. The Expert Panel notes there is lack of clarity over who is responsible for ensuring incremental renovation over time does not lead to unsafe outcomes.

What is CROSS?

Collaborative Reporting for Safer Structures (CROSS) helps professionals to make structures safer by publishing safety information based on the reports it receives and information in the public domain.

CROSS operates internationally in the UK, US, and Australasia. All regions cover structural safety, while CROSS-UK also covers fire safety.



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