

Quick field report

Lorca earthquake 11th May 2011

Patrick Murphy Corella

Director of Architecture

Broadway Malyan

Calle Julián Camarillo 42, 4º

28037 Madrid

T (+34) 91 375 05 49

M(+34) 675 89 43 00

P.murphy@broadwaymalyan.com



BASIC EARTHQUAKE PARAMETERS

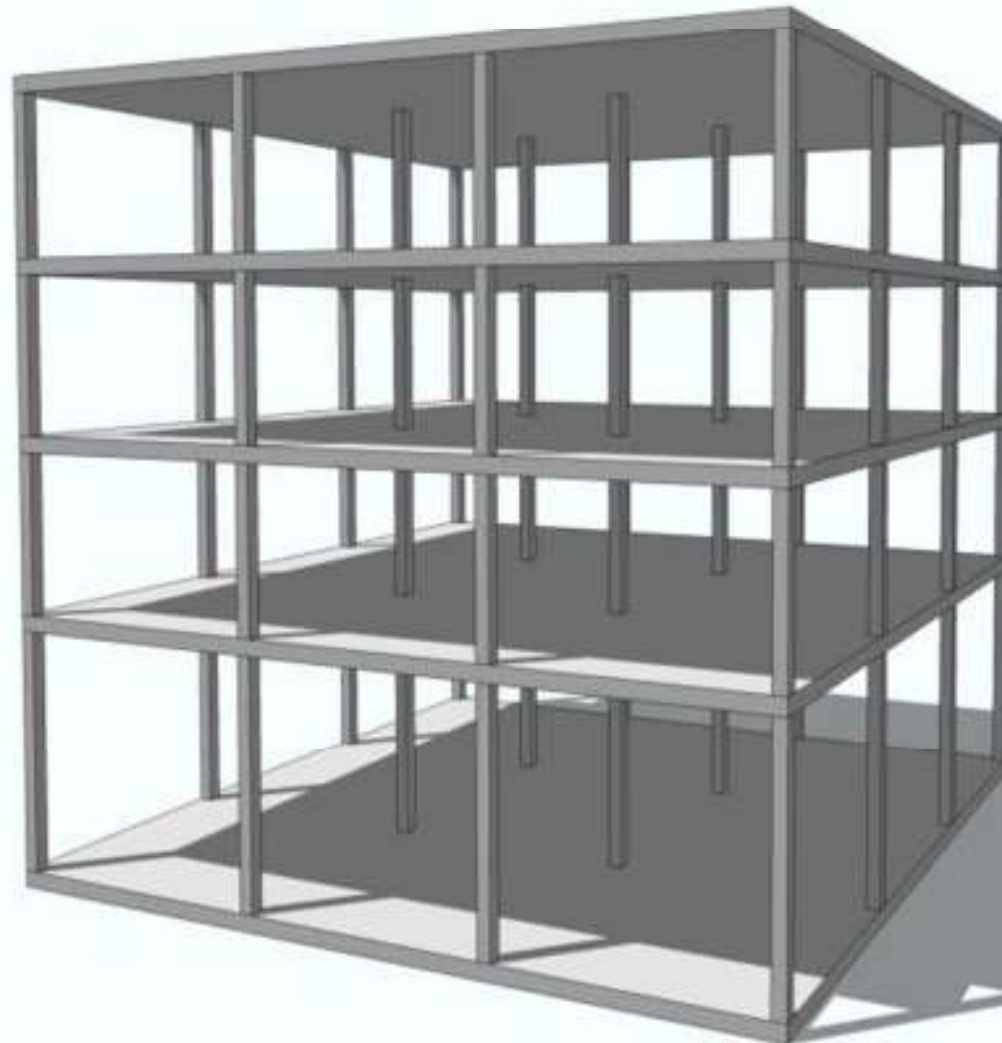
M_w 5,1 at 16:47 UTC 11th May 2011 N 37,69 W 1,67 very superficial focus



1

Summary of observed building performance

Standard dwelling building in Lorca



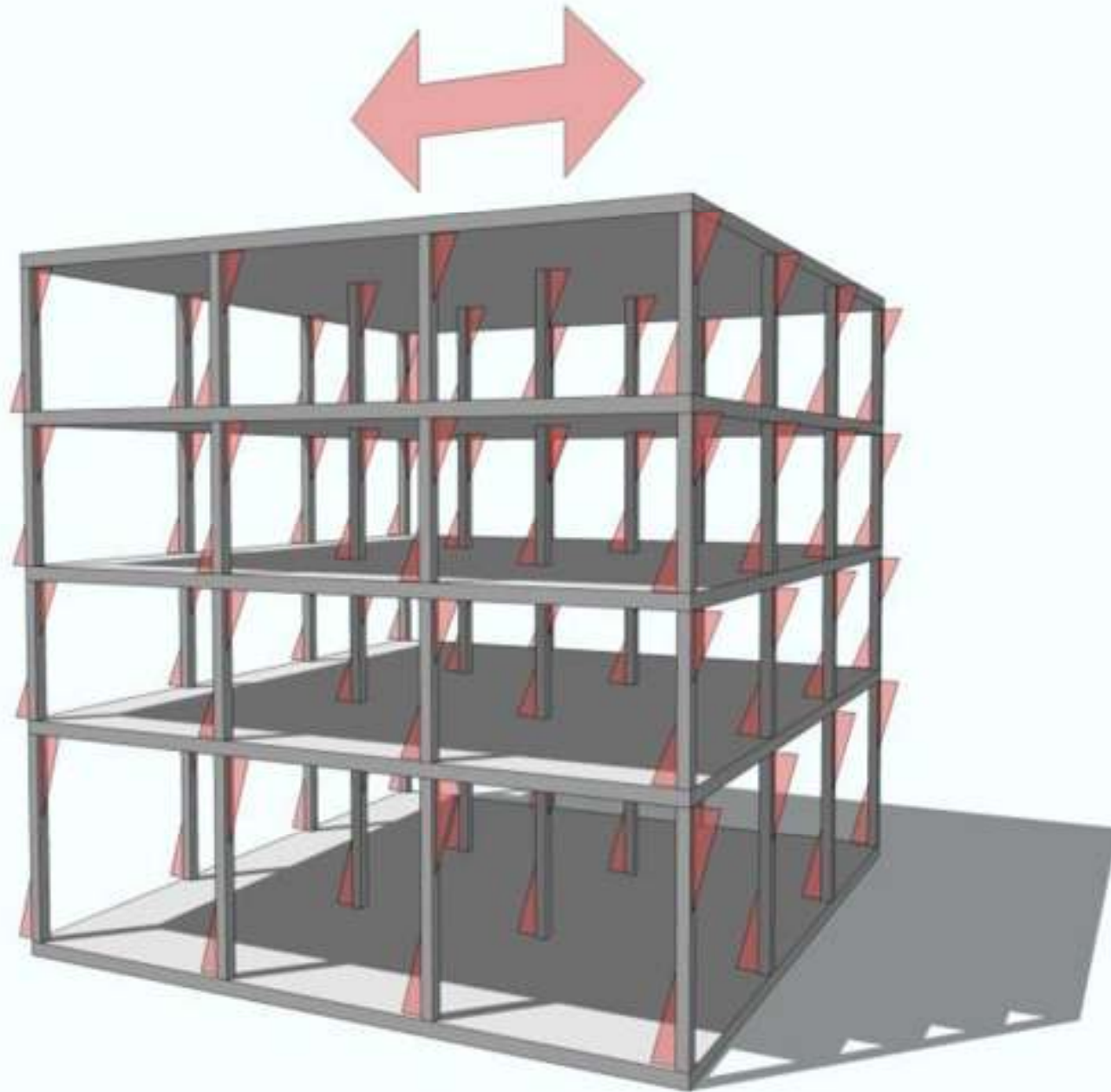
MRF moment frame

Flat slabs (no
beam downhangs)

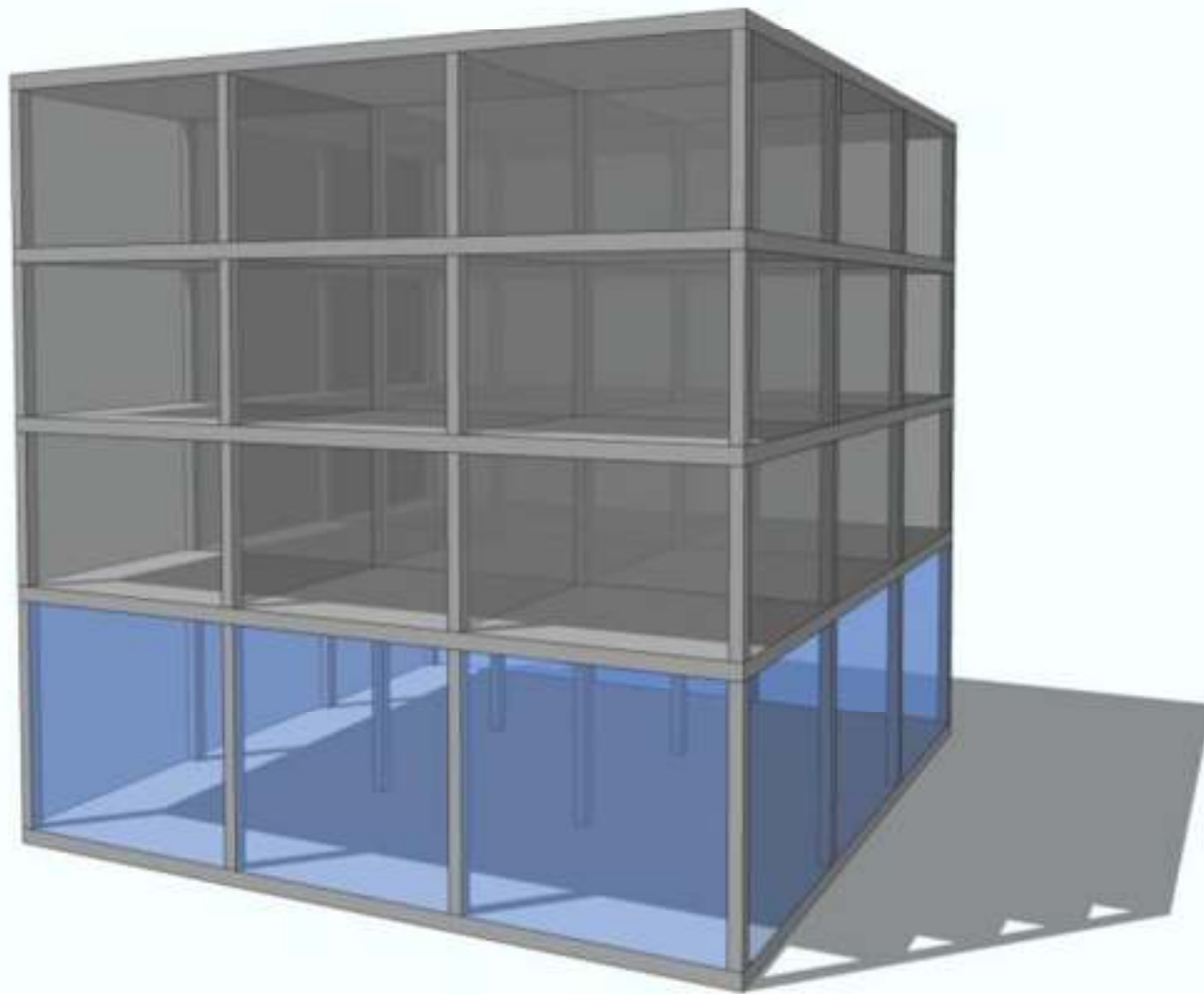
dwellings

Commercial use on
ground floor (higher
clear height by
municipal order)

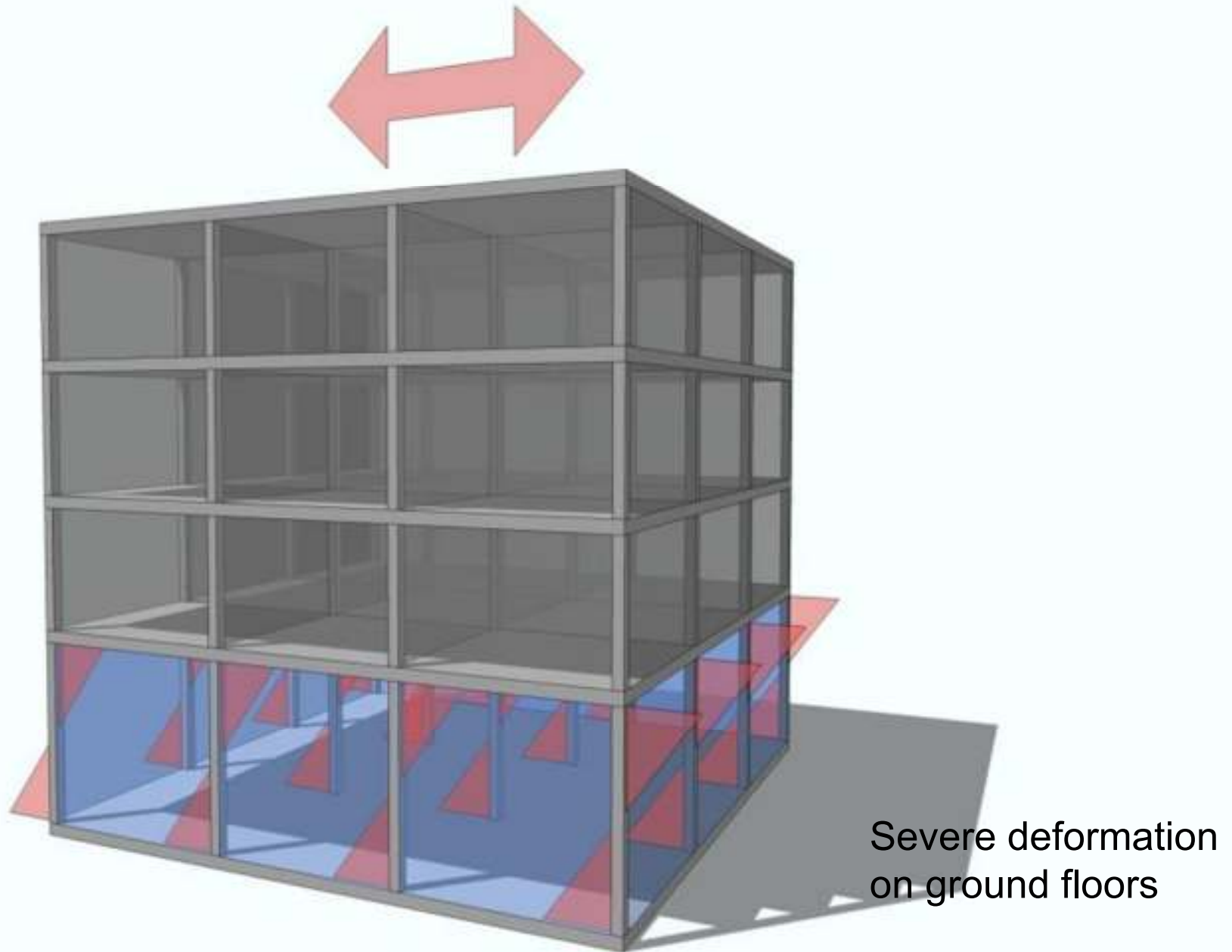
We assume it will perform like this...



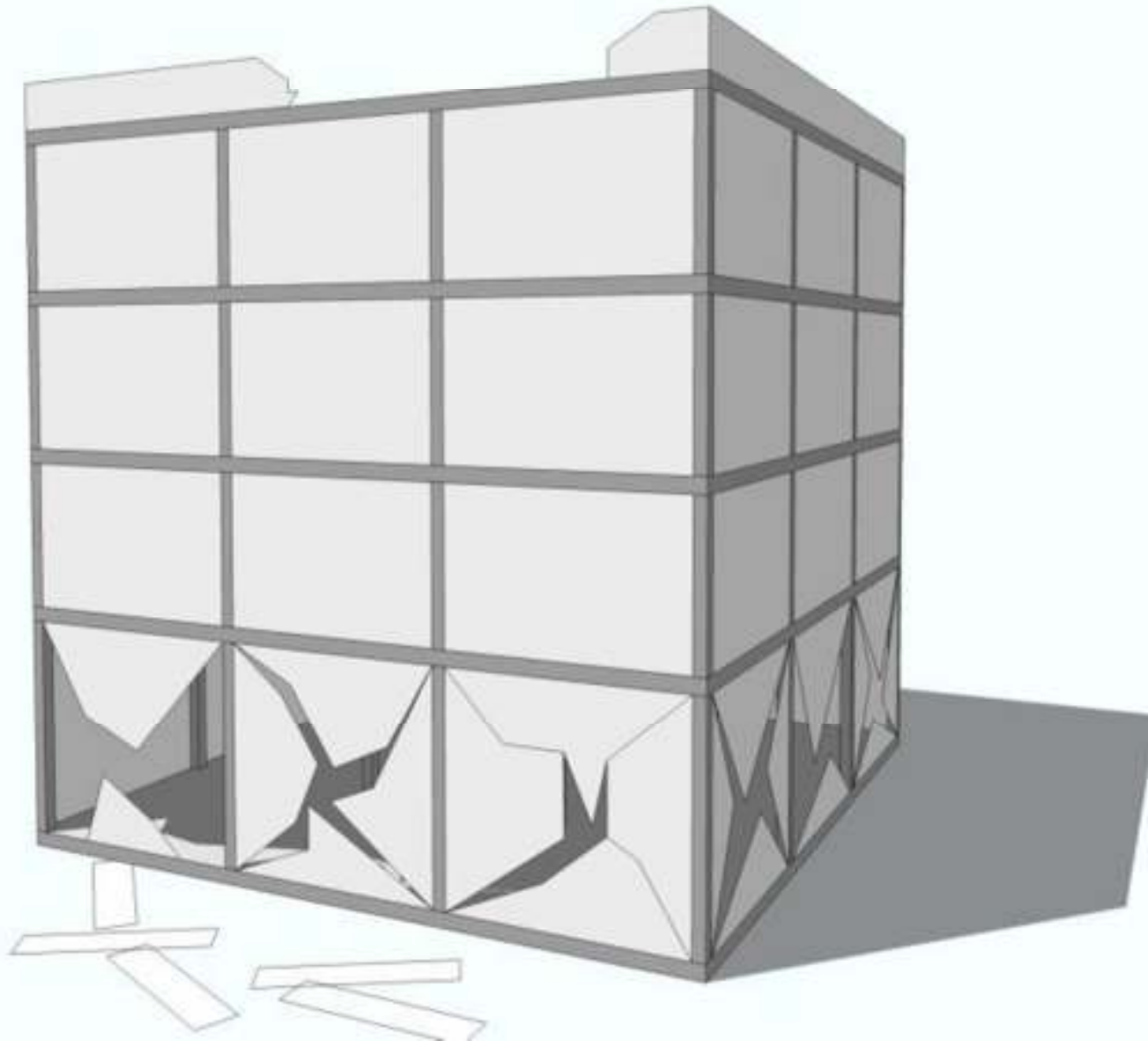
But it is conditioned by masonry infill panels and a soft ground floor...



And it behaves like this.

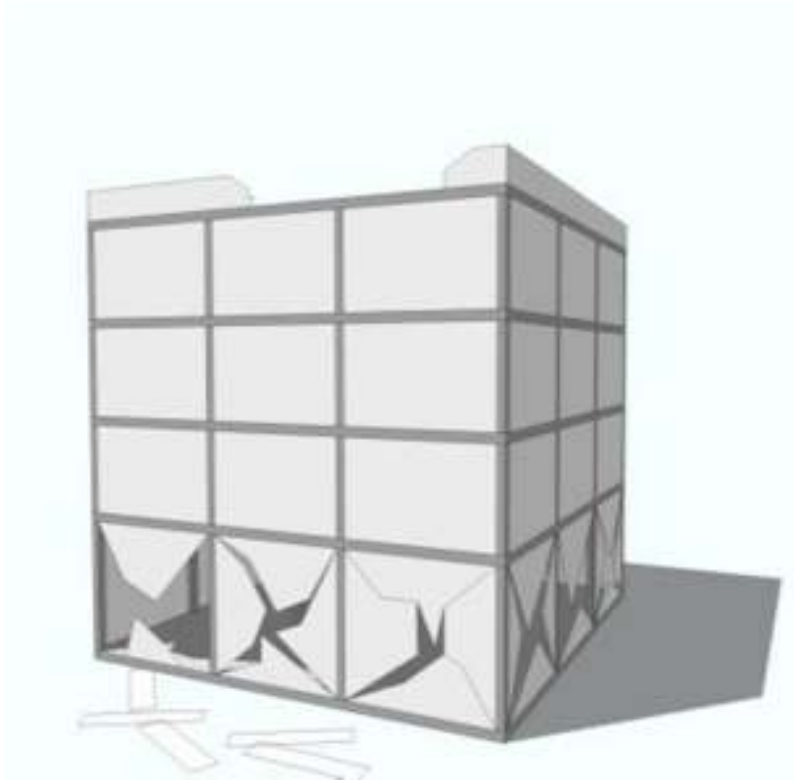


And is damaged like this

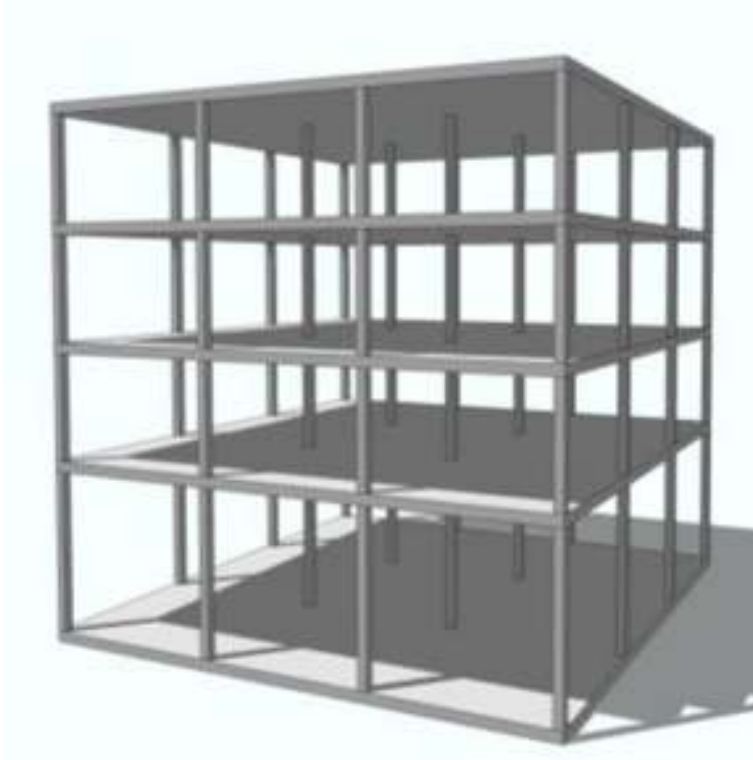


STATIC BUILDINGS

A widespread static approach to building concept is observed...



SOMOS ESTÁTICOS

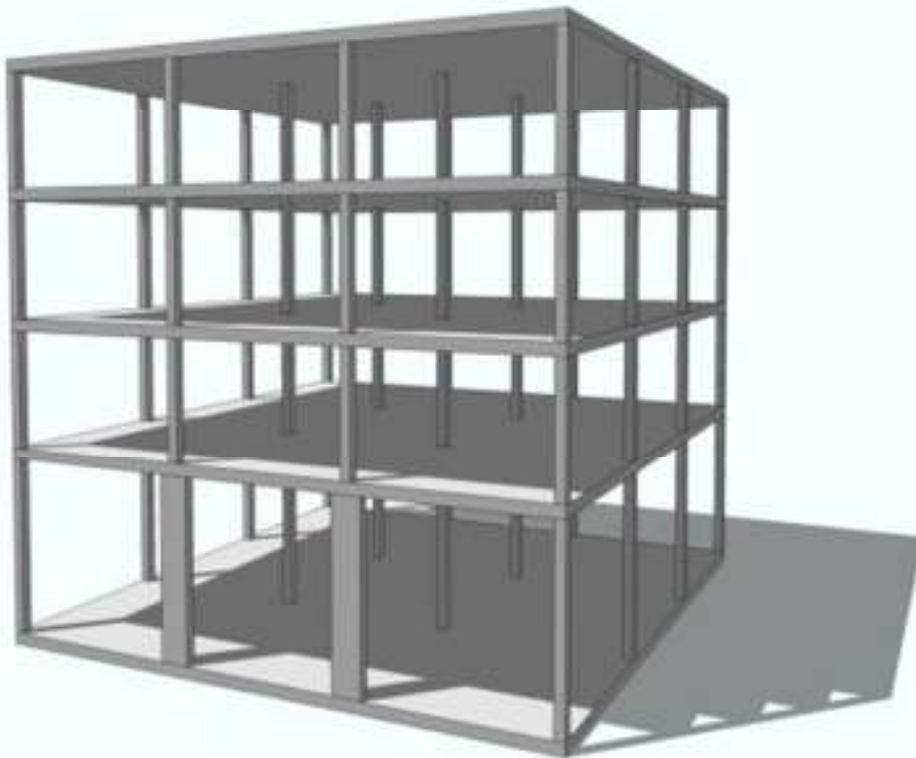


All buildings observed were moment frames

No shear walls, no bracing,

SOMOS ESTÁTICOS

No soft storey corrections were observed in any buildings



Typical damage



SEVERE DEFORMATION ON GROUND FLOOR SOFT STOREYS



SEVERE DEFORMATION ON GROUND FLOOR SOFT STOREYS



EXPELLED MASONRY PANELS



POUNDING DAMAGE



SHEAR FALIURE ON COLUMN HEADS



SHEAR FAILURE ON COLUMN HEADS- INADEQUATE LOOPING



SHEAR FAILURE ON COLUMN HEADS- INADEQUATE LOOPING



SHEAR FAILURE ON COLUMN HEADS- INADEQUATE LOOPING



SHEAR DAMAGE ON LIFT SHEAR WALL



2

SHORT COLUMNS KILL PEOPLE

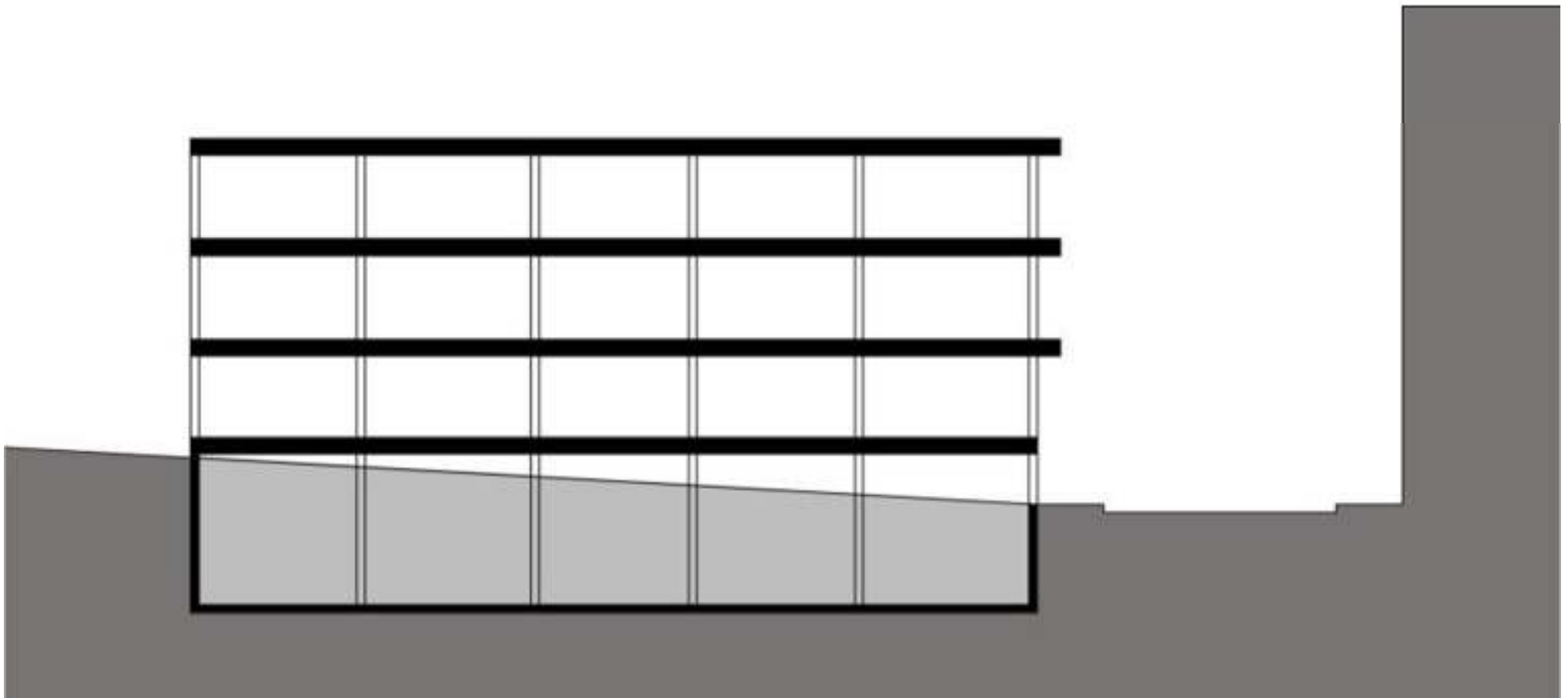
'PANCAKE COLLAPSE'



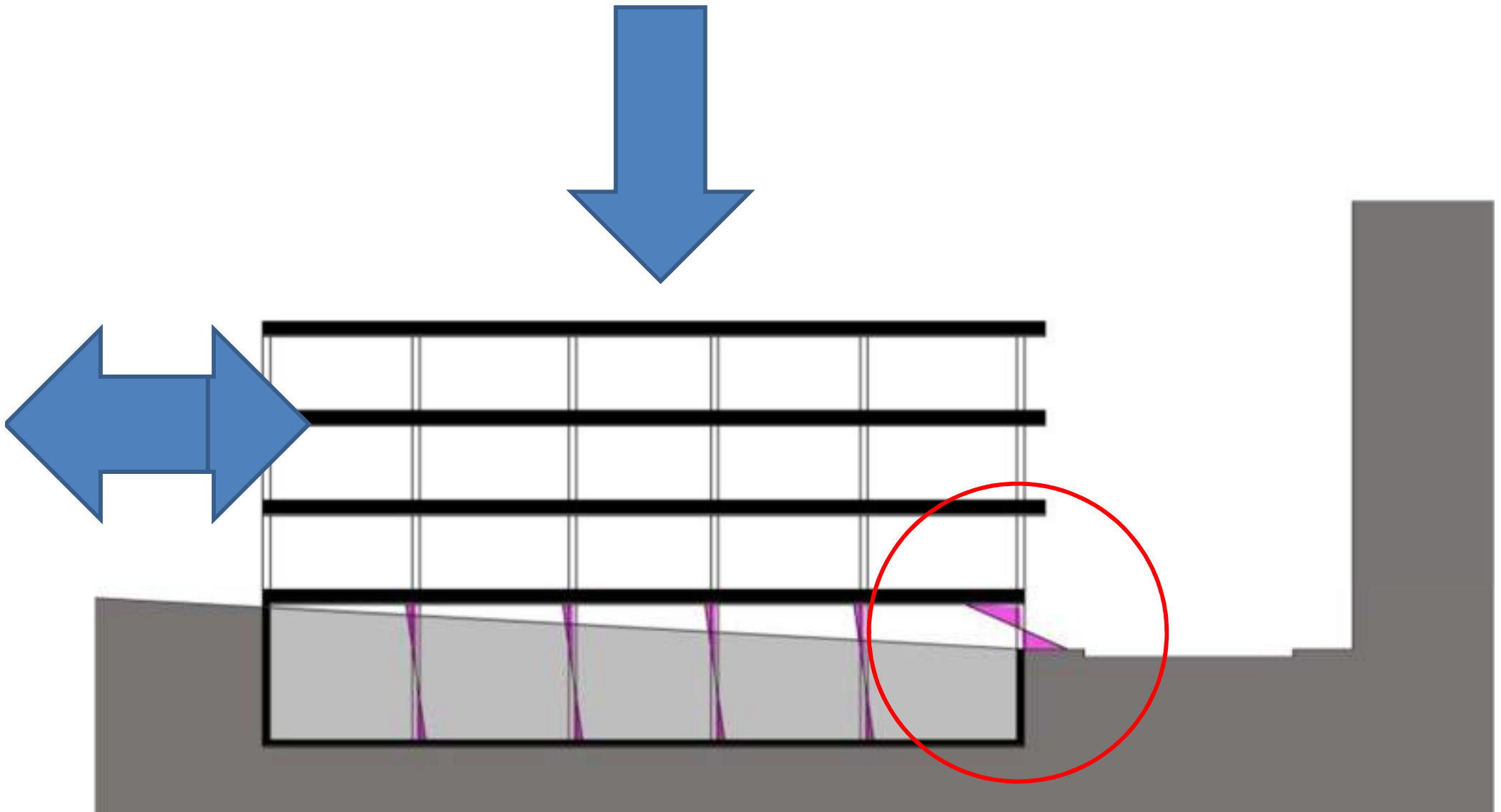
NEIGHBOURING TWIN BUILDING GIVES US A CLUE AS TO THE COLLAPSE MECHANISM – SHORT COLUMNS



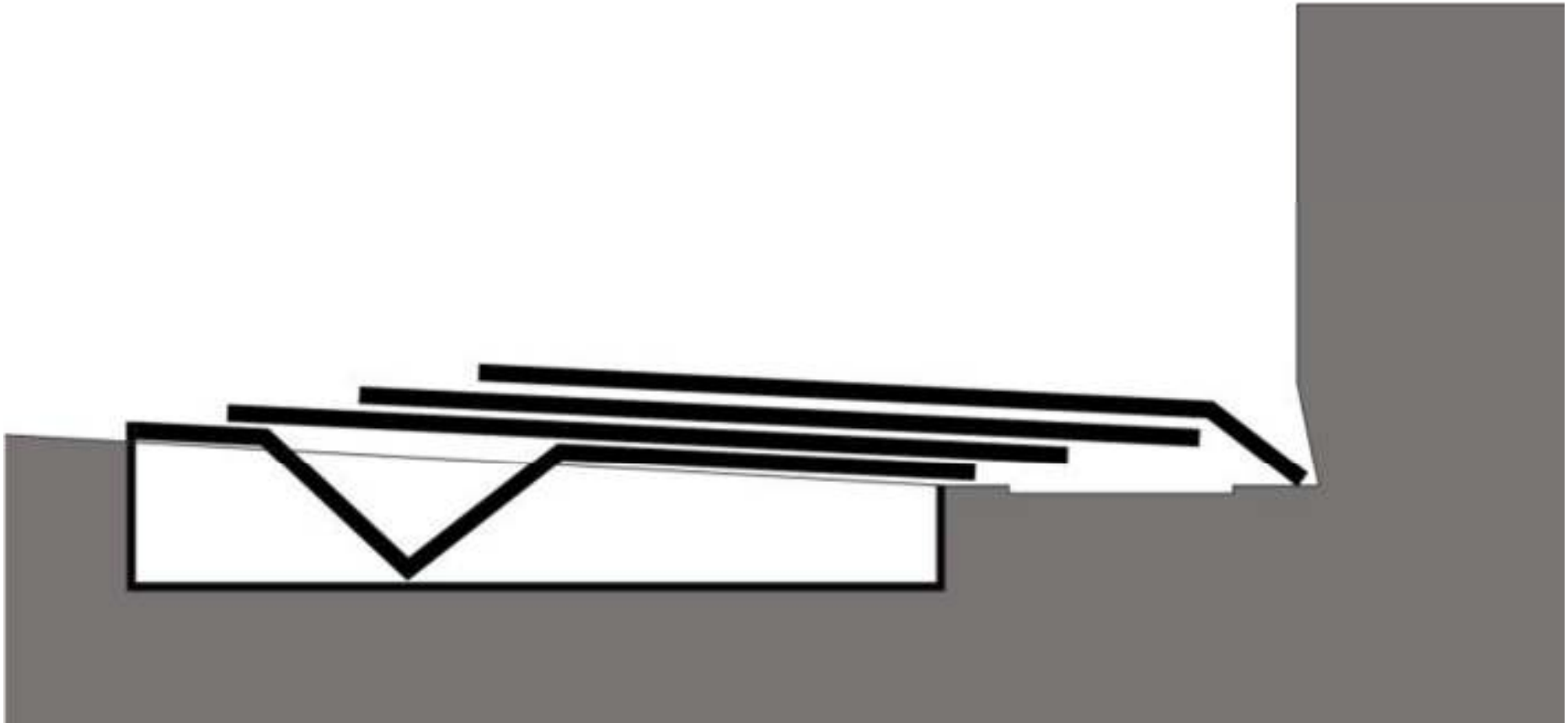
A STATIC BUILDING – SHORT COLUMNS EMERGING FROM BASEMENT



PERIMETER SHORT COLUMNS ARE VERY STIFF AND ATTRACT ALL SHEAR FORCE



CRUSHED SHORT COLUMNS CAUSE BUILDING FAILURE



NEIGHBOUR IS ALMOST KNOCKED DOWN TOO



THANK GOD THERE HAD BEEN A 4,5 EVENT BEFORE
AND PEOPLE HAD LEFT THE BUILDING



INADEQUATE HOOP CONFINEMENT



DAMAGED SHORT COLUMNS EVERYWHERE



CAPTURED COLUMN MADE SHORT BY MASONRY INTERACTION



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3



PLAZA DE LOS APRENDICES – THE RED BUILDING

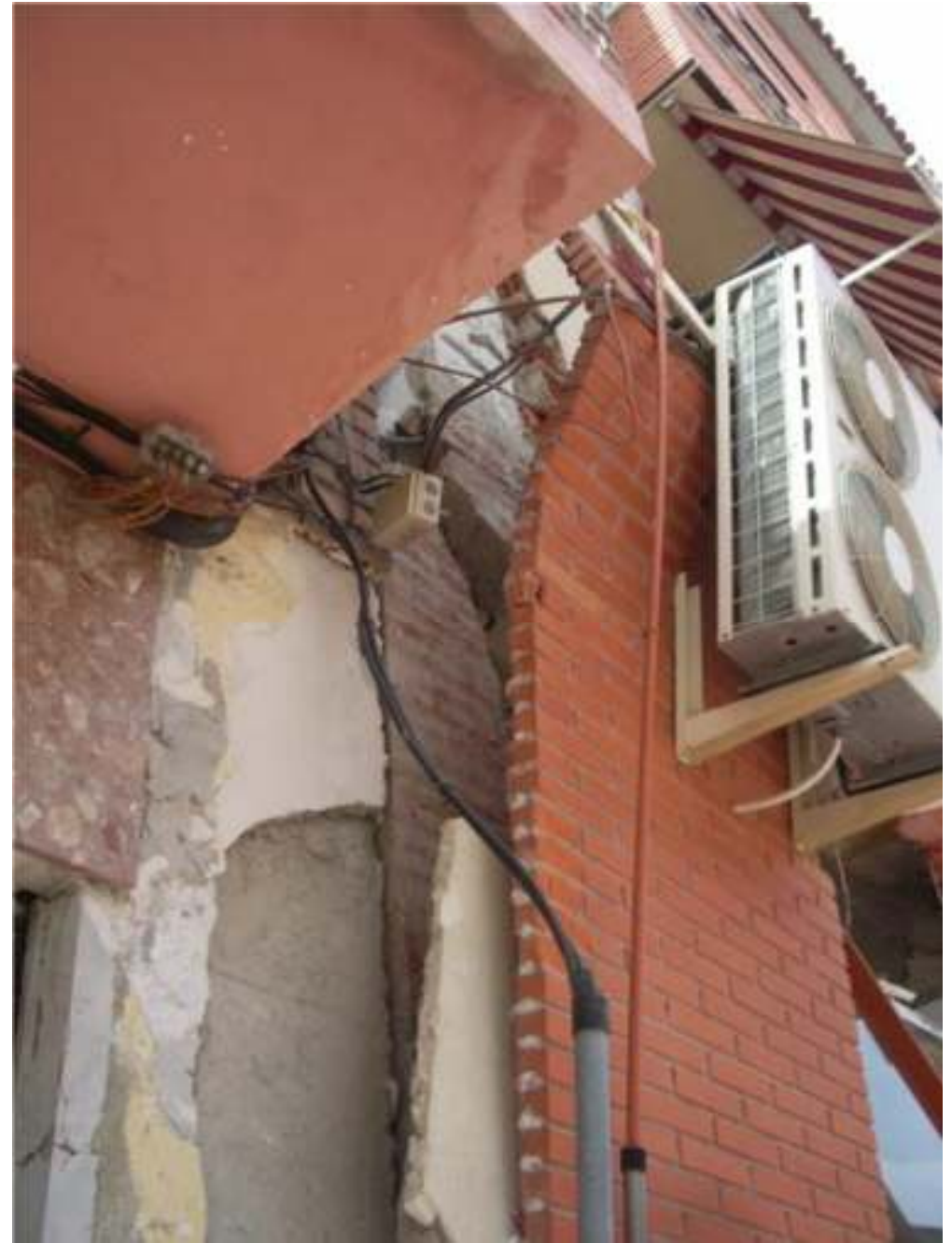
SEVERELY DEFORMED GROUND FLOOR



BUILDING LISTING TO THE NORTH



GROUND FLOOR COLUMN FAILURES



GEOTECHNICAL FAILURE?



IT FELL DOWN BY ITSELF



4

NON-STRUCTURAL ELEMENTS KILL PEOPLE

EXPELLED MASONRY PANELS KILL PEOPLE



UNREINFORCED PARAPETS KILL PEOPLE



UNREINFORCED PARAPETS EVERYWHERE



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WHERE ARE THE SEISMIC JOINTS?

A THERMAL JOINT IS NOT A SEISMIC JOINT



EARTHQUAKE – INDUCED JOINTING



SWAYING AND POUNDING



6

TERRIBLE DAMAGE TO HERITAGE

OUT OF PLANE COLLAPSE OF TRAIN STATION MASONRY BEARING WALL



SANTIAGO CHURCH NAVE COLLAPSE



SANTIAGO CHURCH NAVE COLLAPSE



SANTIAGO CHURCH BUTRESS DAMAGE



PASO AZUL CHURCH HANGING KEYSTONE



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INTERIORS

HEAVY DAMAGE TO PERISHABLE GOODS



OBJECTS THROWN TO THE FLOOR IN LARGE NUMBERS (EMS 7)





MONUMENT ROTATION



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THERE IS GOOD NEWS

LIGHT METAL CLADDING – NO DAMAGE



HIGH RISE WITH CONCRETE PARAPETS
AND SHEAR RESISTANT COLUMNS – NO
DAMAGE



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CONCLUSIONS

- 1 LACK OF STIFFNESS IN SMALL TO MEDIUM SIZED MIXED USE BUILDINGS**
- 2 BUILDINGS ARE STILL BEING CONCEIVED STATICALLY**
- 3 SEVERE MASONRY – STRUCTURE INTERACTION AND INTERFERENCE**
- 4 POOR SEISMIC DESIGN IN THE CONCEPTUAL PHASE OF BUILDING LAYOUT**
- 5 SHORT COLUMNS KILL PEOPLE**
- 6 NON – STRUCTURAL ELEMENTS KILL PEOPLE**