EEFIT

Earthquake Engineering

Field Investigation Team

The Liège Earthquake 8th November 1983

Damage Inspection Report
Volume I

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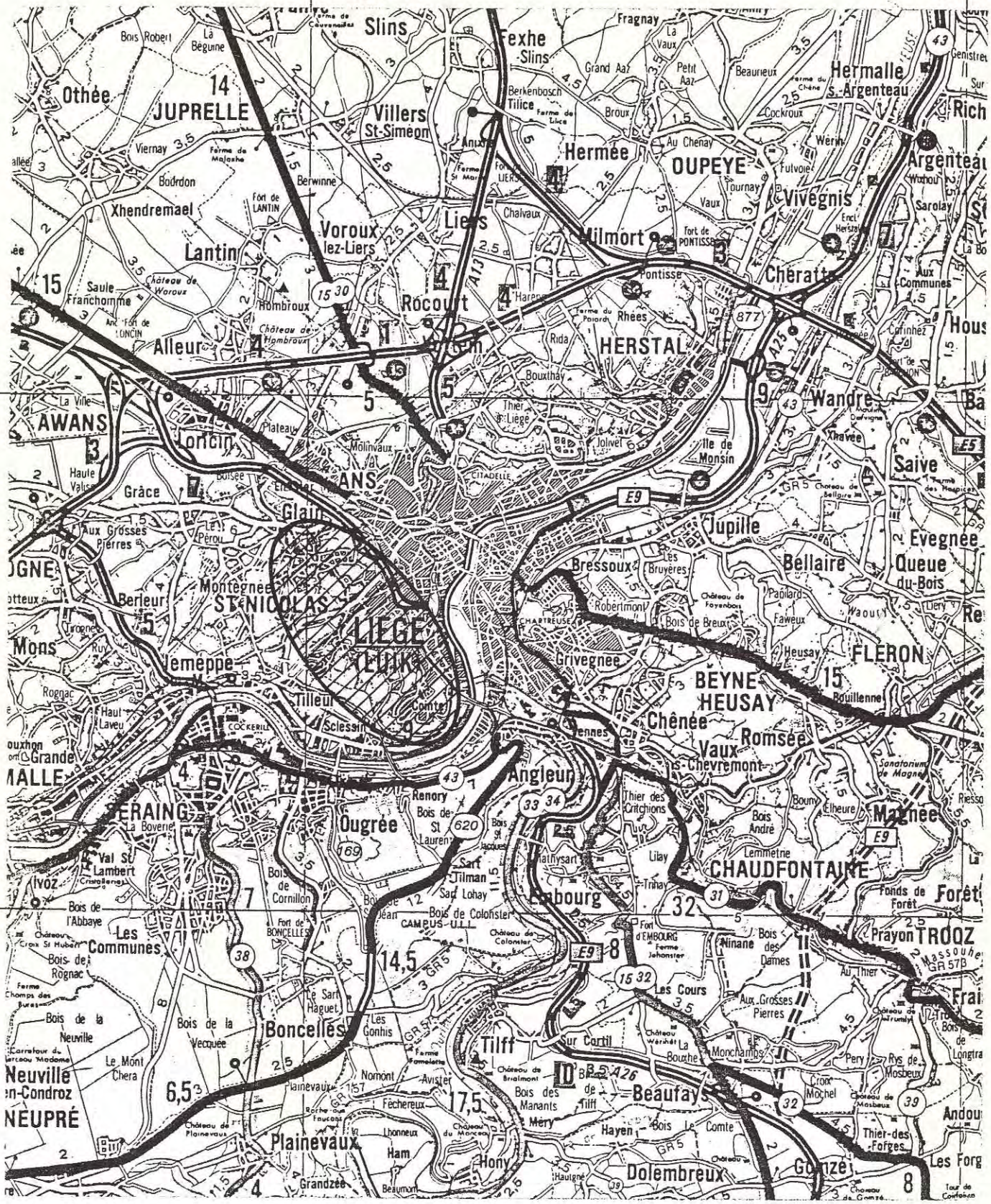
The Liege earthquake, 8th November 1983

Damage Inspection Report by EEFIT Member, E. Booth



LIEGE AND ENVIRONS

figure 1

1.0 SUMMARY

A brief visit to Liège by E. Booth after the November 1983 earthquake is reported. Substantial damage, corresponding to MMI VII, was found in masonry buildings, but there was strong evidence that a poor state of structural repair and poor ground conditions contributed to this damage, and it is likely that undermining by abandoned coal workings was also a factor. There was no evidence of serious damage to modern, well built structures.

2.0 BACKGROUND INFORMATION

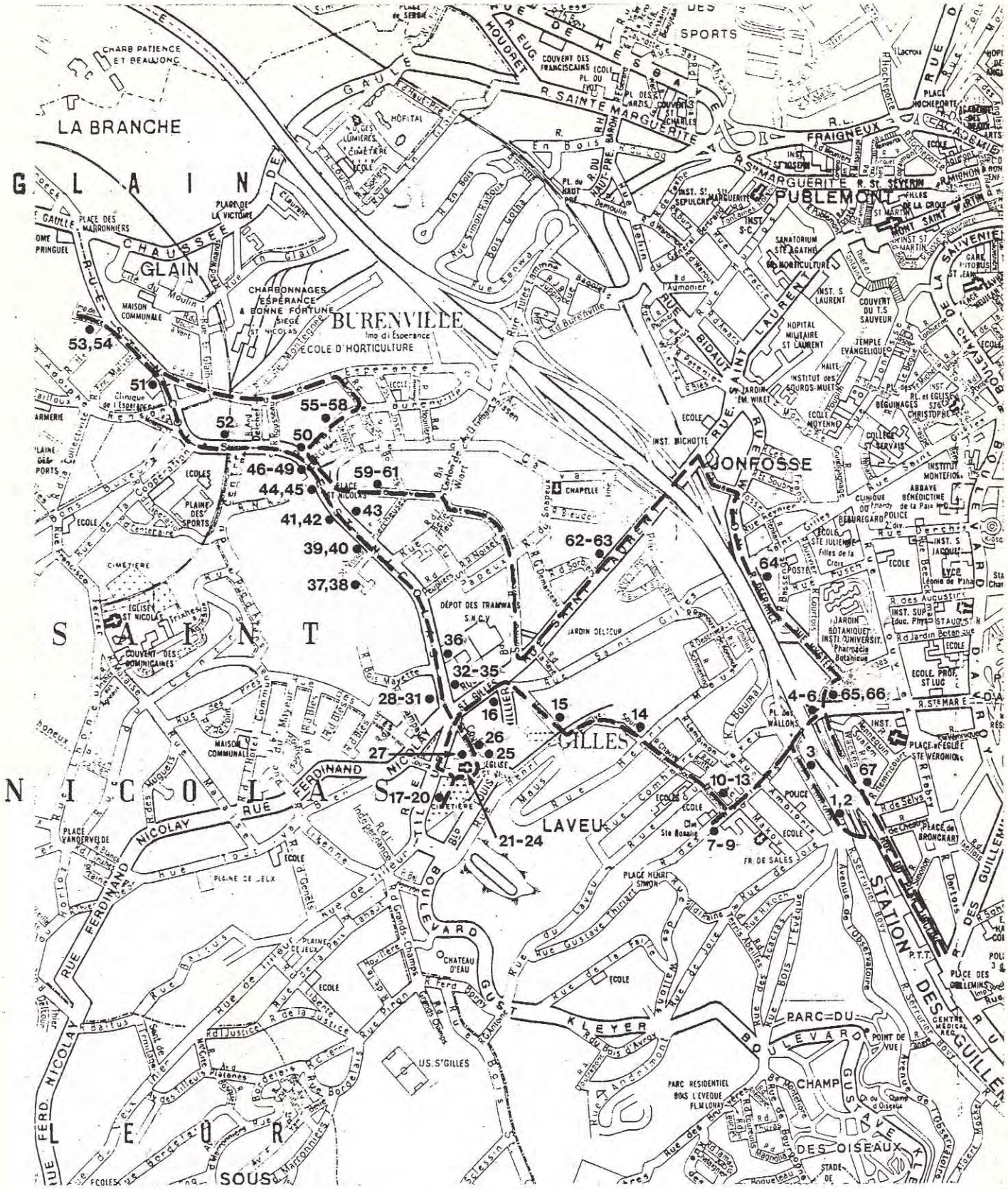
The Liège earthquake occurred at about 2.00a.m. on 8.11.83. A local magnitude of 5, and a body wave magnitude of 4.2 was reported. The preliminary location was 50.7°N, 5.6°E. Two people were killed, several dozen injured, and an estimated £5 million worth of damage was caused. Several hundred people were temporarily rehoused after the earthquake, and a few dozen houses were rendered uninhabitable. There were numerous instances of toppled chimneys, fallen ceilings and cracked plaster over an area approximately 5km long and 2km wide. In the worst hit areas, 90% of chimneys were damaged.

The areas where the main damage occurred were suburbs to the west of the centre of Liège called Glain, St Nicholas and Laveu (See fig. 1). The terrain in these suburbs is hilly. Sheet 121 of the Carte Geologique de Beligique is a 1:40,000 geological map of the area, issued by the Institute Carto-graphique Militaire in 1902. It shows the epicentral region as being chalk with chert, with carboniferous deposits to the north, east and south, and green and black clays to the west.

A noteworthy feature is the presence of abandoned coalmine workings in the area. Although the extent to which the epicentral area is undermined is not at present clear, some undermining must be present, since the pithead is in the epicentral region.

A nuclear power station is sited about 25km west of Liège on the banks of the river Meuse at Tilhange. There are no reports of the earthquake being felt there, let alone damaging the installation, and the strong notion recorder there was not triggered.

Several other inspection teams visited the area including those from Imperial College (N. Ambraseys, G. King) Cambridge University (C. Melville) Principia Mechanica and CEGB. A meeting of SECED devoted to the Liège earthquake is due to be held at Imperial College, London, on 1st February 1984.



LOCATIONS OF PHOTOGRAPHS IN APPENDIX II figure **2**

3.0 EEFIT INSPECTION OF THE DAMAGED AREA

3.1 Scope of Inspection

The author, E. Booth, visited Liège on 17 November 1983, 9 days after the earthquake. He spent most of that day touring part of the damaged area on foot - see fig. 2. The inspection was not intended as a systematic study of the epicentral area, but it attempted to gain an impression of the nature and extent of the damage from a superficial, mainly external, inspection.

3.2 General Findings

Most of the buildings where damage was more serious than a toppled chimney appeared to be in a poor state of repair. Typically, the damaged buildings appeared to be brick built, and 80 to 100 years old. In a number of cases, foundation settlements, sometimes quite severe, had clearly taken place before the earthquake.

Accordingly to some surveyors who were carrying out plumbing surveys on damaged buildings, some of the buildings were still moving signifcantly, 9 days after the earthquake, and they pointed to one building that was undamaged immediately after the quake, but the facade of which had started to crack 2 or 3 days later.

Four substantially built modern brick clad structures in the epicentral area (Ecole St Sebastien, St Gilles, Depôt des Tramways, St Gilles, Clinique de l'Esperance, Glain, housing estate, Rue St Gilles) appeared undamaged by the earthquake. A modern concrete elevated highway in Laveu near the main railway station was carefully inspected, including at the abutment bearings, but no sign of any damage was noticed.

The extent of the damage in the epicentral area was indicated by the numerous piles of fallen masonry, false ceilings and plaster piled on the pavements, and by the amount of repair work being carried out on roofs.

A more cursory inspection was made of the centre of Liège, after dark. There were isolated examples of fallen masonry (Quai sur Meuse, Bd' de la Sauvenière) and many minor instances of cracked masonry, which appeared recent, but may have been unconnected with the quake. Four cases of the road being dug up were noticed, and those may have been connected with reports of cracked service pipes in the centre after the earthquake.

3.3 Lessons for a Future EEFIT Mission

The Liège earthquake was clearly not suitable for a full EEFIT mission, since no modern engineered structures were seriously damaged. Some observations which may or may not be relevant to a full EEFIT mission, are as follows:

(a) There was plenty to be seen and learnt, 9 days after the earthquake;

(b) There were no official obstacles to the inspection, but on the other hand, nothing other than superficial inspection was attempted. For example, there were no systematic interviews, systematic interior checks, inspection of sensitive buildings (eg. the nuclear power station).

(c) Ordinary people on the streets were helpful and keen (even proud) to talk about "their" earthquake.

(d) Repair was in full swing 9 days after the quake. The neat piles of rubble on pavements, shored buildings, and groups of people talking earthquake outside damaged buildings meant the event was still much in evidence, but it appeared that life in general was continuing for most people in the damaged suburbs without dramatic changes.

4.0 DISCUSSION AND CONCLUSION

Based on the observation of damage to buildings, an epicentral intensity of VI to VII MSK, VII to VII + MMI can be assigned.

The evidence of very extensive damage to chimneys suggests that dynamic effects were significant in causing damage. However, it is clear that two non-dynamic factors were responsible for increasing greatly the damage, namely the poor state of repair of many of the affected buildings and the poor nature of the ground and foundations. It may be suspected that the coal mine workings under some or all of the epicentral area was also a significant factor, judging from the continued building settlement 9 days after the earthquake. It may be that much of the damage suffered was latent in the buildings, due to the poor state of repair, weathering damage and foundation settlements, and this damage suddenly became expressed at the time of the earthquake.

APPENDIX 1

Descriptive List of Photographs

The photographs were all taken by E. Booth on 17.11.83 with an Olympus OM1, with both a standard 50mm lens, and a 28/70mm zoom lens. Kodacolour 400 and 100 films were used.

The places where the photographs were taken are shown on Figure 2. Notes on the photos now follow. The photos are in Appendix II, bound separately.

1&2 Door in delapidated building, Rue des Eburons

3. Piles of rubbish, same street

4. Fallen chimneys, same street

5. Fallen chimneys, Rue de Sluse. Note repairs already carried out. No apparent damage to modern r.c. road bridge.

6. No sign of damage or movement at abutment bearings to bridge from 5.

7&8 Rue des Wallons. Steep cobbled rather uneven street. Substantial fall of brick from some gable end parapets on 3 storey brick buildings. No sign of cracks in walls.

9. Rue des Wallons. 1.2m high brick retaining wall displaced up to 15cm out of line, outside Clinique St Rosalie. (Minor cracking observable in the facade cladding panels of the clinique - not shown in photo).

10. Rue Mueseler, fallen chimney and vertical cracks up chimney breast, 3 storey brick house.

11&12 Rue Mueseler. Cracks in window lintel. Note leached white material, possibly suggesting expansive spalling damage. Occupier said that cracking was caused by earthquake and showed me extensively cracked plaster inside the house.

13. Rue Mueseler, general view. Many chimneys (approx. 40%) fallen. A fairly steep slope.

14. Rue Chauve Souris. Fallen chimney pots, steep slopes.

15. Rue Chauve Souris - near top. Fallen chimney pots. No sign of cracked walls.

16. Rue de Tilleur, near Eglise St Gilles. Piles of bricks in street.

17-20 Cemetiere St Gilles. Approximately 10% of headstones damaged. Note some graves had settled unevenly before earthquake, indicating poor ground.

21&22 Eglise St Gilles, north face. Note weathering of masonry surface. Damaged corner of side chapel; rain flow may have caused weathering at this point.

23. The church is closed as a safety measure.

24. Eglise St Gille. Displaced capping stone, and vertical crack in east end window.

25. Damaged gable end on brick 3 storey house opposite church (maison de M. le Cure).

26. Ecole St Sebastien next to 25. According to the sister in the picture, a light and a few small windows were broken by the earthquake, but there was no other damage.

27. Houses opposite Ecole St Sebastien. No observable or reported damage, apart from a few small cracks, as reported by householder.

28&29 Rue St Nicholas. 5 storey (including semi-basement at back) brick house on steep slope. Reported extensively damaged inside.

30&31 House behind previous. Extensively damaged inside. Retaining wall approx. 2½m high to right of photo, within 2m of single storey brick extension, which is leaning away from the main house, with a separation of up to 5cm. Note that shear cracks in main house indicate a shear rotation in the opposite sense from a settlement of the right hand wall, which is puzzling. Owner of house was rudely awakened by earthquake.

32. Rue St. Nicholas, opposite side of street from slope. Right hand wall appeared out of plumb - top leaning to right. Note apparent pre-existing damage above 1st floor window, consistent with spreading above window, and a drop in the lintel bricks.

33. Detail of 32, ground floor lintel. Cracks apparently new, consistent with a drop in the lintel.

34&35 Shoring and repairs to service pipe, Rue St Nicholas.

36. Depot des Tramways, Rue St Nicholas. No sign of damage apart from a broken window.

37. Rue St Nicholas, looking up slope. 2 chimneys being repaired.

38. Looking down slope into Meuse valley, same position as 37.

39&40 Rue St Nicholas, surveying a building. Front facade 8 to 13cm out of plumb in 6m, but movement still taking place. Some internal damage reported - shift of floor boards.

41&42 Rue St Nicholas, clearing out lathe and plaster ceiling.

43. This house, opposite previous, was undamaged immediately after the quake, but started to crack 2 or 3 days later. Now it shifts every day.

44. Rue St Nicholas at Place St Nicholas. Vertical crack at corner of house.

45. Same house as 44.

46. Place St Nicholas. Municipal lorries preparing shoring.

47&48 Rue St Nicholas. Shores being erected.

49. Rue St Nicholas. Evidence of large settlements before earthquake.

50. Rue St Nicholas. Whiskey in Liège lasts longer than buildings.

51. Clinique de l'Esperance. No signs of damage.

52. Pit head, view from top of railway tunnel in Rue St Nicholas. The brick portal to the tunnel had been propped by a steel portal frame, evidently added some time ago, and suggesting settlement problems.

53&54 Impasse de l'Esperance, Glain. Severely damaged buildings.

55. Rue de Burenville. Dilapidated buildings, with coalmine winding tower in background.

56-58 Rue de Burenville. 3 out of 4 of these buildings were considered uninhabitable. Cracks and settlement were present before the quake, according to householders. A steep slope behind these houses leads to pithead.

59-60 Boulevard St Beuve. Modern 3 storey r.c. frame housing, one of 3 or 4. No serious damage, but note settlement of paving flags in front of building and vertical cracks at corner - possibly unconnected with earthquake.

61. Older houses backing onto previous in Rue St. Nicholas, most of which had damaged chimneys.

62&63 Rue St Laurent. Shoring and cracking in brick terraced houses. Piles of rubble observed outside nearby Rue Sorbier.

64. Rue Defrance. Buckled pavement slabs, indicate ground movements. A number of fallen chimneys observed in the adjacent streets.

65&66 Rue du Sluse. Shoring to balcony, and vertical crack at corner.

67. Rue Wacken. Broken glass at base of building evidently recent. Most chimneys in this street have fallen.

LIEGE earthquake, 8.11.83

D. Tel. 9.11.83

QUAKE DEATHS IN BELGIUM

By Our Staff Correspondent in Brussels

A woman was killed when a ceiling collapsed and several people were badly injured during an earthquake in eastern Belgium yestereday. A man died later, apparently from a heart attack.

The earthquake, with a magnitude of five on the Richter Scale, was the most severe in Belgium since 1938. Several thousand people had to evacuate their houses and in Liege and other cities roads were closed and schools were shut.

Earthquake danger

From Dr Robert Muir Wood

Sir, Your correspondent at the British Association meeting in August reported (August 25) my talk in which I drew attention to the earthquake fault zone that passes up through the Rhineland and Belgium into Kent.

The earthquake last night in Liège (report, November 9) is a sharp reminder of the potential hazard that this zone poses for centres of industry and population that lie along it.

For although the event was of moderate Richter magnitude, the damage caused was substantial and fatalities resulted.

Your leader of August 27 made light of earthquakes here, but only a few hundred miles away the people of Liège are taking them very seriously indeed.

Yours faithfully,
ROBERT MUIR WOOD,
Principia Mechanica Ltd,
Newton House,
50 Vineyard Path,
East Sheen, SW14.
November 8.

Times 14.11.83

Two die in Belgian earthquake

From Our Own Correspondent, Brussels

Two people died when Belgium suffered its worst earthquake for more than a century early yesterday. Centred on the city of Liége, it registered 5 on the Richter scale and its effects were felt as far as Brussels in the west and Cologne in the east.

The two who died were a woman crushed when the ceiling of her bedroom collapsed and an ederly man who collapsed with a heart attack after being awaken by the violent shaking of his home.

Another 15 people needed hospital treatment after being hit by falling masonry and glass fragments. The streets of the Liège suburb of Saint Nicholas, which was the worst hit area, were clogged with rubble and power and telephone cables were broken.

Nearly 100 people had to leave their homes and were given temporary accomodation in the town hall.

● LONDON: South-east England could be hit by an earthquake similar to the one which struck Belgium, a British firm of consultant engineers said yesterday

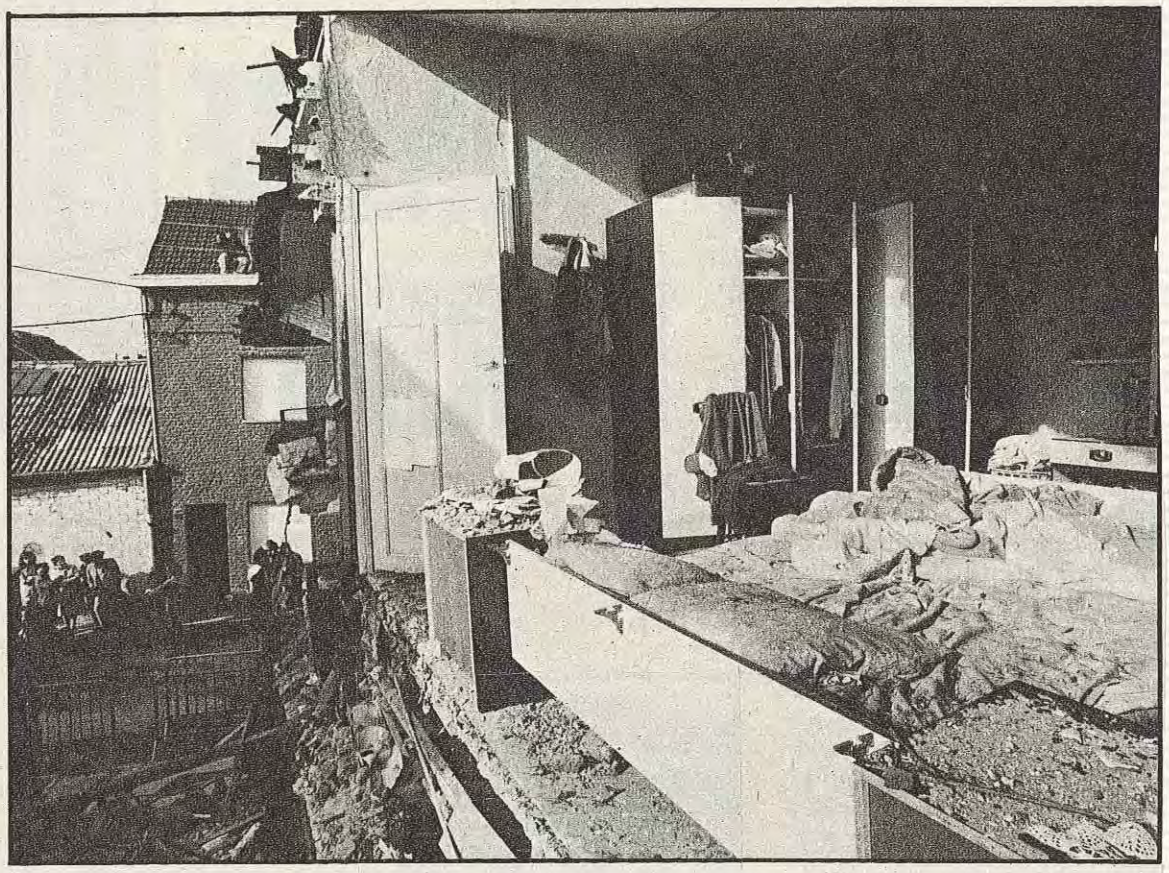
A spokesman for Principia Mechaniea, which has conducted a four-year research project into British earthquakes, said that the Liège area straddles a long geological fault line which runs from West Germany along the Rhine, through Belgium and into the North Sea towards the Kent coast.

● PEKING: Rescue teams sifted through the wreckage of thousands of homes yesterday after an earthquake in the densely populated Shandong province of China, the New China news agency said (Reuter reports). The death toll, officially remained at 34 but it was thought that it could be higher. Times 9.11.83

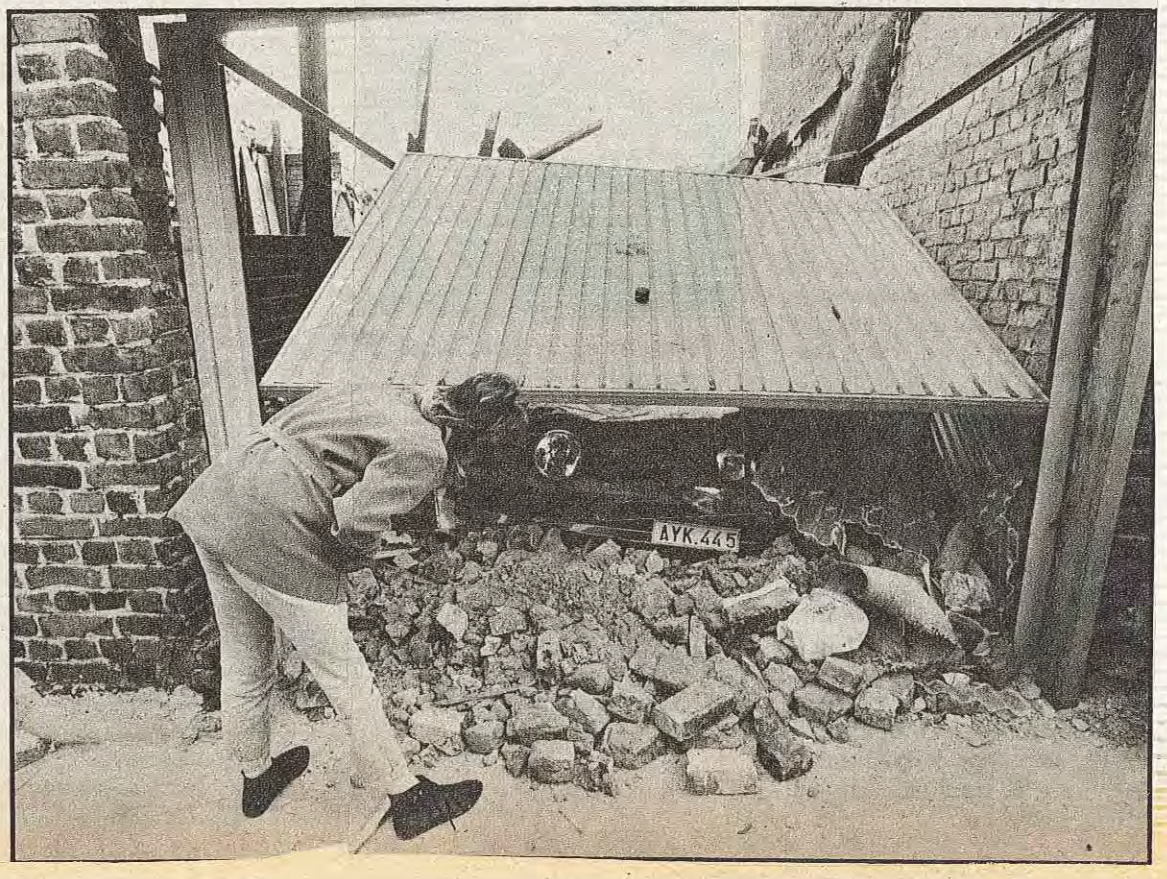
Preliminary location 50.7°N
5.6°E

Magnitude 4.2 to 5

...nd, après la grande peur
...a nuit,
...our s'est enfin levé...



Terrible. Et, pourtant, le pire a été évité dans cette maison de Glain : elle s'est rompue juste au pied d'un lit...



LIÈGE

le sa visite dans la région liégeoise, la reine Fabiola a pu se rendre compte de l'incroyable étendue des dégâts et, surtout, réconforter les sinistrés.

PHOTOS J. GOESSENS — J. GUYAUX — PHOTO NEWS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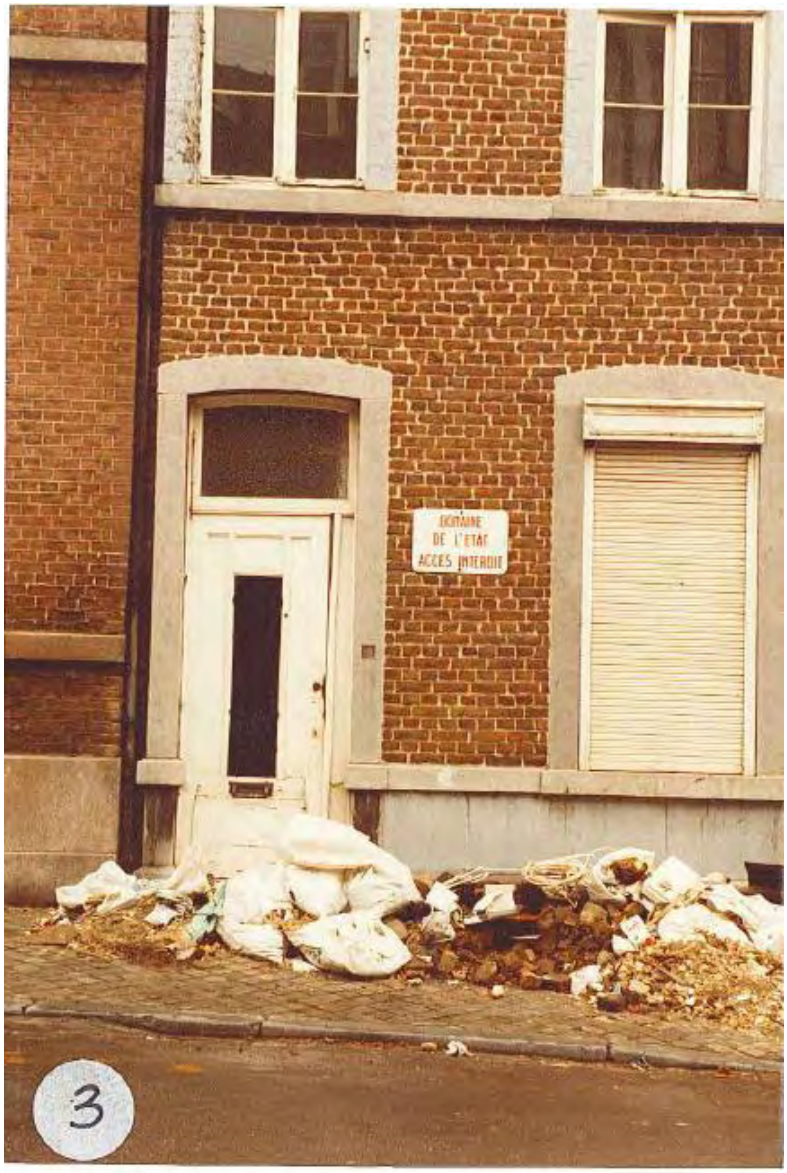
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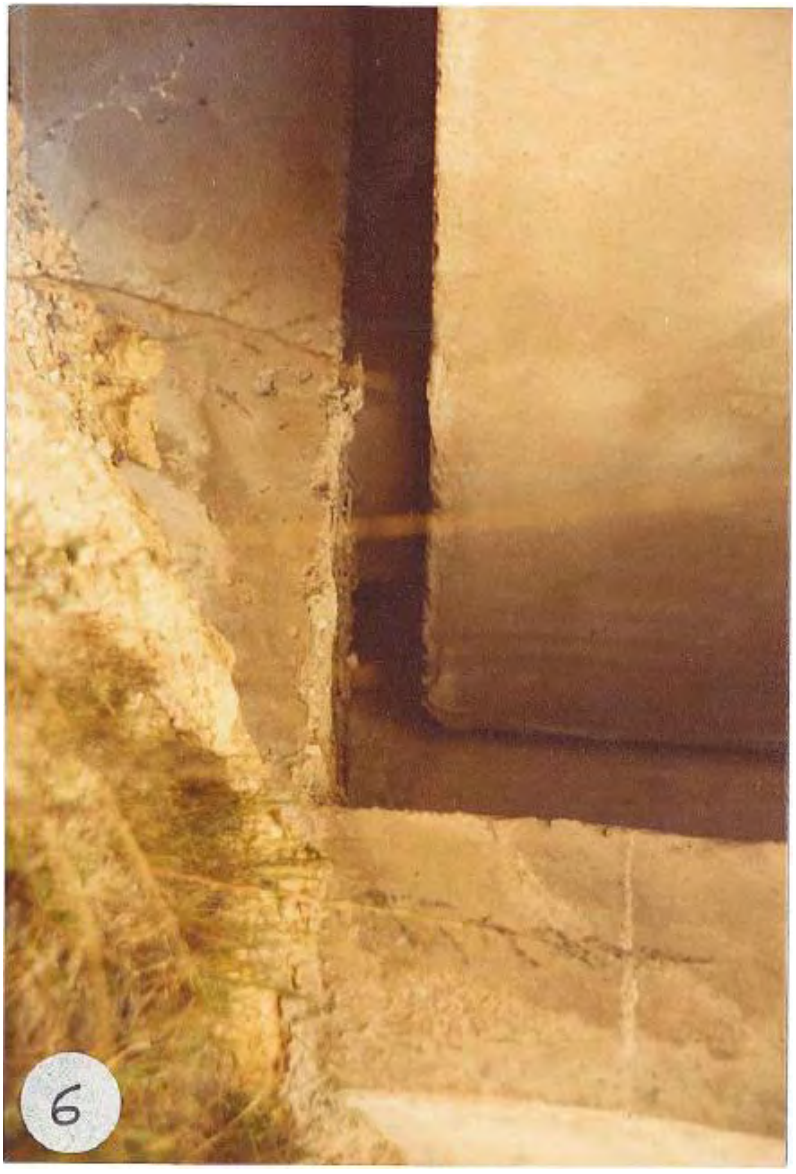
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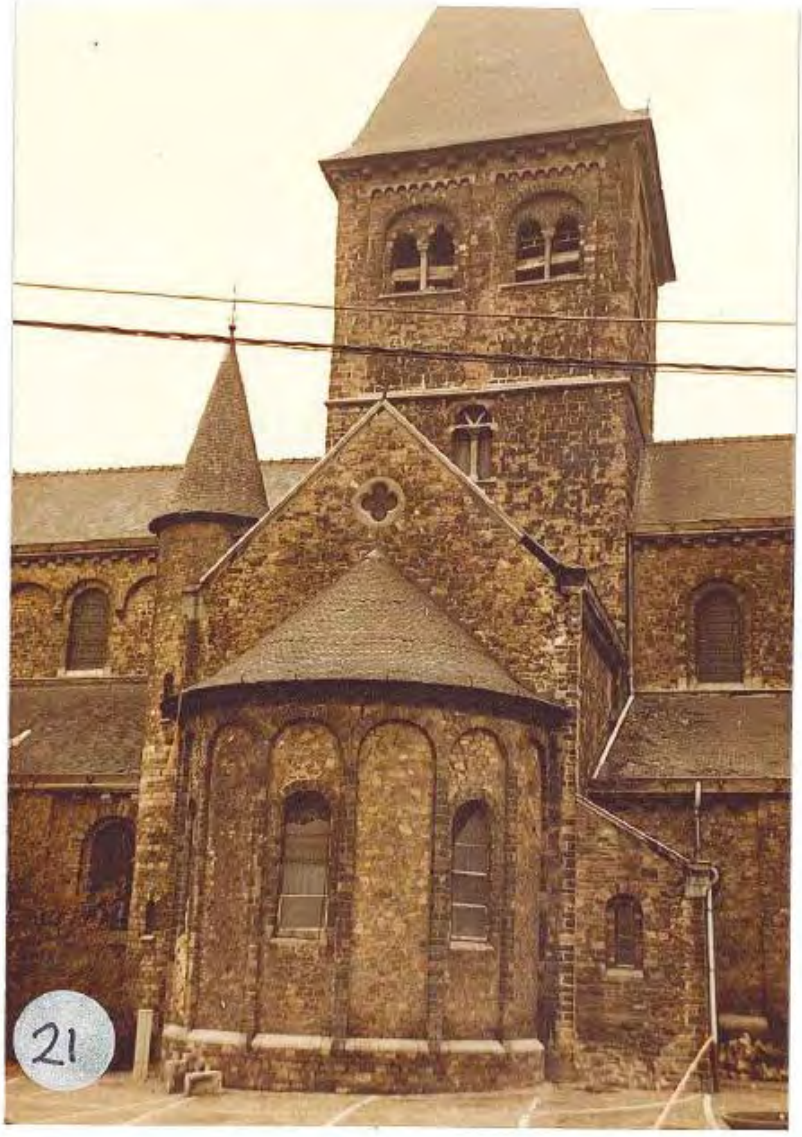
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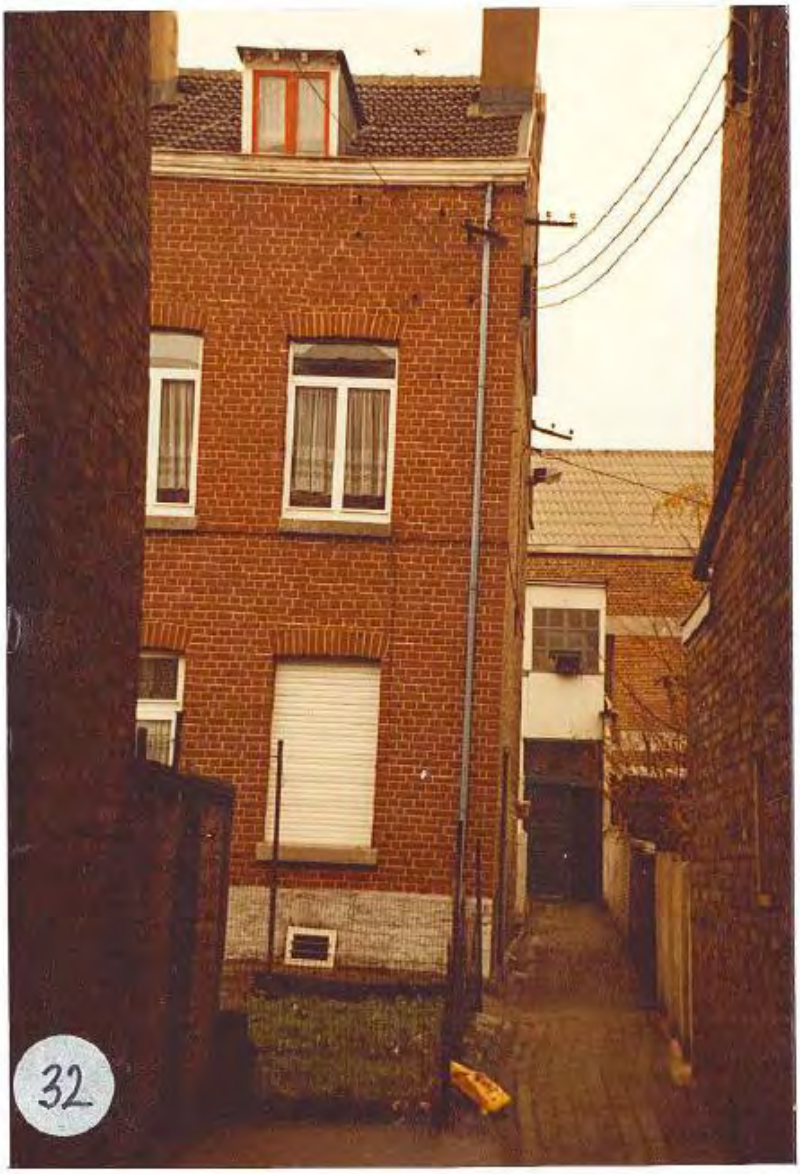
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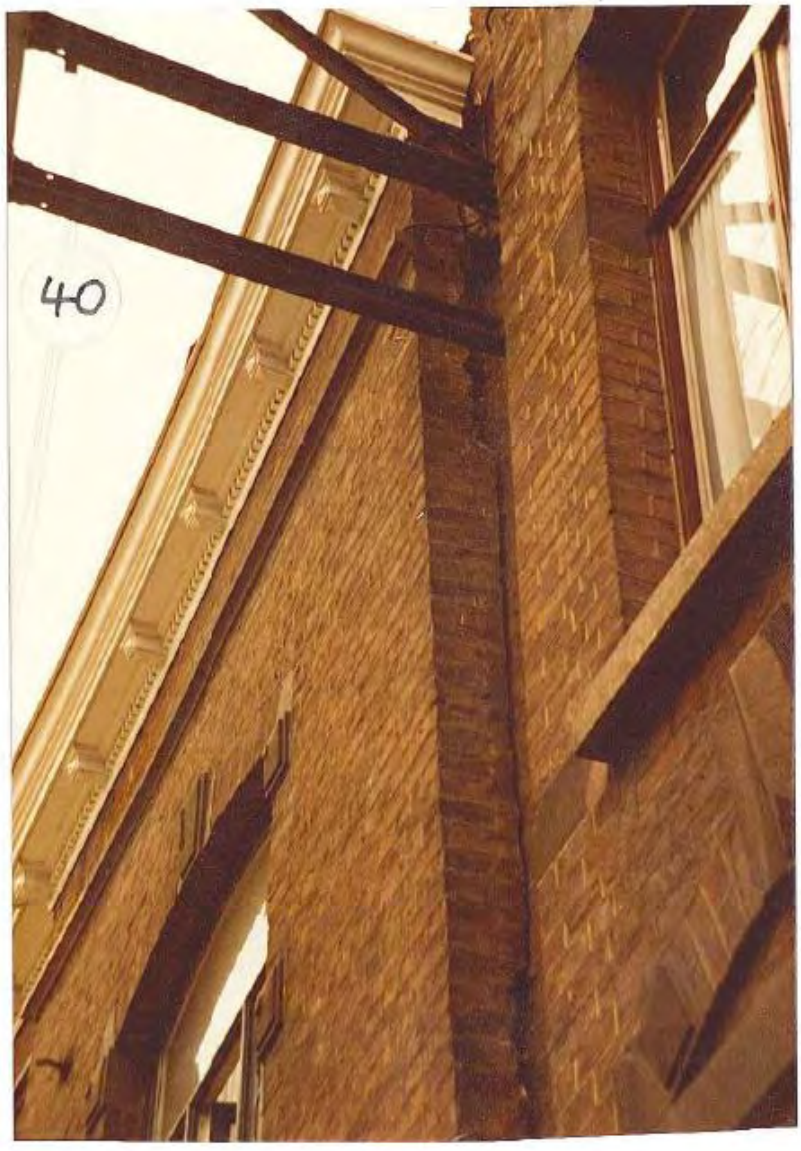
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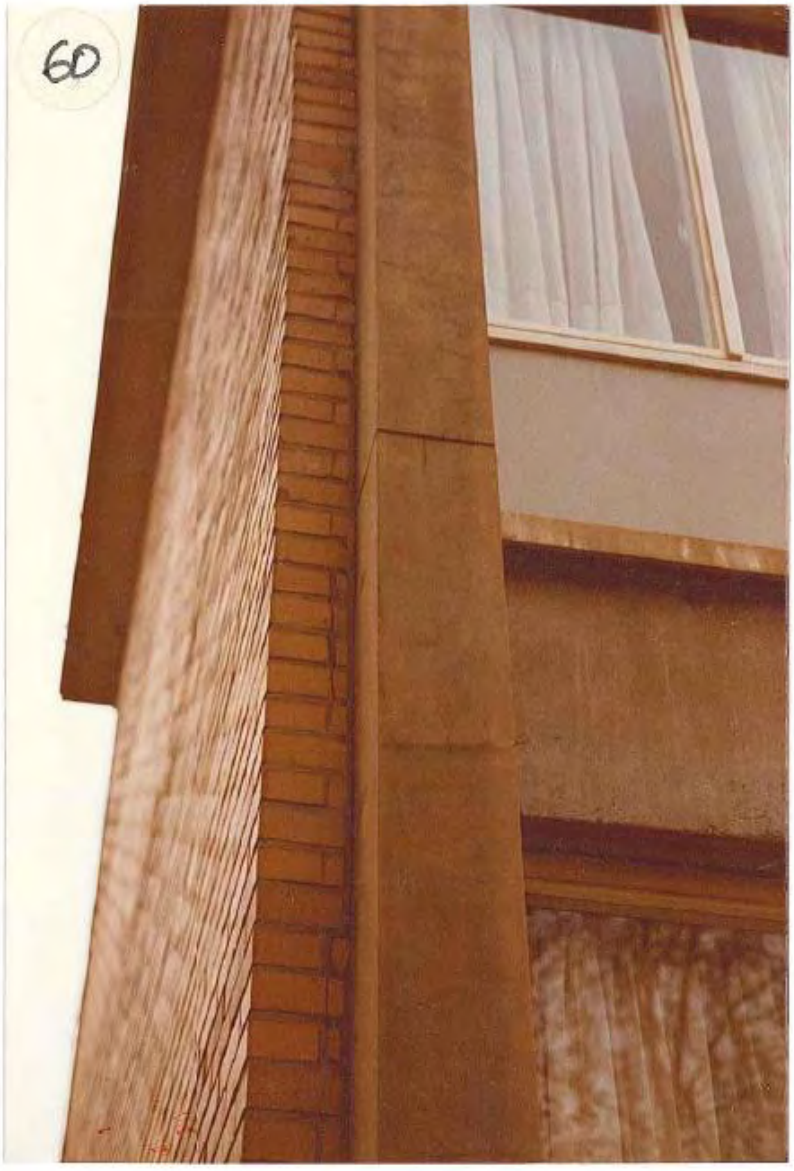
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