Design to Minimize Damage from Explosion

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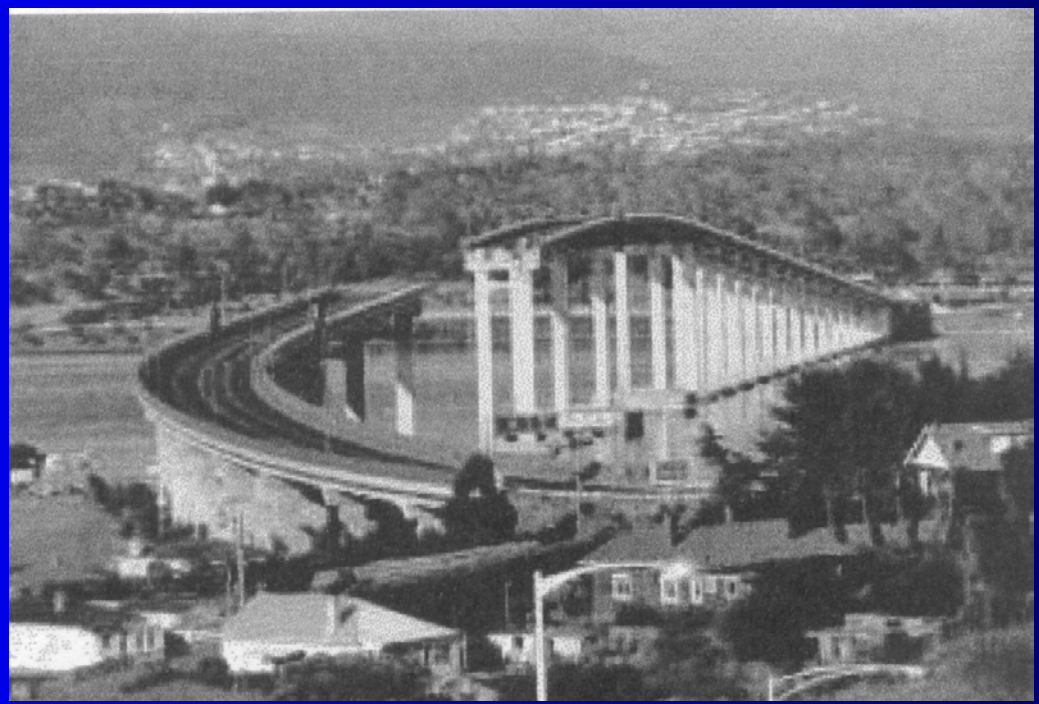
September 11th did bring home the realism that terrorism has on our daily lives

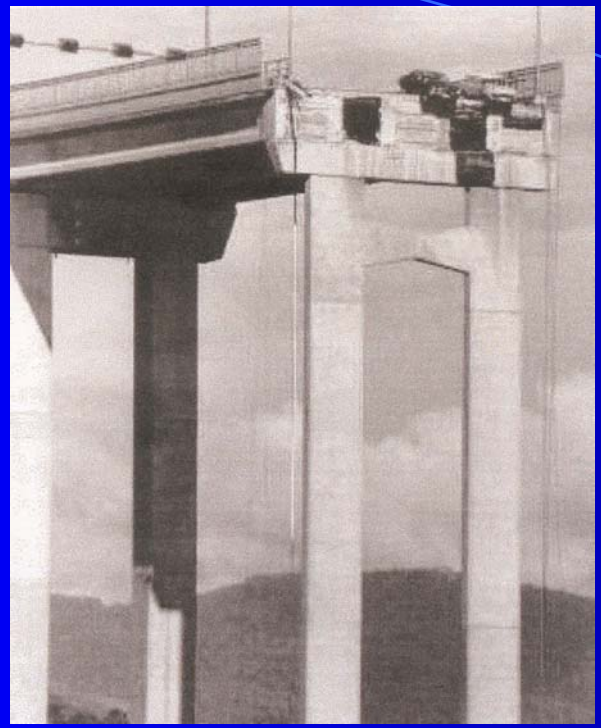
However not only are disasters caused by terrorists

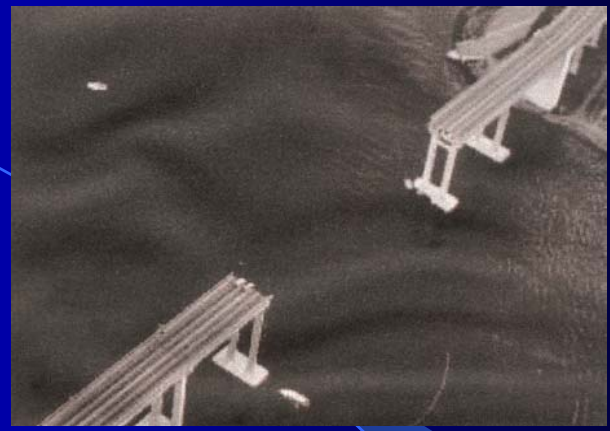
Gas explosions

Accidental impacts

A typical accidental impact damage was the Tasman Bridge in Hobart







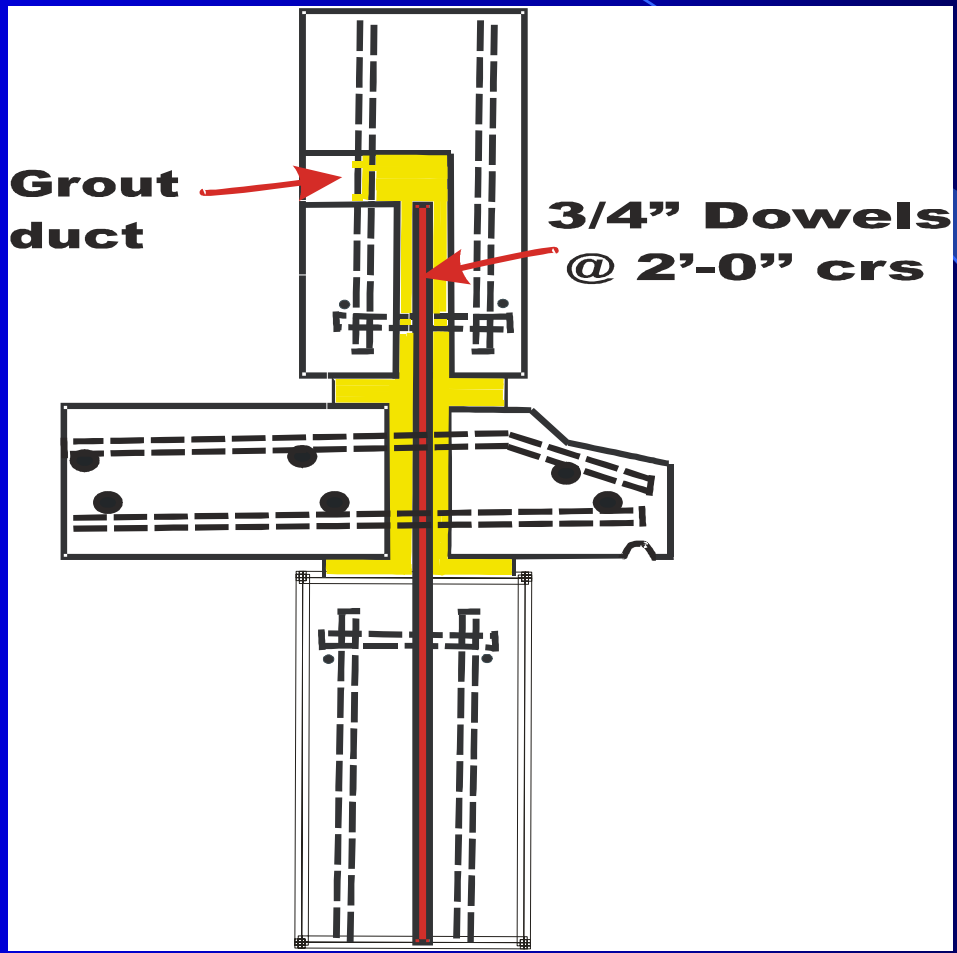
Result of Lake Illawarra impact

Gas explosion

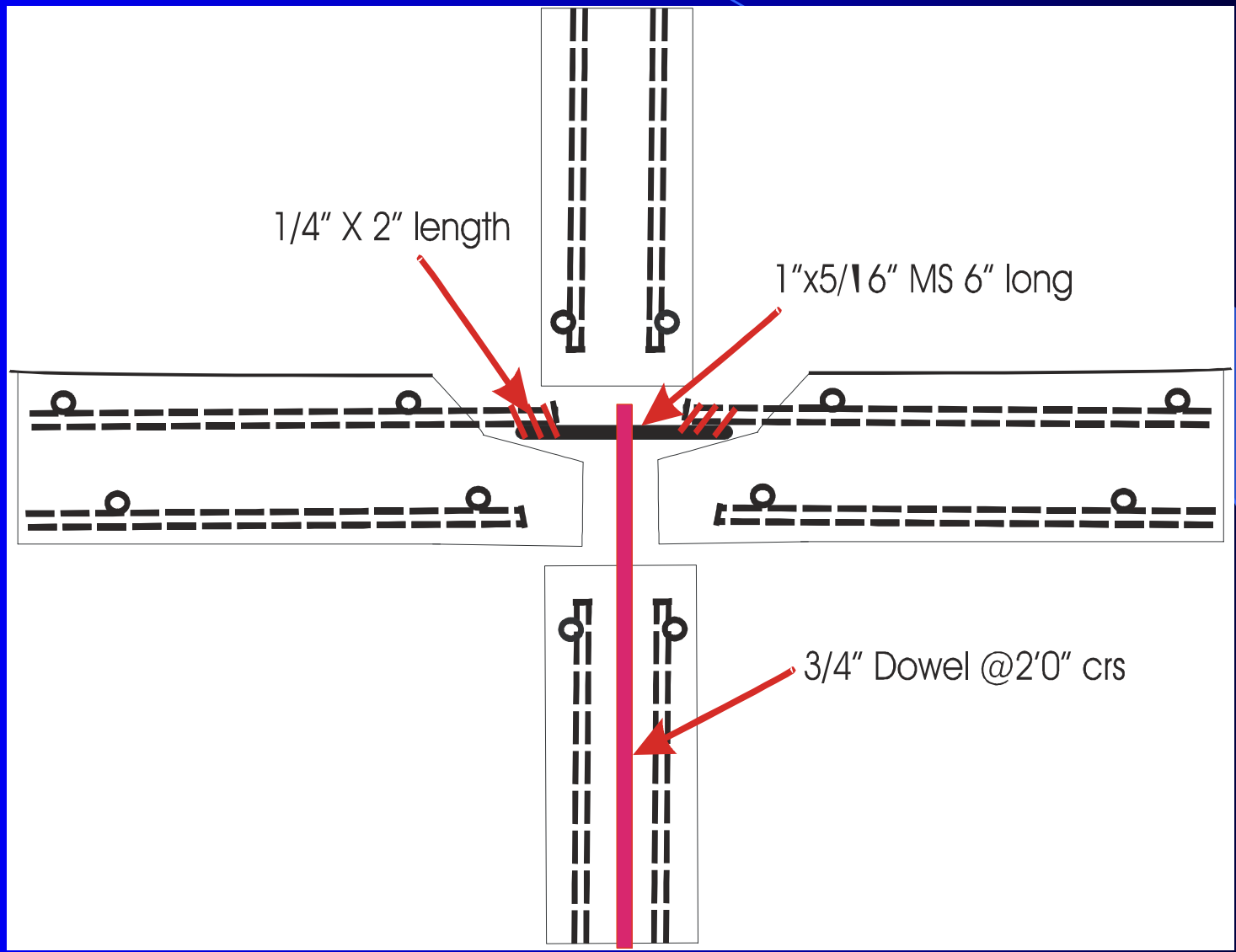
Ronan Point – 1968

CSIRO was contracted to study progressive collapse of precast government high-rise housing apartments

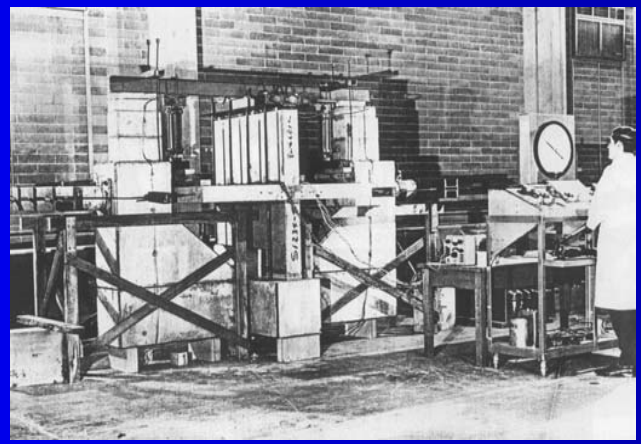
External wall joint detail



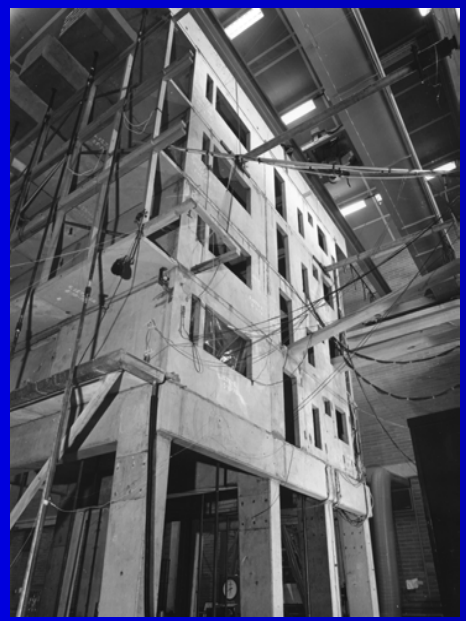
Internal wall joint detail



Two stages to test program



Full size joint tests

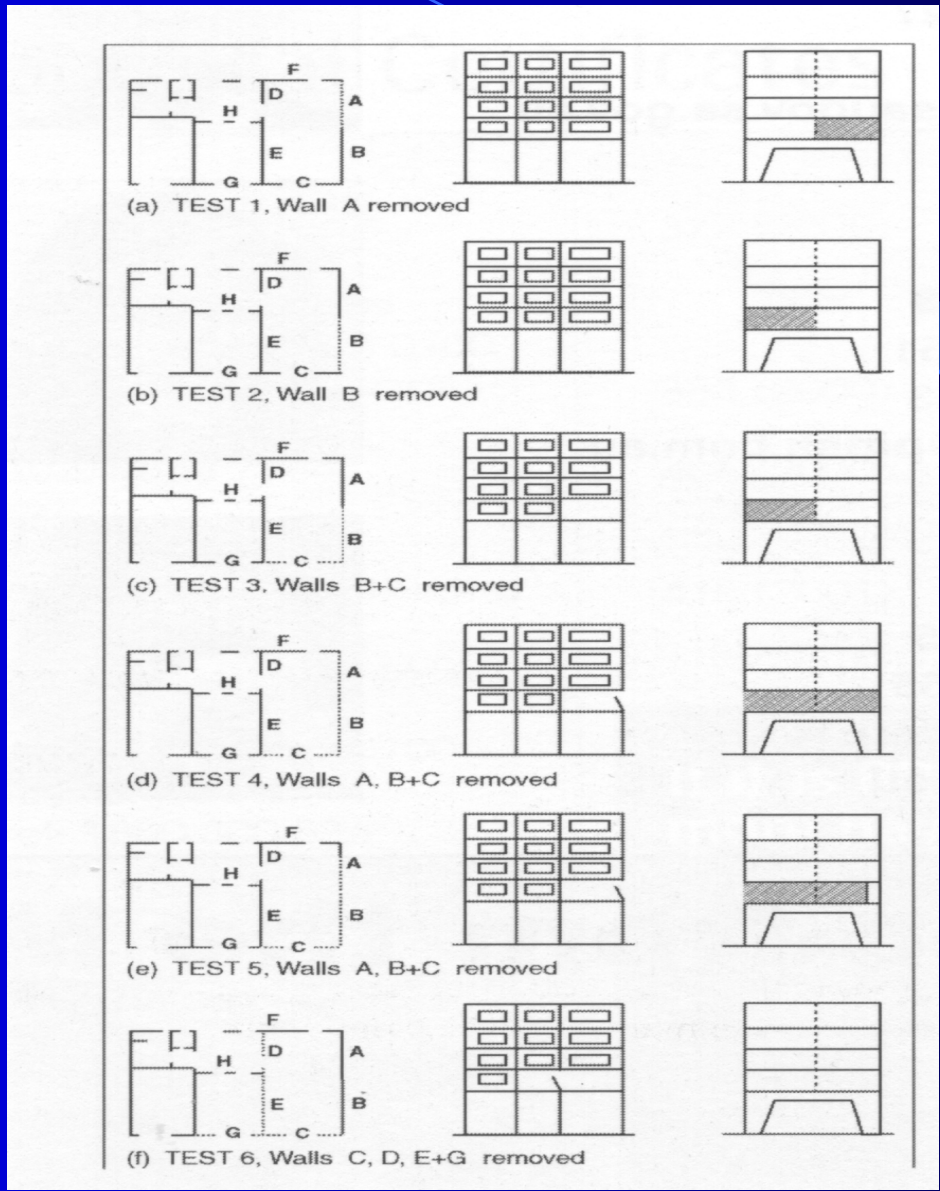


Half scale model

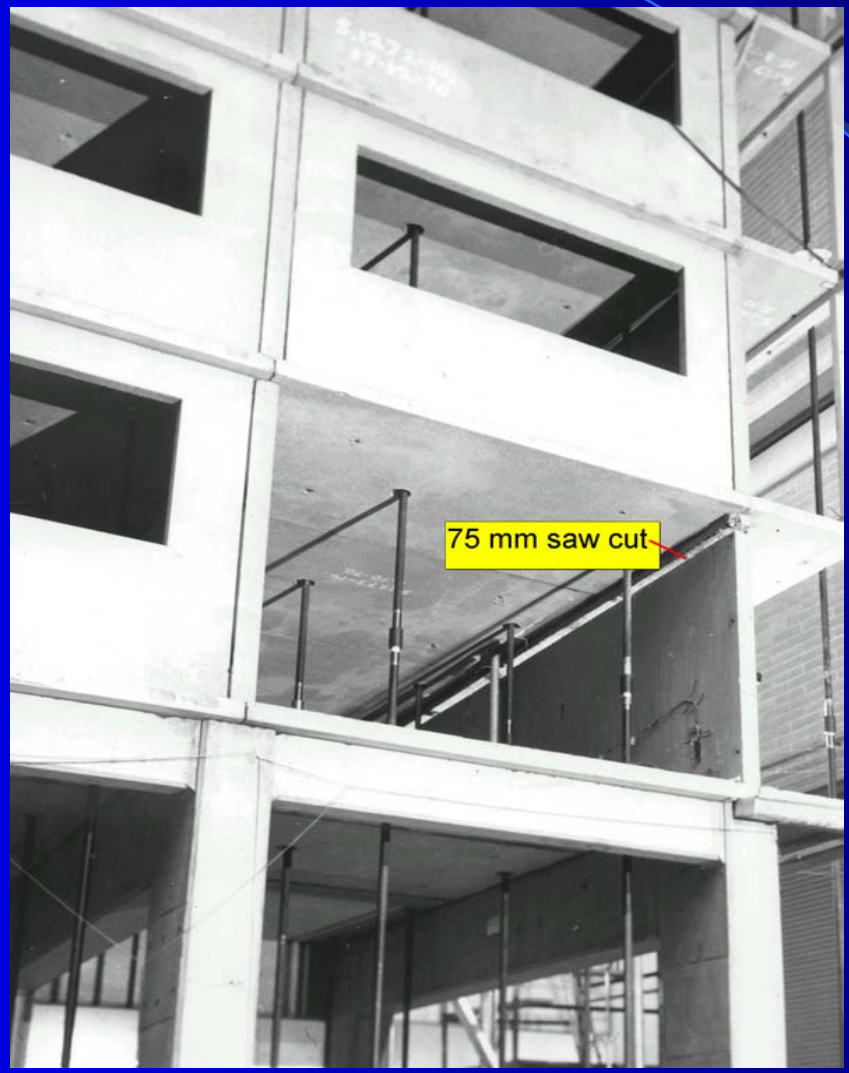
The fist stage showed joint strength to be adequate

Tested with simulated loads as if at top and bottom locations

Stage 2 – wall removal program for model

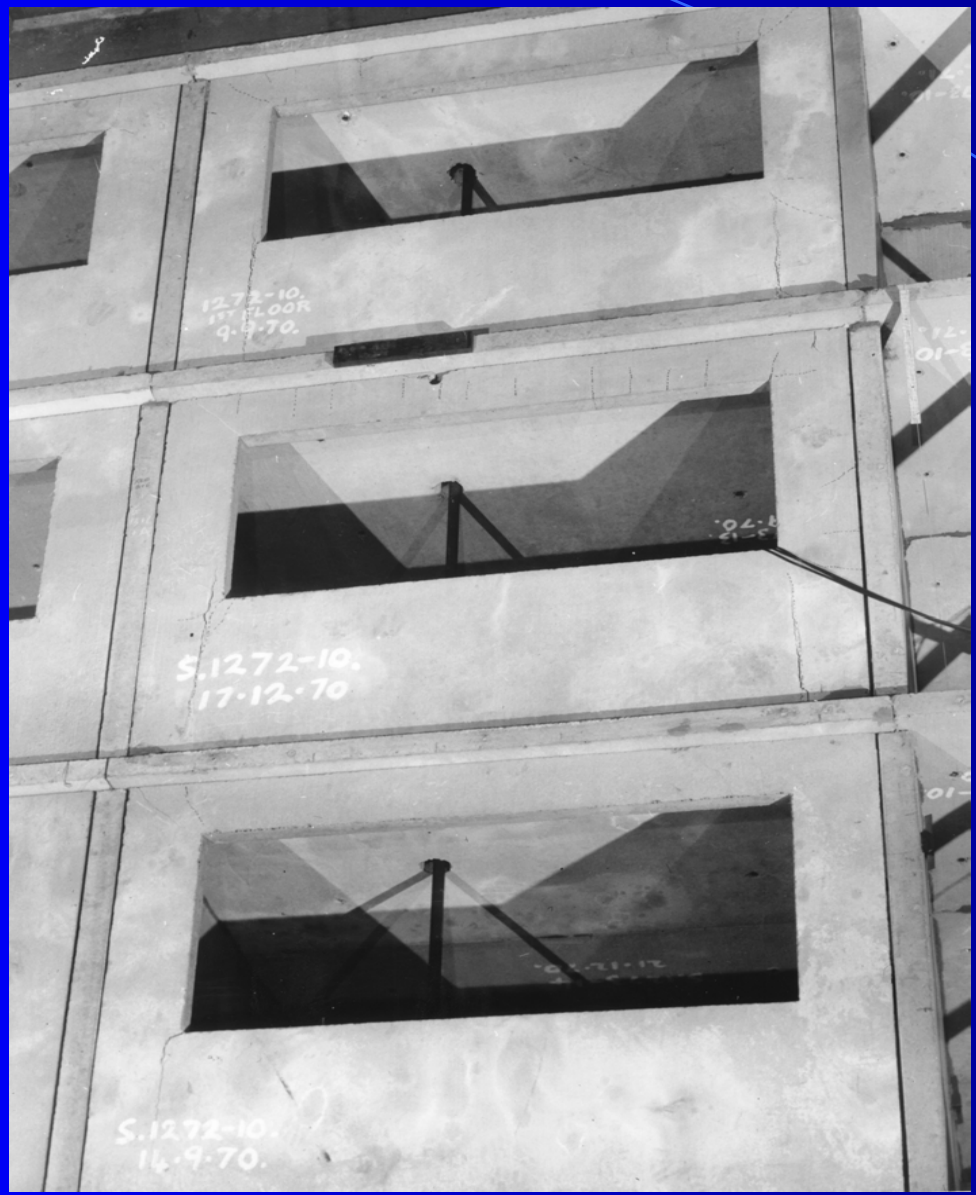


Test 4 – Walls A, B & C removed



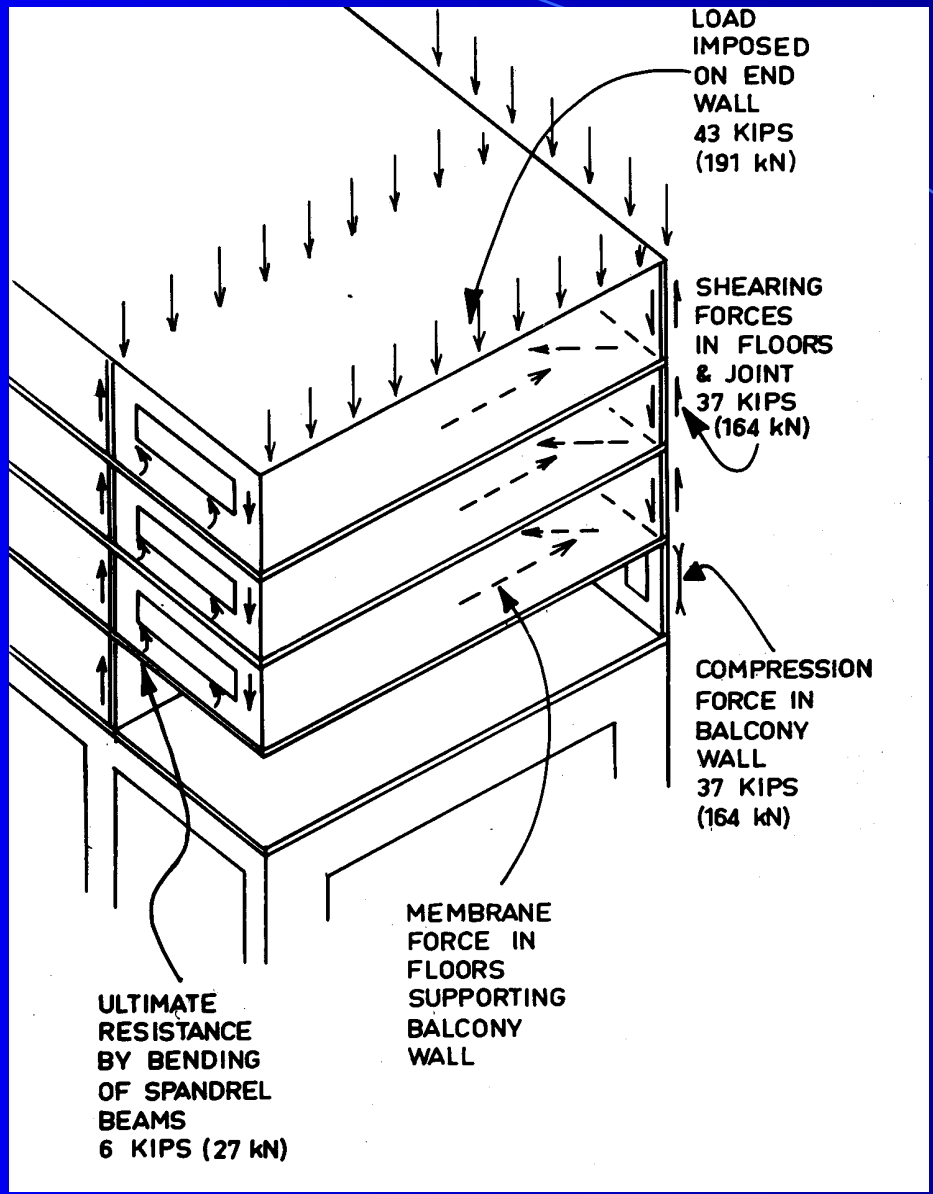
Test 4

Cracking in infill window walls



Shear failure in floor at Junction of walls A & F

Load transfer mechanism for Test 4



Shear failure occurred at 56% of target load

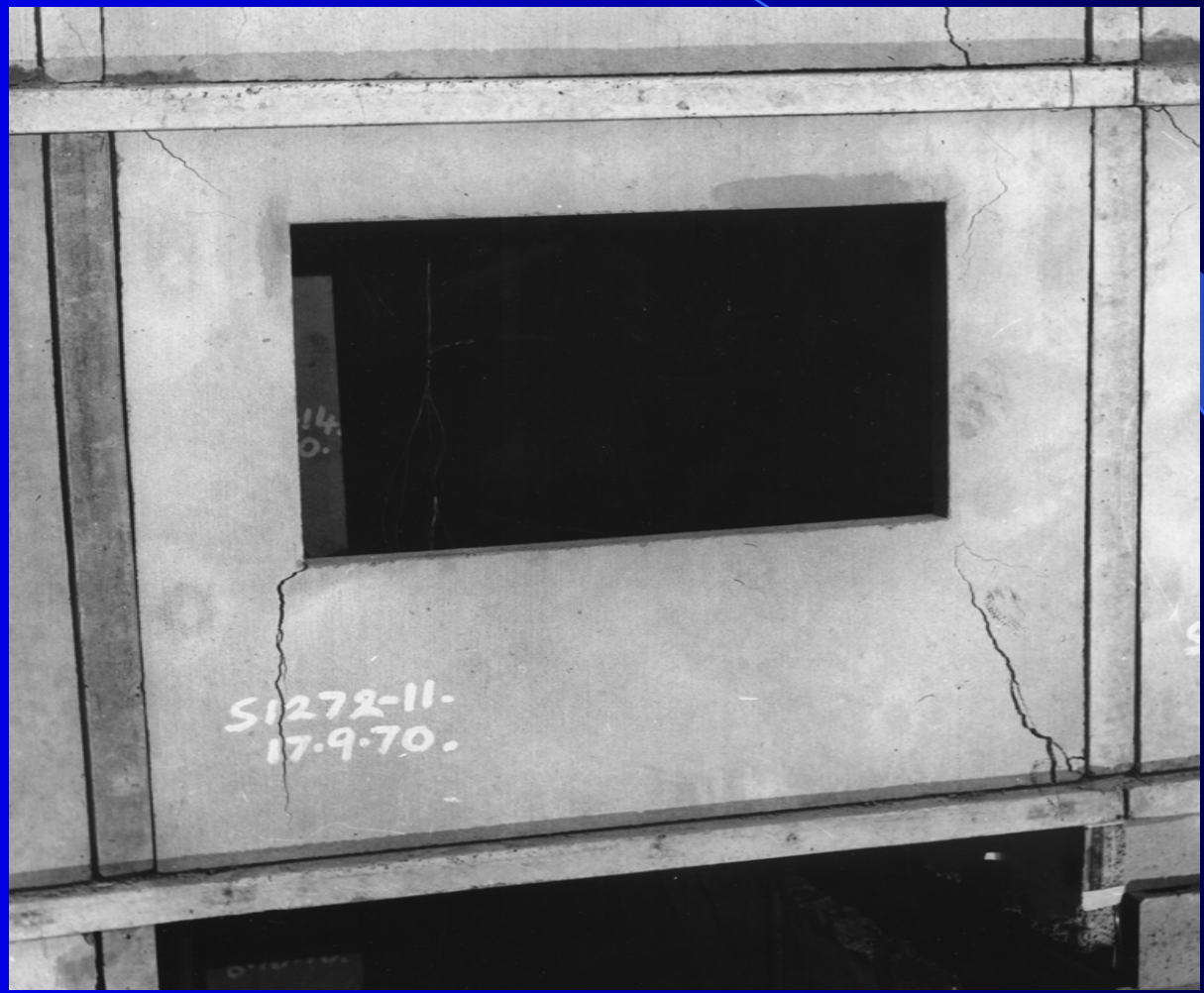
Model had only 3 floors contributing

Using calculations from stresses measured by strain gauges, the shear from only 7 floors would be required to resist the target load

Test 6 – Walls D, E, G, & C removed

Damage to walls C & G – Test 6

Most damaged wall G – Test 6



Maximum load for Test 6

Shear failure at 52% of target load

With full structure there would be 19 floors rather than 3 to resist in shear

Actual bomb damage to a block of flats

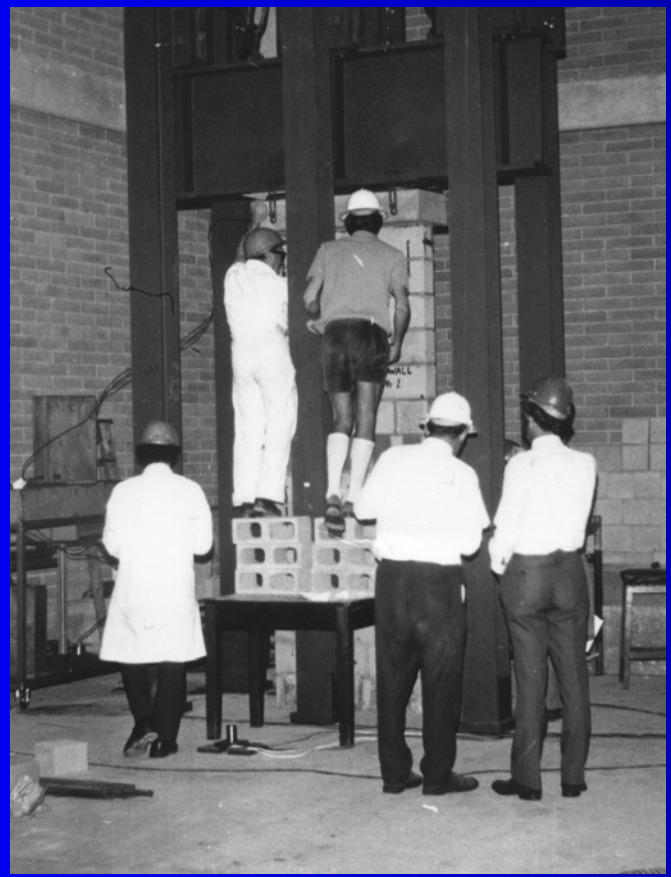
Things to be considered in resisting explosions:

Structural integrity against collapse

(sag but not collapse)

Minimize shrapnel by careful selection of materials used especially at street level

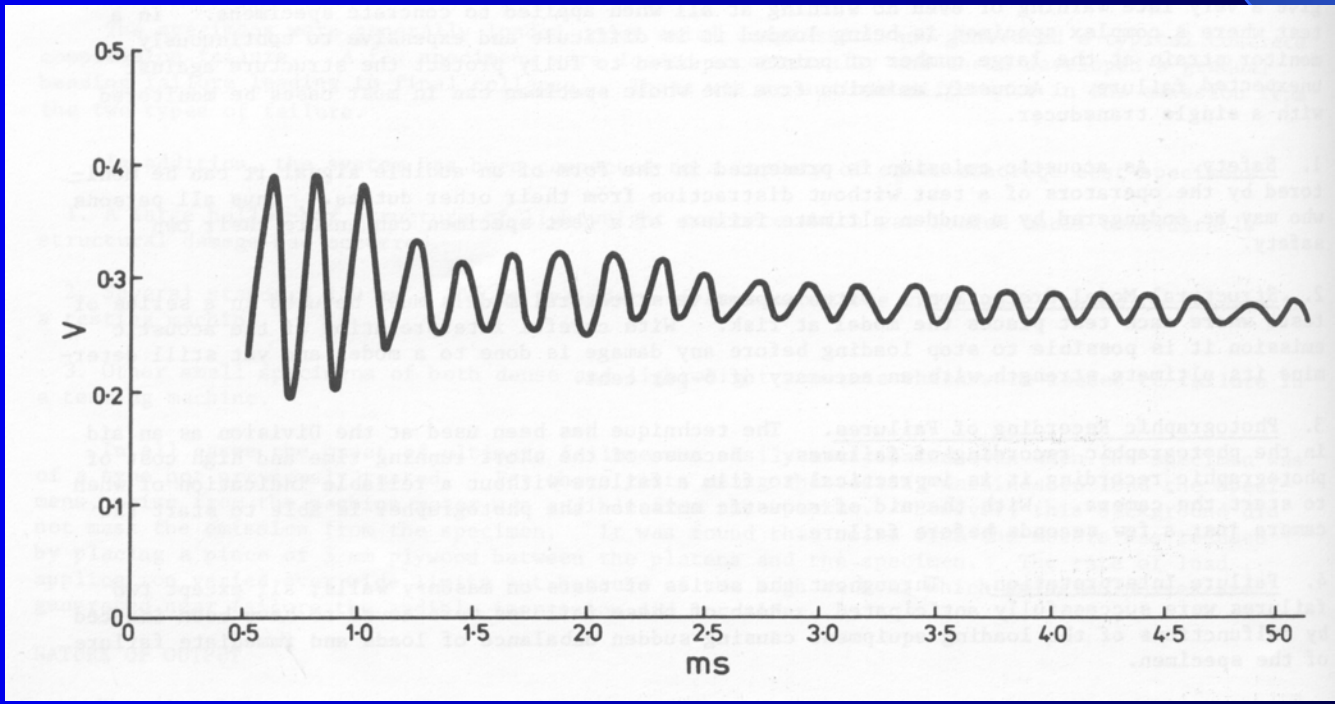
Acoustic Emission – to predict failure



Emission starts from about

75% of ultimate load

Firstly as individual impulses



Slowly increasing in frequency and intensity

Using the system given in the appendix of the paper the output is a continual roar giving a proactive warning that some failure is eminent

This method could be a useful tool to judge if a damaged building is safe

The position of the detector is not critical

For the model of the flats it was located on the far side of the failure and gave adequate warning of the failure

With experience can accurately predict failure from 85% of ultimate load

CONCLUSIONS

Buildings need to be designed to withstand removal of major structural elements

Care in selection of materials to minimize shrapnel – especially near street level

Acoustic emission can be a useful tool to determine safety of concrete structures