



**ROADS DEPARTMENT
ENGINEERING & DESIGN SERVICES**

Structural Survey Report

*Lochside Leisure Centre
Forfar.*

26 July 2001

INTRODUCTION

This report was requested by Mr. I. Lingard (Property Services), the report was written by Mr. D. Davidson (Roads Department).

The report is the fourth written by this department since the formation of Angus Council Unitary Authority:

Report 1 (July 1996)

The first report was written by Mr. C. Strachan and requested by Mr. I. Lingard. This report dealt specifically with the "North Elevation Wall" ie: the cracking to the rear wall to the sports hall store.

Report 2 (October 1997)

The second report was requested by Mr. E. Mann (Property Services) and was written by Mr. D. Davidson, and reported upon the condition of various sections of the building highlighted by both the building users and maintenance inspectors as requiring attention.

Report 3 (July 1998)

The third report was written by Mr. D. Davidson, and augmented the two previous reports in greater detail and provided strengthening solutions to the Sports Hall store and other areas, and also requested the whole building be investigated.

Report 4 (July 2001)

This the fourth report augments the previous reports above and will cover the following points:

- Comprehensive level survey of precast suspended floor units in order to gauge settlement.
- Soffit / screed removal inspection of all suspended slabs and 1st floor support systems suspected as being exposed to excessive movement and/or subject to cracking.
- Analysis of all steelwork and/or structural components subject to excessive movement and /or damage and/or burning out to accommodate services.
- Preliminary design of further strengthening schemes for costing purposes as required.
- Recommended further works / investigations as required.

The aim of this report is to outline what measures are required in order the structural stability of the Leisure Centre as a whole. The Sports Store has been covered in previous reports. The remedial / strengthening works will be listed in terms of priority in order to aid allocation of funds.

CONTENTS

The report is divided into the following components:

1. Floor Level Survey
2. Interpretation of Contour Plots
3. Inspection of Suspended Slabs and 1st Floor Support Systems
4. Analysis Of Structural Components
5. Strengthening Schemes For Costing Purposes.
6. Conclusions and Further Recommendations

Appendix 1: Photographic Plates

Appendix 2: Figures

Appendix 3: Floor Level Survey

Appendix 4: Beam 2 Web Stiffener Detail

1.0 Floor Level Survey.

The purpose of the floor level survey was to accurately determine the level of movement experienced by the floor units throughout the building; therefore providing a complete picture of settlement. This will in turn aid diagnosis of structural faults, and also help find problem areas that may not have previously been reported by building users and maintenance inspectors.

This was achieved by employing standard levelling techniques providing spot levels on a 1m square grid basis throughout the ground and first floors. One of the main advantages of a close grid survey is that localised unit failures can be pinpointed and highlighted for inspection.

All timber floors including the squash courts and sports hall were not levelled as they would not reflect the true deflection of the suspended / ground bearing concrete floors below. The removal of timber flooring to gain access to the concrete slabs below was not considered justifiable at this stage.

The results of the survey were plotted using "MOSS" computer software to provide a contour plot of the first and ground floor suspended units; when combined with the span directions and support positions of the units; the result is an accurate representation of the degree of movement experienced by the floors and hence the building as a whole.

The basic building layout was taken from original contract drawings and does not represent "as-built" accuracy. Therefore the floor level surveys should not be scaled off or relied in any way other than to act as a guide for aiding structural diagnosis.

See Appendix 1: Floor Level Survey

2.0 Interpretation of Contour Plots

2.1 Soft Spot Locations

- **Sports Hall Store / Polygym Rear Door Soft Spot:** Here the wall separating the sports hall store from the polygym has settled along its length pushing the external sports hall store wall out at its head (Report 3). The floor units and walls in both the polygym and the sports hall store all slope towards the rear door to the polygym. A slope of 1:40 can be observed in the Sports hall store area. This suggests there is a "soft spot" within the landfill below the area of the rear polygym door. This has probably been caused by using early vibro-replacement piling as a ground improvement technique in the 1970's, this technique relies on the use of "bottom feeding piling rig" which may not have been developed sufficiently at the time of the building's construction. The floor units in the sports hall store are not considered to have been subject to cracking, they have simply moved relative to each other, cracking the screed above, whilst the units remain structurally intact on an individual basis. Although monitoring of the building has revealed the on-going building movement to be very slow, remedial works including mini-piling should be instigated in this area to prevent further deterioration of the building fabric (Report 3) in the medium to short term.
- **Polygym Front Wall Soft Spot:** Here the contour plots show the floor sloping by 60mm over 3m (1:50) from the middle of the polygym to the front of the building. There is however no significant cracking in evidence in the building fabric other than cracks to the screed where units have settled next to each other. Therefore this suggests the settlement may have happened during construction and does not pose a threat to the building's fabric in the future, however annual surveys are recommended for walls in this area as large variations in ground water level may lead to heavy cracking.
- **Sports Hall Corner Next To Café Soft Spot:** Here the ground floor contour plot shows the floor of the café having a run of 1:50 towards the sports hall viewing area. This soft spot is also further evidenced by a slope of 1:60 across the ground floor corridor floor. The first floor contour plot shows a 1:100 fall across the crèche room above the supporting steel beam (see analysis of structural components), again falling to the corner of the sports hall. No evidence of the steel columns frames moving has been observed, this is probably due to the frames being founded on piles which bear in the sand / silt stratum below the soft landfill layer.

Therefore the level survey has confirmed all previous reports of where the soft spots are in the building, and has uncovered a previously unknown soft area to the front of the polygym.

2.2 1st Floor Corridor to Gym

Another area merited further investigation, the corridor on the 1st floor allowing access to the gym from the stairs shows signs upward bulging (1:100 slope), this is unusual and merits further investigation.

2.3 Minor Floor Level Variations

Various floor covering types and their locations are provided on the contour plots in order to their relative thickness into account when assessing small differences in levels between adjacent rooms for instance.

3.0 Inspection of Suspended Slabs and 1st Floor Support Systems

3.1 Areas Requiring Inspection

From the above interpretation it is evident that four areas require investigation. Of the four; one has already been fully investigated and strengthening solutions given (polygym / sports hall store – Report 3); the second has been partially investigated (crèche floor – access hatch required to complete survey from 3rd Report); the third has had only preliminary investigations before (polygym rear floor area); and the fourth has never been investigated (1st floor gym access corridor).

Therefore the following areas were investigated:

- **Crèche Room Floor** – investigate cracks to screed and determine if they continue through units.
- **Café Ceiling** – install new access hatches and inspect remaining unit soffits and floor support steelwork, also size up steelwork which has been subject to burning out of web for structural analysis.
- **Polygym Floor** – investigate cracks to screed and determine if they continue through units.
- **1st Floor Corridor to Gym** – investigate upward bulging at midspan.

3.2 Crèche Room Floor Inspection

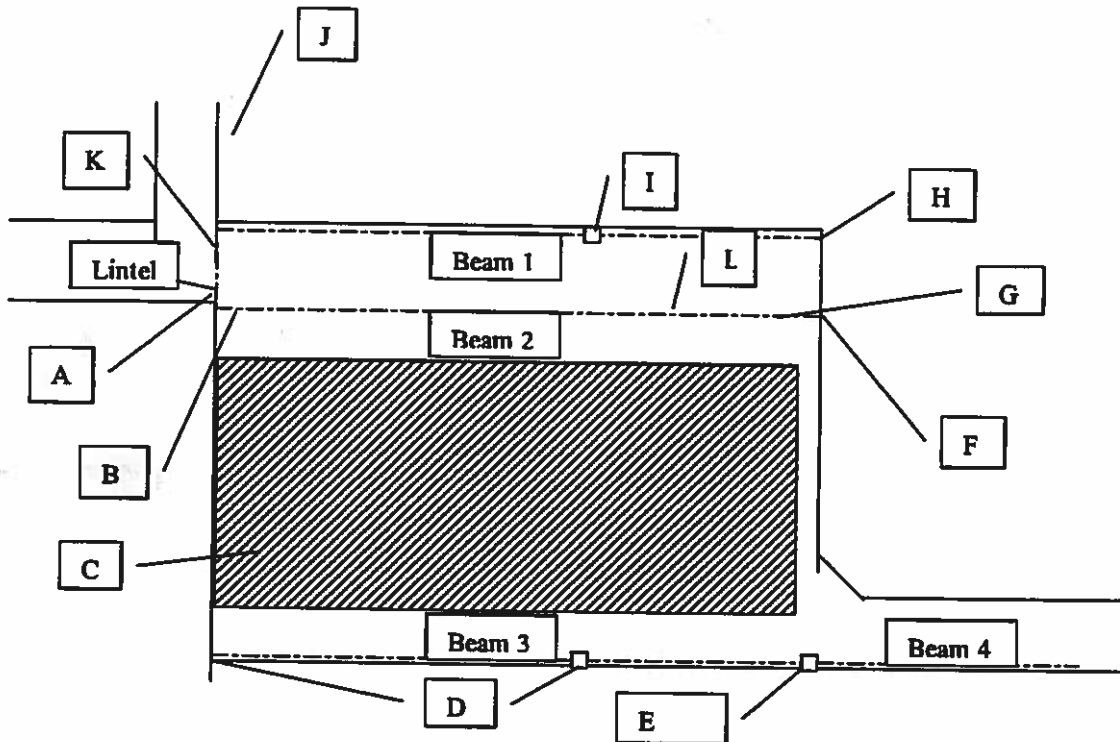
The crèche room floor has a measured slope of up to 1:100 falling towards the sports hall corner (Appendix 3), carpet tiles were removed to reveal cracking in the screed as per Figure 1.

Screed was removed in the area shown in Figure 1 and the cracking to the screed was found to be directly above the joint between two adjacent units and did not to continue through into any units and compromise their structural capacity (Plate 1).

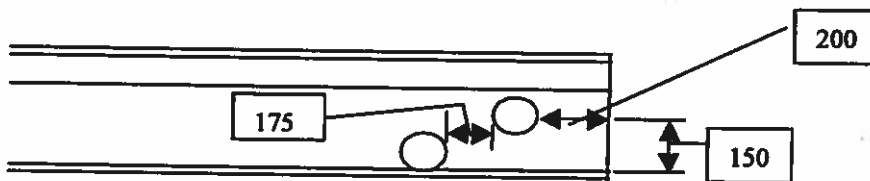
3.3 Café Ceiling

The survey to the café ceiling follows on from that in Report 3, the main purpose being to size up the steel beams for structural assessment, and inspect the remaining areas not accessible during the previous survey.

Café Ceiling Survey: 18/07/2001

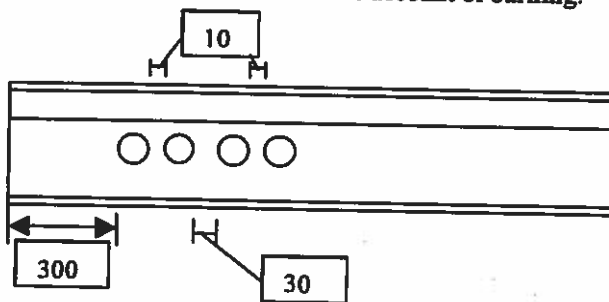


- A. Beam 2 has rotated anti-clockwise by approximately 2mm.
No padstone below bearing, this has resulted in signs of crushing and mortar loss to brick.
30mm service pipe through brick immediately below beam
Lack of access prevents full inspection
(Plate 2).
- B. 2no 100mm diameter ducts with 20mm insulation.
Take design size of ducts as 135mm to allow for weakening effect of burning on steel.



- C. No signs of cracking to soffit or concrete units, 2 no. 300mm wide infill panels in good condition.
- D. Beam 3 good condition continuous support over brick column good, but lack of concrete infill to slab edge (Plate 3).
No sign of crushing to bearings
Lack of access prevents full inspection.
- E. *Lack of access prevents full inspection*
10-15mm gap above Beam 4 padstone – no adjacent cracking, therefore gap likely to be due to poor construction.
Chasing cut in brickwork for services
(Plate 4)
- F. Padstone and bearings in good condition.

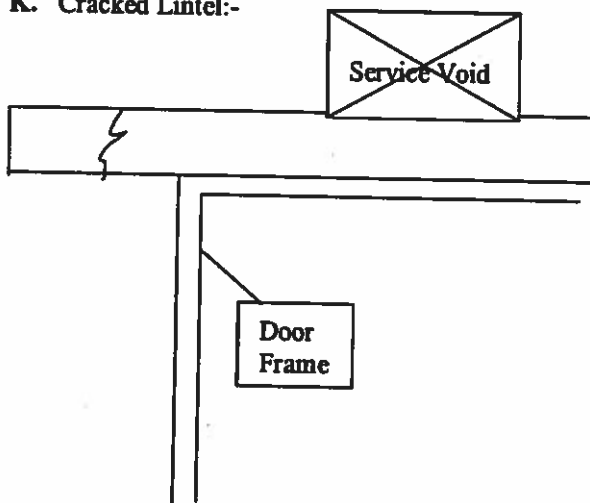
- G. 4 no. water pipes, listed from end of beam towards middle:
 35mm, 22mm, 25mm and 35mm.
 20mm insulation on all 4
 design diameters 80mm to take account of burning.



(Plate 5)

- H. Good condition, some loose mortar around padstone.
 I. Padstone in good condition.
 J. First 2m from lintel:
 Generally poor brickwork supporting slabs.
 Service ports directly under unit bearing, poorly filled
 Evidence of steel supporting units above wall.

- K. Cracked Lintel:-



- L. Service Voids Through Pre-Cast Units (Plate 6)

In summary the main problem areas in the Café ceiling are Beam B and its bearing nearest the sports hall. This beam and bearing require analysis and strengthening solutions as per Sections 3 and 4.

3.4 Polygym Floor Inspection

Carpet tiles were removed in the polygym where the contour plot shows a slope of 1:75 running towards the front of the building from the middle of the floor. The floor slopes away from the centre where a dummy wall supports the floor unit bearings. The ends of the units have rotated to form a crack which has been in evidence before and been repaired (Plate 7). The capacity of the floor units has not been affected.

As the floor slopes to the rear polygym door from the dummy wall, differential movements between adjacent units can be observed (Plats 8 & 9), again these movements only cause cracking in the screed and do not affect the structural capacity of the individual floor units.

3.5 1st Floor Corridor to Gym

The upward bulge shown in the 1st floor contour plot was investigated, hairline cracks in the screed were observed mid-span and the screed removed to confirm that the cracks did not progress into the units below. The structural capacity of the units is therefore unaffected.

4.0 Analysis of Structural Components

Beam 2

Each of the service openings in Beam 2 was analysed in accordance with the CIRIA / SCI Joint Publication "Design for Openings in the Webs of Composite Beams".

The four no. duct holes at position G were found to be positioned so as the structural capacity of the beam was not reduced below that which is required. The two no. duct holes at B however were found to be of such size and in their location do significantly reduce the capacity of the beam below that which is required in accordance with current British Standards.

Floor Units

The floor units above the café have been punched through to allow service access, this has not resulted in serviceability cracking in the units and has therefore not been subject to analysis and no strengthening is required.

4.0 Strengthening Schemes for Costing Purposes

The main area which requires strengthening is the sports hall store / polygym walls as detailed in Report 3.

Beam 2 requires two web stiffeners to be welded as per Appendix 4.

works

5.0 Conclusions and Further Recommendations

The following recommendations are listed in terms of priority:

5.1 Increased Frequency of Building Maintenance Inspections – Focusing on “Soft Spots”

The contour survey has revealed that the building is situated on three “soft spots”. It is recommended that the frequency of the maintenance inspections be increased from 2 years to an annual inspection looking for cracking in the three areas as follows:

- Sports Hall Store / Polygym Rear Door Soft Spot
- Polygym Front Wall Soft Spot
- Sports Hall Corner Next To Café Soft Spot

See 2.1

Any obvious movements to the building structure in these locations observed by the maintenance inspectors should be investigated by this Department. These increased frequency inspections are recommended to be carried at the earliest opportunity.

5.2 Provide Angle Support to Cracked RC Lintel in Café Doorway

As in Report 3 - 9 July 1998 5.5.3

FB. \$1000 121 02/03

Install 200 x 200 x 16 RSA bolted to the wall via 4 no. M16 “Rawbolts” or similar approved. The angle should be shimmed tight to the underside of the lintel via steel shims and non-shrink grout. NB: this may require installation of new doors and frame.

Also fanlight by omitting same same frames from door lintel up

Although propping is not required, the lintel should be supported at the earliest opportunity.

5.3 Strengthening of Beam2 in Café Ceiling

Webs stiffeners should be installed in Beam 2 as per Appendix 4, due to the significant loss in section capacity, this is recommended to be carried out in the short term.

FJS \$1500 221 02/03
FV

5.4 Strengthening of Sports hall Store / Polygym

As in Report 3 - 9 July 1998 5.4

Please refer to previous report.

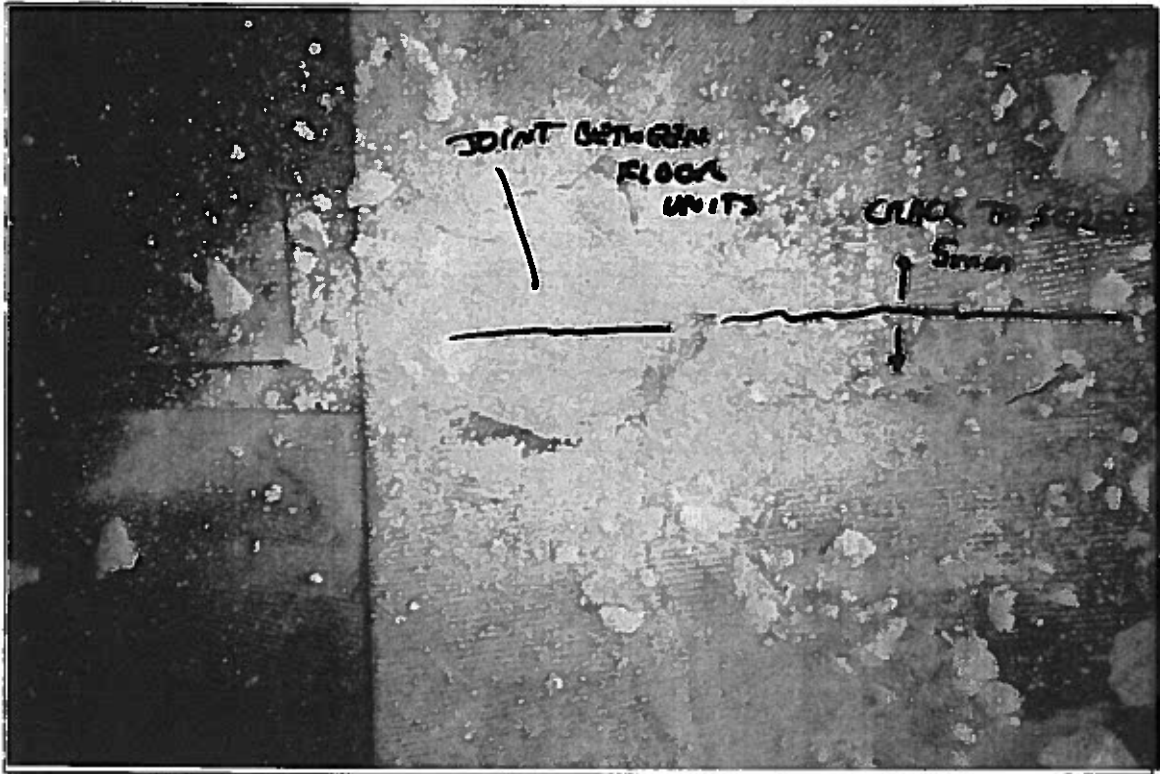
The building was monitored for a year and showed only slow progressive movements, the above strengthening measure are therefore recommended to be carried out in the short to medium term.

Appendix 1: Photographic Plates



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Structure Name: LOCHSIDE LEISURE CENTRE



Defects: 5mm CRACK TO SCAFFED ABOVE JOINT BETWEEN ADJACENT FLOOR UNITS

Comments: NO COMPROMISE TO STRUCTURAL CAPACITY OF FLOOR UNITS.

Plate No.: 1

Location: CRECHE ROOM FLOOR

Date: 17/7/11

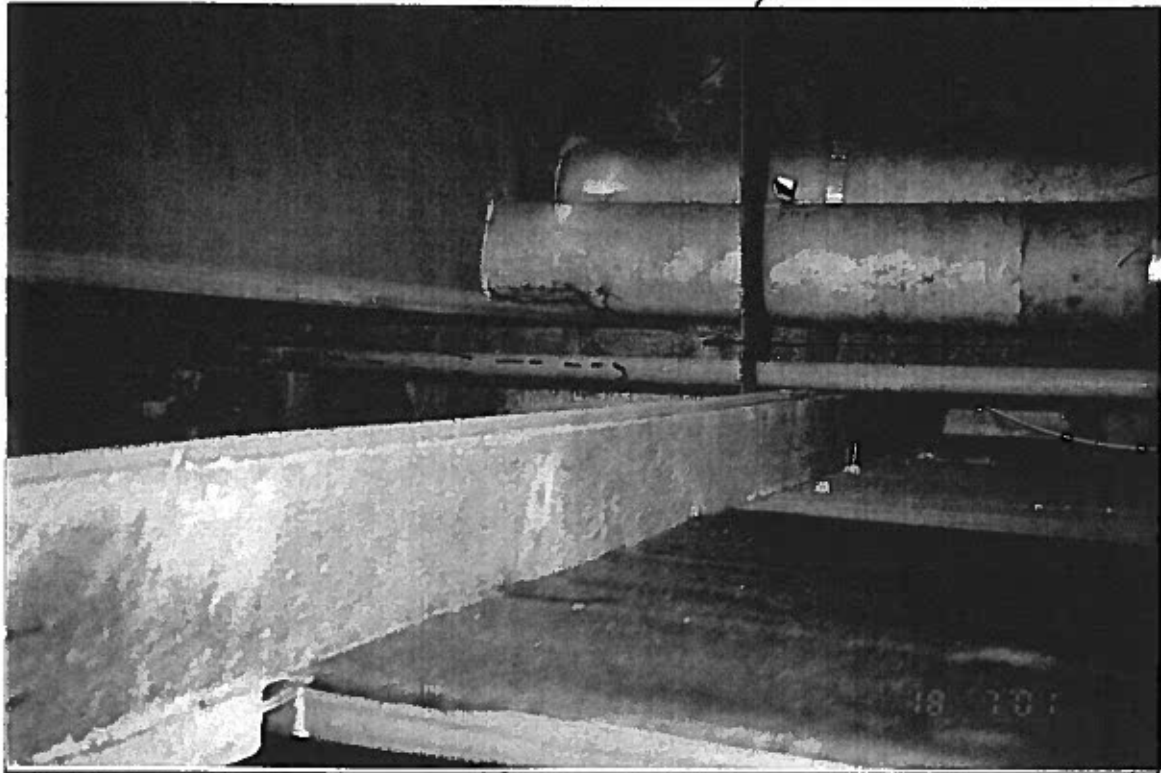
Signature: Derek Davidson.



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Structure Name: LOCHSIDE LEISURE CENTRE

2mm GAP DUE TO ROTATION



DUCTS THROUGH WEB
NEED
SUPPORT

NO
PADS

Defects: NO PADSTONE BELOW BEAM, 2mm ANTI - CLOCKWISE ROTATION AT BEAM TOP FLANGE, 30mm DIA. SERVICE PIPE BELOW BEARING, 2 NO. 125mm DIA. DUCT HOLES GUMED IN WEBS.

Comments:

Plate No.: 2

Location: CAFE CEILING
BEAM 2 BEARING MUST. SPORTS HALL.

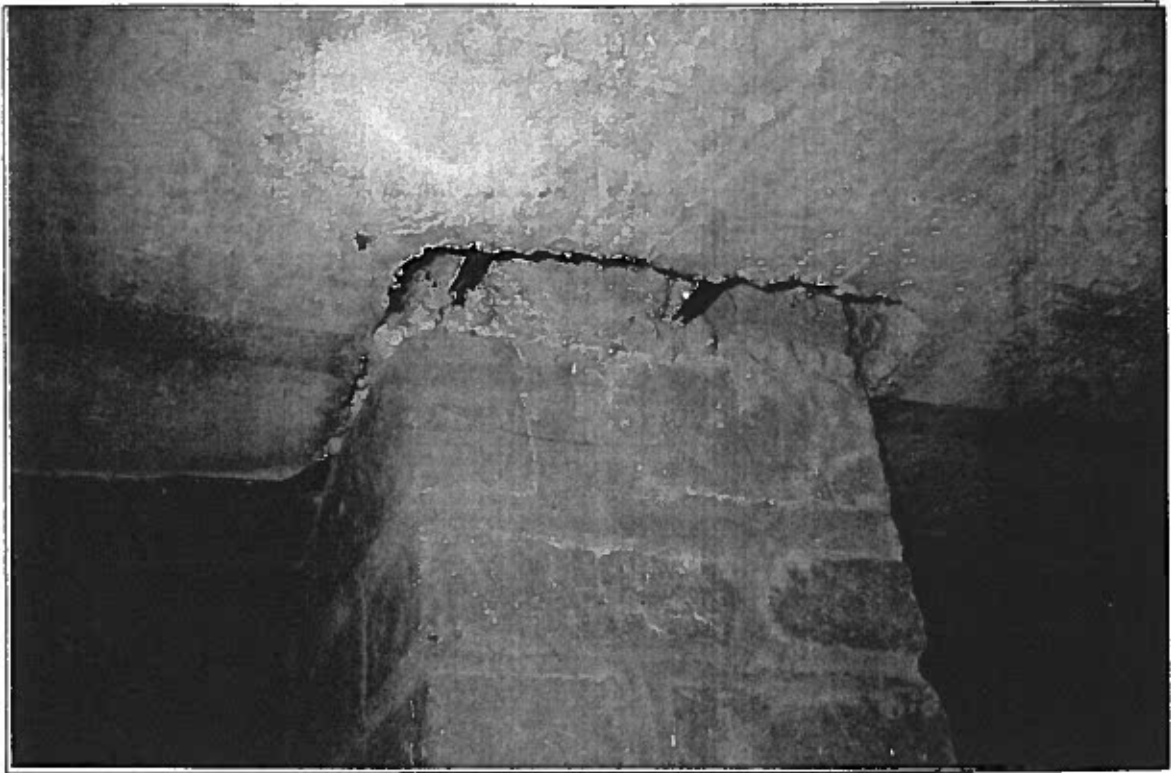
Date: 18/7/11

Signature: Derek Davidson.



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Structure Name: LOCHSIDE LEISURE CENTRE



Defects: LACK OF CONCRETE INFILL BETWEEN PRECAST UNITS AND MASONRY COLUMN.

Comments: EXPOSED RE-BARS PROBABLY USED AS A MAKESHIFT BEARING WHEN PRECAST SLABS FOUND OUT TO BE CUT TO WRONG SHAPE.

Plate No.: 3

Location: CAFE CEILING - BEAM 3

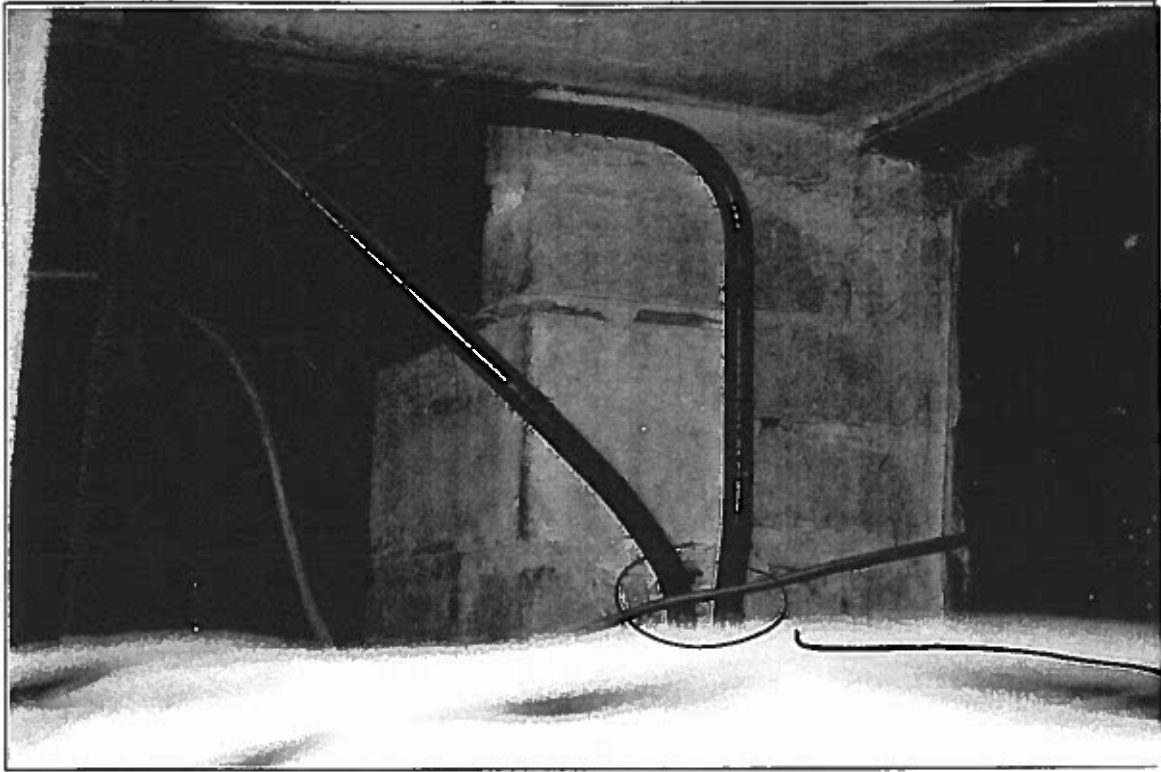
Date: 18/7/11

Signature: Derek Davidson.



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Structure Name: LOCKSIDE LEISURE CENTRE



CHASING
CUT IN
BRICKWA

Defects: 10-15mm GAP ABOVE PADSTONE, PROBABLY DUE TO POOR CONSTRUCTION.

Comments: LACK OF ACCESS TO OPPOSITE

Plate No.: 4

Location: CAFE CEILING - BEAM

Date:

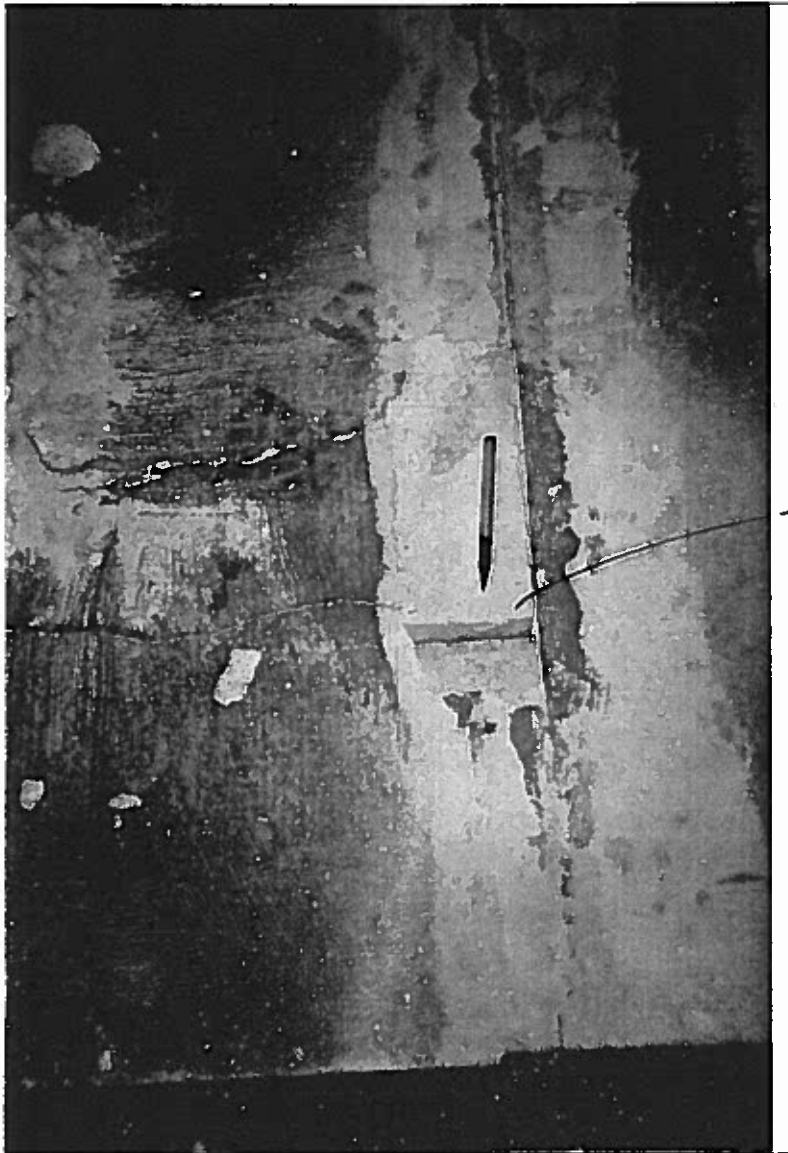
Signature: Derek Davidson.



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Structure Name: LOCHSIDE LEISURE CENTRE

Defects:



END OF UNIT

Comments: CRACKS IN SCAFFOLD ONLY - UNIT UNAFFECTED.

Plate No.: 9

Location: POLYGYM.

Date: 18/7/11

Signature: Des Dailson.

Appendix 2: Figures

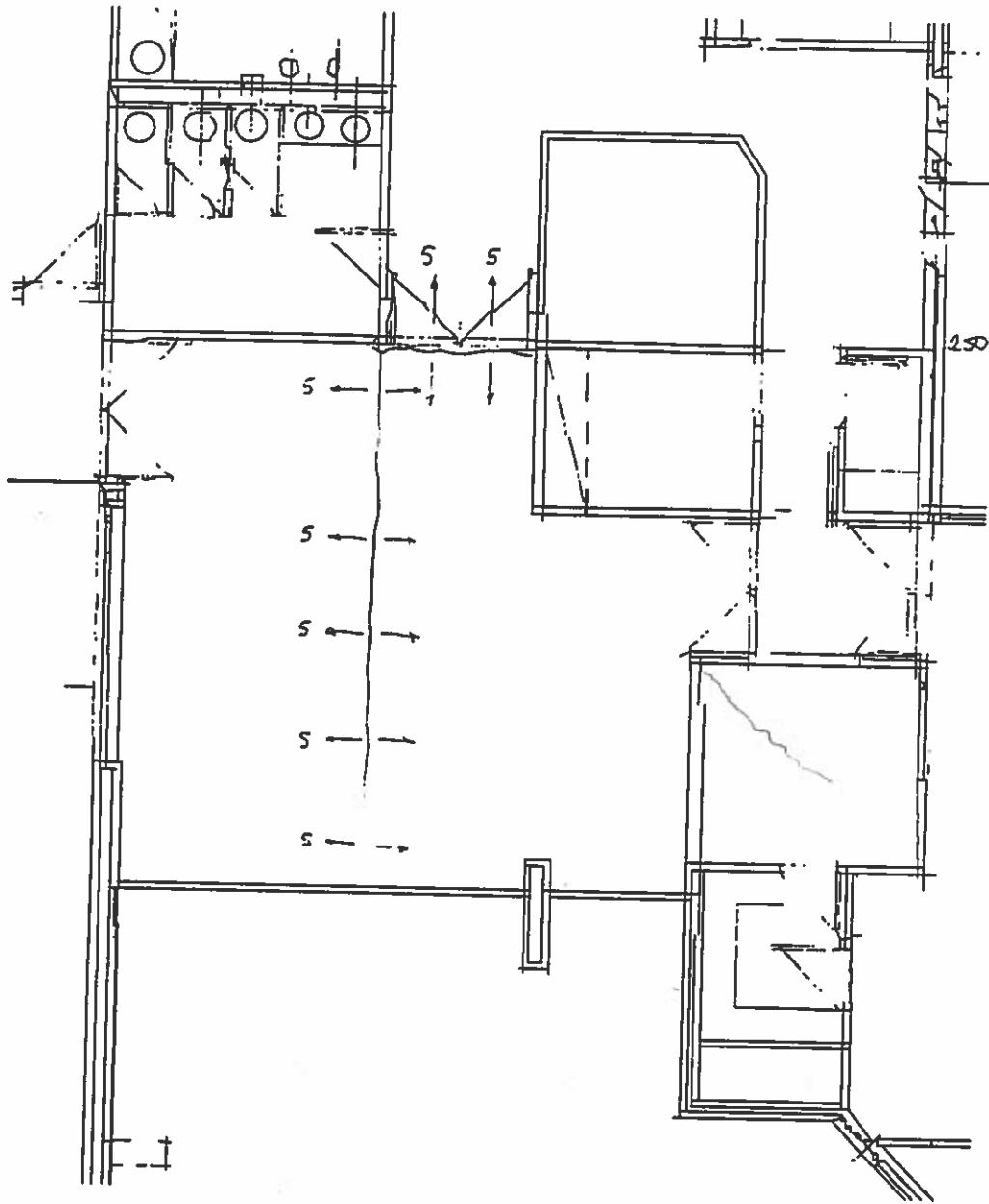


Figure 1: Creche Room: Cracking to Floor Screed

Appendix 3: Floor Level Survey



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Structure Name: LOCKSIDE LEISURE CENTRE



Defects: 4 NO. SERVICE DUCTS BURST THROUGH WEB

Comments: BEARING & PADSTONE IN GOOD CONDITION.

Plate No.: 5

Location: CAFE CEILING, BEAM 2 BEARING

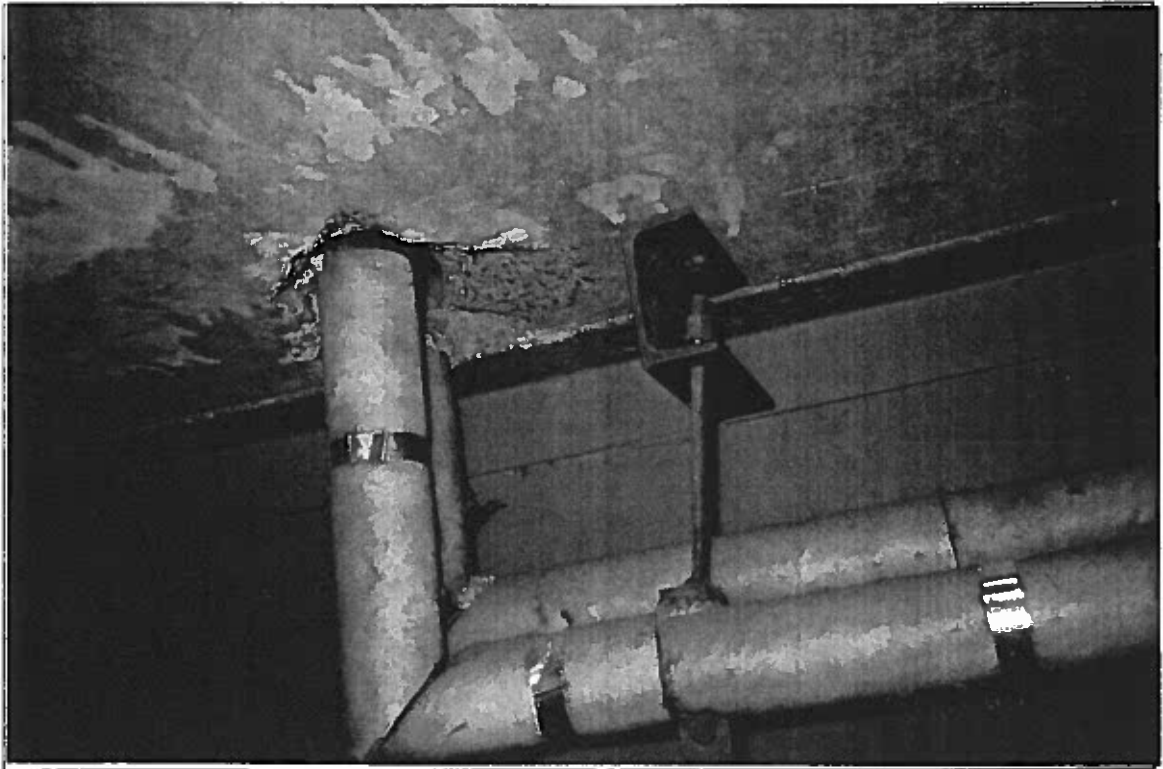
Date: 18/7/11

Signature: Derek Davidson.



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Structure Name: LOCHSIDE LEISURE CENTRE



Defects: Holes cut in precast units.

Comments: Evidence of steel beam continuing through depth of slabs can be observed.

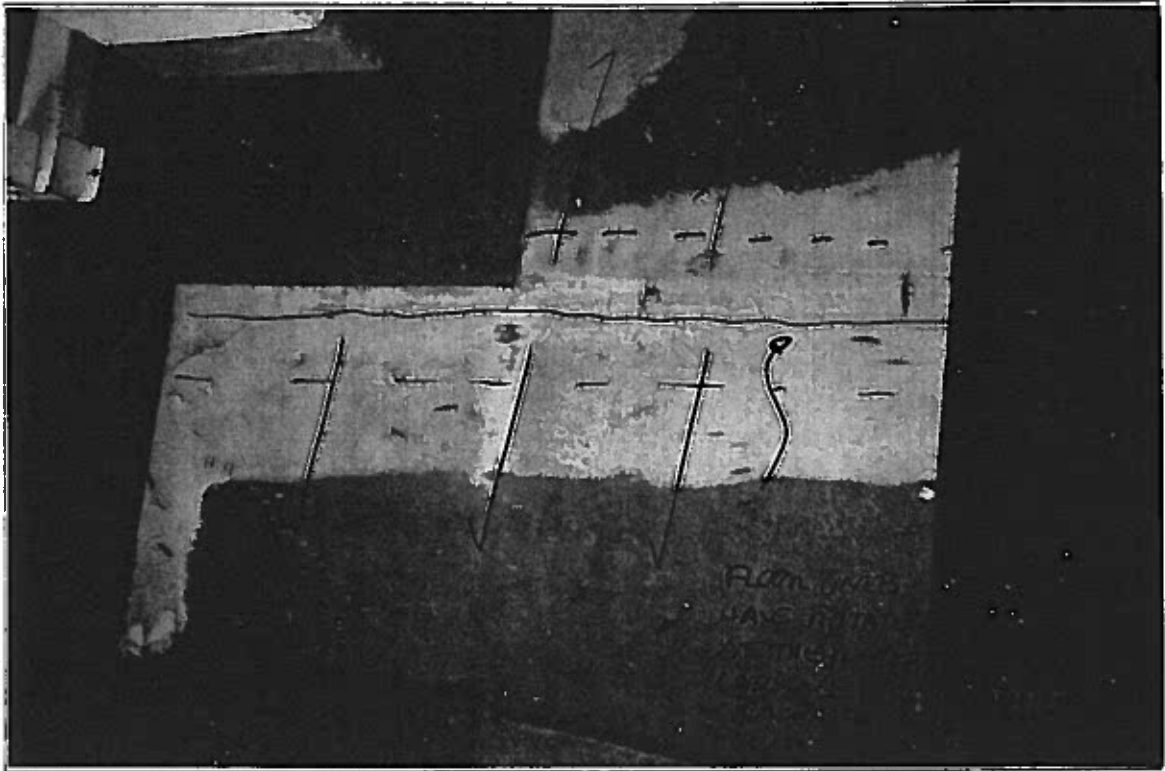
Plate No.: 6 Location: CAFE CEILING (L)

Date: 18/7/11 Signature: Derek Davidson.



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Structure Name: LOCHSIDE LEISURE CENTRE



Defects: LONG TERM RC REPAIR MADE TO ENDS OF WALL

Comments: CRACK CAUSED BY OVERALL ROTATION OF FLOOR :

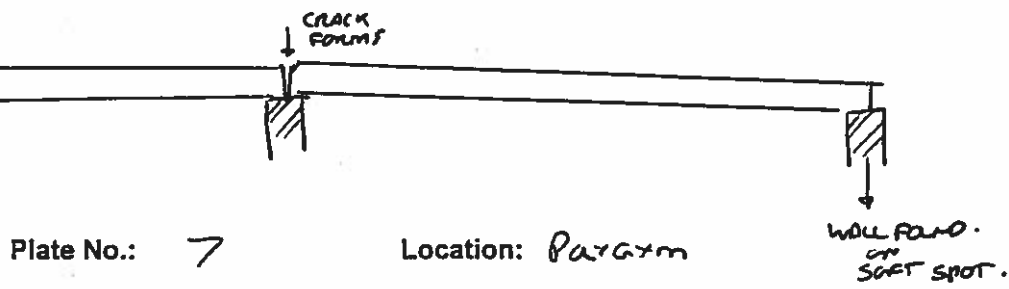


Plate No.: 7

Location: PAUGYM

Date: 18/7/11

Signature: Derek Davidson.

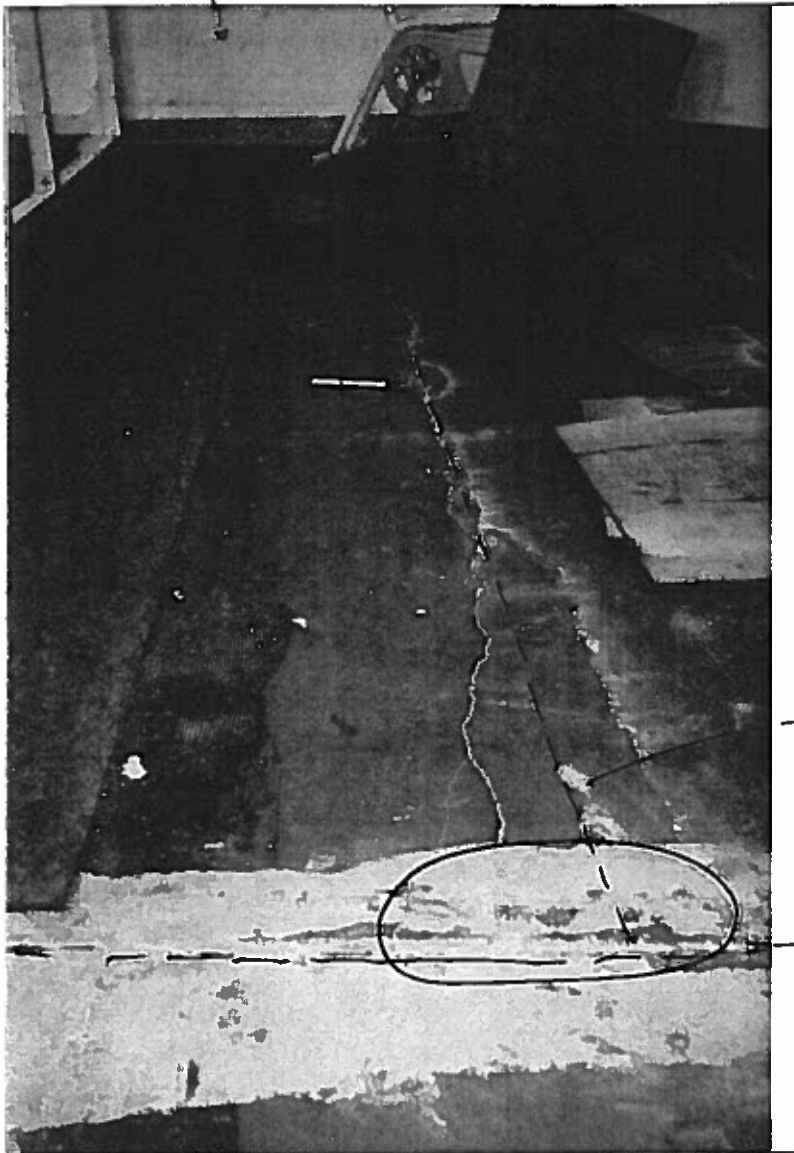


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Structure Name: LOCHSIDE LEISURE CENTRE

REAR WALL

Defects:



Comments: Cracks in screed caused by LHS units deflecting relative to RHS unit

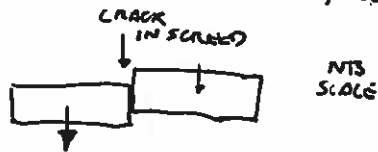


Plate No.: 8

Location: POLYGYM

Date: 18/7/11

Signature: Deek Davidson

Appendix 4: Beam 2 Web Stiffener Detail