

Engineering investigation report



CLIENT

CLIENT REF

Kamarooka Hall 7720 Kamarooka Store Road
KAMAROOKA VIC 3570

Client Ref:

Kamarooka Hall, 420 Kamarooka Store Road, KAMAROOKA, VIC 3570

©

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The opinions expressed in this document are based upon a visual inspection conducted with reasonable care. Areas not reasonably accessible and not readily viewed without disturbing the existing structure, finishes or furnishings have not been inspected, unless noted otherwise.

[REDACTED] has not carried out a review with respect to combustibility, fire resistance or fire safety provisions of the external insulation and finishing system, wall panelling, cladding or façade material or any associated fixing system that is to be or that may be applied to this project. Cladding systems must comply with the Building Code of Australia, the NCC, relevant Australian Standards and any other applicable regulations and test requirements. [REDACTED] advises that project specific advice with respect to fitness for purpose and statutory compliance of any proposed cladding materials shall be sought from a suitably qualified and experienced Materials or Fire Services Engineer.

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Document Status

REV	AUTHOR	REVIEWER	ISSUE DATE
0	[REDACTED]	[REDACTED]	[REDACTED]

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1.0 Introduction

- 1.1 [REDACTED] has been engaged by [REDACTED] to undertake an engineering investigation of the damage to Kamarooka Hall, 420 Kamarooka Store Road, KAMAROOKA, VIC 3570. A site inspection was carried out by [REDACTED] Forensic Engineer at [REDACTED] on 23 February 2024, in the presence of the property coordinator, [REDACTED].
- 1.2 [REDACTED] received the following instructions, dated 21 February 2024:
- "Council claim storm damage to various sites following significant storms 2nd and 7/8th January 2024.*
- Many sites have sustained minor damages, however, the Kamarooka Hall appears to have sustained significant movement, per attached photo.*
- Please undertake site inspection, verifying the cause and origin of the damage, structural integrity of the damaged building and provide scope of works for reinstatement of the storm damage, also identifying any maintenance issues for rectification."*
- 1.3 There are concerns that damage to the building may have been caused by one of the storms which occurred on 2, 7 or 8 of January 2024 ('the Event').
- 1.4 The purpose of [REDACTED]'s investigation is as follows:
- Observe and record the extent of damage to the building.
 - Provide an opinion as to whether the Event may have caused, or contributed to, the observed damage.
 - Provide an opinion as to the cause(s) of the observed damage.
 - Report on the findings of the investigation and provide recommendations where appropriate.
 - Prepare a scope of works for event related damage.
- 1.5 Photographs taken during the inspection are provided in Appendix A. These photographs are referenced in the report as [1], [2], [3] etc. A floor plan / floor level survey is provided in Appendix B.

2.0 Description of site and building

2.1 For the purpose of this investigation, project north is shown in Figure 2.1.



Figure 2.1 - Google Earth aerial photograph dated November 2022. Note the trees in relatively close proximity to the building.

2.2 The subject building is a single storey weatherboard building, understood to have been constructed circa 1900, and its general construction comprises:

- Roof – Corrugated metal sheeting supported on conventional timber framing and expected timber trusses added recently.
- External walls – Timber framed stud walls with weatherboard cladding externally and internally.
- Internal wall – Timber framed stud walls with timber cladding.
- Floor – Timber framed construction supported by the footings.
- Footings – Timber stumps with isolated pad footings supporting the walls and internal floor areas.

2.3 The subject site slopes slightly down towards the west, which is generally consistent with the natural topography of the surrounding area.

2.4 There are several mature trees in relatively close proximity to the building perimeter.

2.5 The ground immediately adjacent to the perimeter of the building is unsealed.

3.0 Investigation

Information provided by the owner's representative

3.1 At the time of inspection, the owner's representative offered some background information.

Matters of relevance are paraphrased as follows:

- The inclination/leaning to the building was first observed following the storm events which occurred in early January 2024.

Site observations

3.2 The site observations are not intended to be a complete list of observations, damage or defects.

■ made the following relevant observations during the inspection:

3.3 External

- The west end of the building is leaning towards the west by 3.2° (56mm/m) [1]. Refer to Appendix B for the inclination/leaning measured in other regions of the building.
- Temporary bracing has been installed as part of the make safe works [1].
- The ground immediately adjacent to the building perimeter is unsealed [1-2].
- Timber splitting, detachment/misalignment to the weatherboard cladding [3-4].
- Dilapidation to the window frames along the building perimeter including timber splitting and damaged to the sealing [5].
- Cracked dried soil surface adjacent to the building perimeter [6].

3.4 Internal

- The west end of the building is leaning towards the north by 3.2° (56mm/m) [7-9].
- Deformation of the western wall [8].
- Staining to some of the exposed timber studs of the western wall of the building [10-11].
- Detachment/misalignment of the internal lining boards of the wall on the east side of the stage [13].
- Detachment/misalignment of the internal lining boards of the northern wall [14].
- Pre-existing splitting to the internal lining boards of the northern wall [15].
- Detachment of the timber cornice and cracking to the ceiling boards on the north end of the hall [16].

3.5 Subfloor

- Variation of ground surface levels in the subfloor space [17].
- Loss of material to a perimeter timber stump [18].
- Decay to a perimeter timber stump [19].
- Minor decay to an internal timber stump [20].

Floor level survey results

- 3.6 A floor level survey (consisting of spot levels) of the ground floor was undertaken using a 'ZIPLEVEL® PRO-2000', manufactured by Technidea. The manufacturer's specifications indicate that the levels measured are accurate to within $\pm 2\text{mm}$. Refer to Appendix B for a graphical representation of the results. Note that the levels have been approximately adjusted to account for steps and changes in the floor finishes.
- 3.7 Zero was assigned to the lowest point identified in the survey which was recorded at the southwest corner of the building. The highest point in the survey was recorded in the kitchenette area. The maximum difference in floor levels recorded was 54mm.
- 3.8 There is a general pattern of lower levels towards the southwest corner of the building.

Site geology and foundation soil reactivity

- 3.9 The Australian Standard AS2870–2011 *Residential slabs and footings* enables assessment of the foundation soils at a given site by identification of the mapped soil profile without taking site specific soil samples. To that end [REDACTED] has undertaken the following for the subject site:
- Review of the Geological Survey of Victoria maps. These maps indicate that the subject site is located within the province of ordovician aged silt deposits. Referring to the AS2870–2011, Table D1, it is known that this soil profile is reactive.
 - Review of the Climatic Zone maps provided in AS2870–2011 Figures D1 and D2. These maps indicate that the subject site is located within Climatic Zone 4. Therefore, referring to AS2870–2011 Table 2.5, the depth of soil suction (i.e. the depth of soil affected by normal climatic moisture variations) for the subject site is expected to be 3.0m.
 - Review of [REDACTED]'s extensive database of geotechnical information (e.g. borelogs, soil testing results, soil reports) of nearby sites with similar geological and climatic characteristics, which also indicates that the soil profile at the subject site is reactive.
- 3.10 Based on the findings of the above desktop review, and general site observations, [REDACTED] expects the foundation soils at the subject site to be slightly to moderately reactive (i.e. class S/M type reactivity in accordance with AS2870-2011).
- 3.11 Reactivity is the term used to describe the tendency of clay soils to swell upon wetting and to shrink upon drying.
- 3.12 When buildings are founded on reactive clay soils, differential variations in the foundation soil moisture content can result in building movement related damage i.e. if the moisture content increases the clay soils tend to swell resulting in "heave" of the building footings, and if the

moisture content decreases the clay soils tend to shrink resulting in "settlement" of the building footings.

- 3.13 'Normal' soil moisture conditions are present where a given site is subject to normal moisture variations caused by seasonal and regular climatic effects, effects of the building and subdivision, and normal garden conditions. AS 2870-2011 Table 2.3 indicates that moisture variations due to 'normal' soil moisture conditions may result in vertical surface movements in reactive clay sites, with the magnitude of movement being dependent on the degree of reactivity, as follows:

SOIL REACTIVITY	CHARACTERISTIC SURFACE MOVEMENT (y_s)
S	$0 < y_s \leq 20$
M	$20 < y_s \leq 40$
H1	$40 < y_s \leq 60$
H2	$60 < y_s \leq 75$
E	$y_s > 75$

- 3.14 However, in the presence of 'abnormal' soil moisture conditions the magnitude of surface movements is expected to be much higher and consequently there is an increased risk of building movement related damage occurring. Factors that can contribute to 'abnormal' moisture conditions are described in AS2870-2011 Section 1.3.3 and include, but are not limited to, the following:

- Tree root drying effects of trees in the vicinity of the building.
- Removal of existing trees in the vicinity of the building.
- Excessive or irregular watering of gardens adjacent to the building.
- Failure to maintain appropriate site drainage.
- Failure to repair plumbing leaks.

- 3.15 AS2870-2011 Appendix B provides recommendations for site maintenance in order to avoid the development of abnormal moisture conditions. However, [REDACTED] observed the following adverse conditions at the subject site that are contributing to abnormal soil moisture conditions:

- The presence of trees in close proximity to the building.
- The absence of a protective paving adjacent to, and sloping away from, the external walls/footings of the building.
- Unsealed ground immediately adjacent to the building.

Wind gust records

3.16 [REDACTED] has reviewed the wind gust records taken by the Bureau of Meteorology ('BOM') closest meteorological station (located 31Km away from the subject site), and found that a maximum wind gust of 69km/h (19m/s) was recorded from the southwest on 2 January 2023 at 1:40 pm; refer to Figure 3.1. [REDACTED] note that there were wind gusts of the same or similar magnitude recorded prior to the date the damage was noticed, most notably on 12 October 2023 and 8 September 2023 where 69km/h (19.2m/s) and 67km/h (18.6m/s) were recorded respectively. However, the movement of the hall is consistent with wind pressure from a south-westerly direction.



Australian Government

Bureau of Meteorology

HOME

ABOUT

MEDIA

CONTACTS

NSW

VIC

QLD

WA

SA

Bendigo, Victoria

January 2024 Daily Weather Observations

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9 am			3 pm								
		Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSLP
		°C	°C	mm	mm	hours	km/h	local	°C	%	g th	km/h	hPa	°C	%	g th	km/h	hPa			
1	Mo	12.7	31.9	0			NNE	35	11:56	20.0	61		E	15	1019.6	30.3	35	2	N	17	1015.4
2	Tu	17.5	31.9	0			SW	69	13:40	22.7	61	8	E	19	1015.4	17.9	91	8	SW	35	1012.9
3	We	16.8	30.6	30.8			SSE	46	19:42	21.6	81	5	ENE	11	1014.5	29.4	52		N	13	1012.0
4	Th	17.9	29.1	0			SSE	39	09:33	19.5	74	8	SSE	19	1017.0	28.0	46		S	19	1016.3
5	Fr	17.1	32.1	0			SE	35	21:31	22.5	65	5	ESE	17	1019.6	31.2	38	2	ENE	9	1016.7
6	Sa	18.0	31.0	0			NE	33	11:24	23.2	58		NE	17	1018.6	29.3	40		NNE	20	1015.1
7	Su	18.2	20.8	3.8			NE	33	04:18	18.2	90	8	NE	17	1012.0	18.2	96	8	E	13	1009.1
8	Mo	17.6	25.0	91.8			WSW	35	14:51	20.8	88	8	SSW	7	1007.6	23.2	75	7	WSW	17	1008.6
9	Tu	16.1	29.1	0.2			SSE	30	02:24	21.3	66		SE	15	1012.1	27.2	47	1	NNE	11	1010.3
10	We	15.9	32.3	0			W	43	13:28	22.9	67		N	7	1012.4	31.0	25		W	22	1012.0
11	Th	14.2	31.8	0			SE	37	18:17	19.8	60		SE	19	1018.4	30.3	29		SSE	11	1017.4
12	Fr	12.4	35.8	0			SSE	35	21:53	23.5	65		ENE	13	1017.5	33.5	42		NE	11	1014.1
13	Sa	19.8	29.9	0			SSE	46	18:52	22.3	58		SSE	20	1015.4	26.3	49	7	SSE	24	1015.7
14	Su	13.8	28.6	0			SSE	46	05:23	18.2	50	8	SE	19	1018.8	27.7	35		SSE	20	1016.6
15	Mo	17.2	30.3	0			NNE	37	10:20	23.0	60	3	E	15	1018.9	29.1	42	8	NE	19	1015.8
16	Tu	17.7	29.6	0			NE	39	07:54	21.4	56		NE	28	1014.1	28.9	47	8	NNE	20	1009.1
17	We	17.6	24.6	22.8			SW	39	13:38	17.6	91	8	WSW	20	1005.8	22.7	54	5	SW	19	1003.5
18	Th	11.4	23.7	6.4			W	43	14:20	14.7	62	2	SW	22	1007.5	21.6	45	8	WSW	28	1006.3
19	Fr	10.1	26.4	0			SW	28	23:59	15.3	69	8	SSW	9	1011.6	24.7	36		WNW	13	1009.1
20	Sa	13.2	27.3	0			NNW	30	13:19	17.4	72	7	ESE	6	1008.9	26.3	35	5	N	15	1006.1
21	Su	13.0	25.1	0			SW	43	11:57	18.2	62		SSW	17	1005.6	23.0	46	1	SSW	20	1007.4
22	Mo	12.5	24.2	0			S	39	04:13	15.3	59		SSE	22	1013.4	22.9	42		SSE	22	1013.0
23	Tu	11.4	31.0	0			SSE	24	23:02	18.4	60		SE	13	1012.8	29.4	26		NNE	11	1009.3
24	We	16.2	34.2	0			NW	39	12:11	22.5	59	8	NW	7	1007.4	31.4	37	6	NW	20	1006.4
25	Th	20.2	22.4	0.2			ENE	19	08:54	20.4	79		ESE	6	1008.4	17.7	86	8	SE	11	1006.3
26	Fr	12.5	23.7	15.4			SW	41	12:27	16.3	79	1	W	17	1007.1	22.2	36	4	SSW	22	1007.4
27	Sa	7.5	24.7	0.2			WNW	39	15:26	15.2	66		SW	15	1009.4	23.0	37	1	WSW	20	1007.4
28	Su	12.2	28.2	0			SSW	26	08:52	17.4	69		SW	15	1012.3	26.0	40		NNE	11	1010.1
29	Mo	14.1	32.4	0			SSE	46	22:08	23.0	59		ENE	6	1010.8	31.0	33		W	9	1009.4
30	Tu	15.3	31.5	0			S	46	20:23	19.2	65		SSE	19	1013.7	30.2	29		W	13	1011.4
31	We	12.8	25.8	0			SSE	43	12:27	16.6	61		SSE	24	1015.2	23.7	42		SSE	22	1014.5
Statistics for January 2024																					
Mean		14.9	28.5							19.6	66	6		15	1013.0	26.4	45	5		17	1011.1
Lowest		7.5	20.8	0						14.7	50	1	#	6	1005.6	17.7	25	1	#	9	1003.5
Highest		20.2	35.8	91.8			SW	69		23.5	91	8	NE	28	1019.6	33.5	96	8	SW	35	1017.4
Total				171.6																	
IDCJDW3008.202401 Prepared at 16:01 UTC on Saturday 16 March 2024																					

Figure 3.1 – BOM windspeed records taken during the reported storm Events.

Site Address:

Kamarooka Hall, 420 Kamarooka Store Road, KAMAROOKA, VIC 3570

Review of relevant provided documents

- 3.17 Reviewed correspondence and renovation plans prepared by [REDACTED], dated September 2010, indicates that due to deterioration and sinking of the perimeter stumps, the external stumps and some floor bearers and joists were required to be removed and replaced; refer to Figures 3.2 and 3.3.

Following our phone conversation this morning I confirm the following:

- The external stumps of the building will need replacing
- The internal stumps may be left in place if in good condition (per inspection).
- The timber floor bearers and joist will only require replacement where required
- The floor boards may be left or replaced where required.

The flooring system only needs replacing if they are in poor condition. The floor convexes as the external stumps have either dropped or deteriorated. I understand that GFC reblocking may be engaged to completed the necessary works. I am only too happy to make a site visit during the re-stumping works, to assist in determining what timbers require replacement and what can be re-used.

Kind Regards

Figure 3.2 – Extract from [REDACTED] correspondence indicating remediation works to the footing of the subject building.

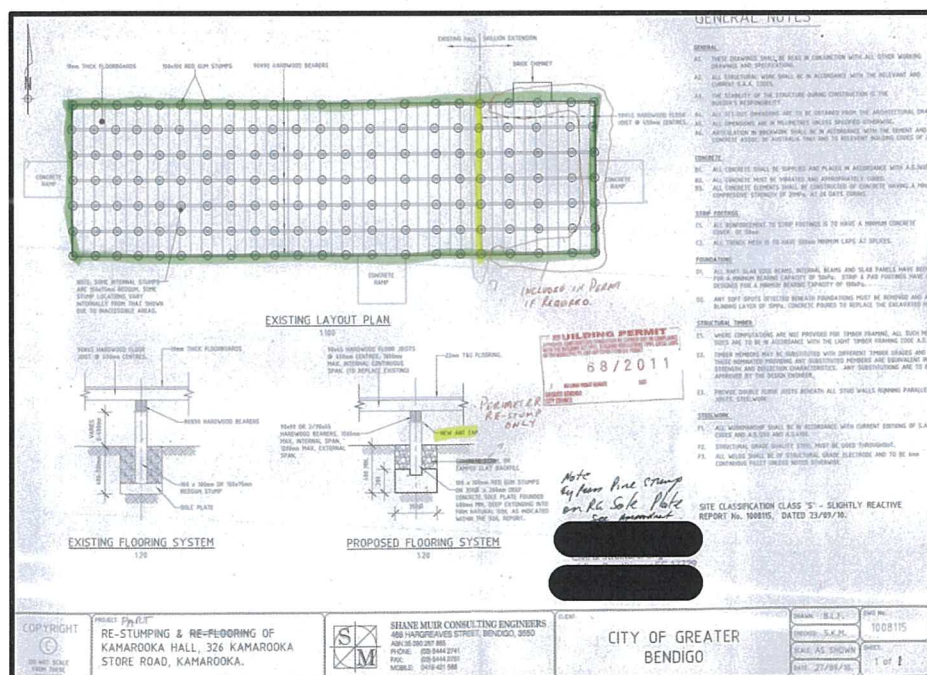


Figure 3.3 – Extract from a plan prepared by [REDACTED] dated 27 September 2010 indicating the re-stumping works to be conducted to the subject building.

Client Ref: [REDACTED]
Site Address: Kamarooka Hall, 420 Kamarooka Store Road, KAMAROOKA, VIC 3570

3.18 A reviewed building inspection report prepared by DAV Building Constructions Pty. Ltd (DAV), dated 1 June 2017, indicates that termite damage was observed to some structural elements of the building, particularly in the roof area; refer to Figure 3.4.

1st June 2017

Building Inspection, Observations, and Estimated Repair Costs

Location:
Kamarooka Public Hall
326 Kamarooka Store Rd, Kamarooka

For:
City of Greater Bendigo

Observations:

- Although termites have caused significant damage to structural elements of the building none were observed on the day of inspection. It is likely that this damage may have occurred several years ago.
- Only hardwood timbers have been visibly attacked.
- Timber members that have been damaged and should be replaced or repaired include: ceiling battens; hip rafters; common rafters; jack rafters; collar ties; top plates; studs; eave blocking; roof battens; hanging beam; ridge beam; cleats and propping.
- Diagram A shows the area inspected inside the roof space (orange section only). The (*) show the area where termites have most likely gained access into the roof space via the walls.
- Diagram B (next page) shows the approximate position of photographs that were taken showing some of the damaged structural timber members.

Diagram A:

OF SPILLING AND HANGING BEAMS

AREA INSPECTED AND NOTED FOR HAVING TERMITE DAMAGE

SKILLION

Figure 3.4 – Extract from the inspection report prepared by [REDACTED] dated June 2017 indicating termite damage to some building elements.

3.19 A reviewed building permit BP/2/2018 dated 8 February 2018 indicates that re-roofing works to remediate termite damage to the subject building were approved in early 2018.

4.0 Discussion

- 4.1 There are concerns that damage to the building may have been caused by one of the storms which occurred on 2, 7 or 8 of January 2024 ('the Event').

Pre-event building condition

Timber stumps

- 4.2 With respect to the condition of the timber stumps, a visual inspection of some of the perimeter an internal timber stumps indicates minor decay and loss of material evident below the sub-floor surface. The observed decay and loss of material has occurred over many years and is not the result of a single one-off event. Note that perimeter stumps were replaced circa 2010 following the observation of damage (to the timber stumps) during building inspections conducted by [REDACTED]
- 4.3 The lack of adequate impervious paving around the building and the lack of adequate graded surface drainage in the subfloor space have facilitated water pooling around the stumps during several rainfall events contributing to the observed damage to the timber stumps.

Differential footing movement

- 4.4 The floor levels survey included in Appendix B indicates notable variations in the floor levels throughout the building, with a general pattern of lower points towards the southwest corner of the building.
- 4.5 As noted in section 3, there are different adverse factors/conditions at the subject site, including the presence of mature trees in close proximity to the building, which are contributing to abnormal moisture conditions of the foundation soils and, therefore, to the observed footing movement.
- 4.6 As such, the observed differential building movement has been caused by natural dilapidation of the timber stumps combined with on-going long-term fluctuations in the moisture content of the foundation reactive soils due to the combined effects of:
- Soil drying caused by the trees located in relatively close proximity of the building.
 - Seasonal changes in soil moisture contents, which are amplified by the nearby trees. The moisture content of soils tends to increase during the wetter periods of the year (i.e. Winter and Spring) causing them to heave. Conversely, the moisture content of soils tend to decrease during the drier periods of the year (i.e. Summer and Autumn) causing them to shrink/settle. This continual fluctuating movement of the foundations can result in the occurrence and exacerbation of building movement related damage.

- Lack of adequate impervious paving protection (unsealed ground) adjacent to the perimeter walls of the building, causing amplified wetting/swelling of reactive soils.

4.7 Accordingly, the long-term differential footing movement, is not the result of a single one-off event.

Condition of walls

- 4.8 Regarding the condition of the walls, observations non-intrusive site observations indicate long-term deterioration (which predates the reported storm events) of the external weatherboard cladding which have compromised the weatherproof protection of the timber framing. As such, in the absence of adequate weatherproof protection, it is expected the natural decay of the walls' timber framing (and connections) has been accelerated/exacerbated.
- 4.9 Evidence of repairs to the external and internal cladding indicates that the long-term damage to the walls predates the reported storm events.

Structural adequacy - reviewed documentation

- 4.10 As part of this investigation, design recommendations included in the first modern wind loading code published in Australia AS 1170 Part 2—1973, *Rules for minimum design loads on structures (known as the SAA Loading Code) (Metric units) - Wind forces*, and the Australian standard for timber structures AS 1684.2:2021, Residential timber-framed construction, Part 2: Non-cyclonic areas have been reviewed as part of this investigation. The subject building is understood to have been constructed circa 1900; hence, construction was completed before the abovementioned standards were issued. Whilst the above documents were not applicable at the time of construction of the subject building (and it is not expected a building of this age to comply with current standards), the requirements included in the reviewed standards (understood and accepted as the best practice to prevent similar failure) have been referenced to illustrate that damage is more likely to occur in the lack of adequate design/construction provisions to withstand wind actions.
- 4.11 Due to its function, which includes the assembly of people for different purposes, the subject public building is classified as a class 9 building. Although the analysis of subject building is not within the scope of AS 1684.2:2021 as specified in the limitations (section 1.4) of the standard, general requirements in terms of bracing to resist horizontal forces (resulting from wind) are still applicable for the analysis of the subject building.
- 4.12 Regarding the design wind velocity, the minimum design wind velocity for buildings designed for a 50-year return period specified in AS 1170, Part 2—1973 was 25m/s; refer to Figure 4.1.

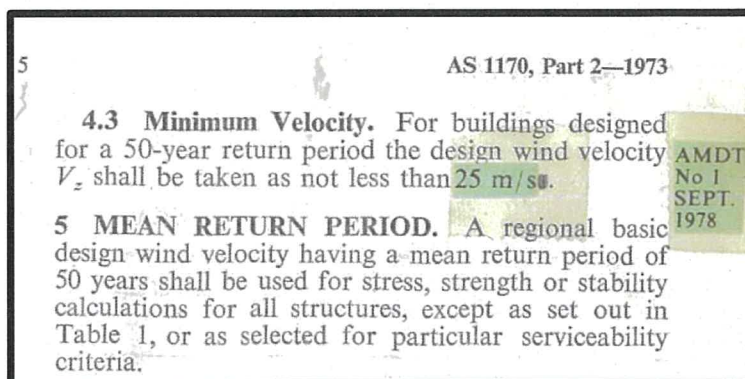


Figure 4.1 - Extract from AS 1170, Part 2 – 1973 showing the minimum wind design velocity as 25 m/s.

4.13 With respect to the required bracing for timber structures to withstand wind loads, Section 8 of AS 1684.2:2021, Racking and shear forces (bracing), states:

"8.1 General

Permanent bracing shall be provided to enable the roof, wall and floor framework to resist horizontal forces applied to the building (racking forces). Appropriate connection shall also be provided to transfer these forces through the framework and subfloor structure to the building's foundation.

Where required, bracing within the building, which normally occurs in vertical planes, shall be constructed into walls or subfloor supports and shall be distributed evenly throughout.

Where buildings are more than one storey in height, wall bracing shall be designed for each storey.

NOTE Figure 8.1 illustrates examples of the types and positions where bracing is required.

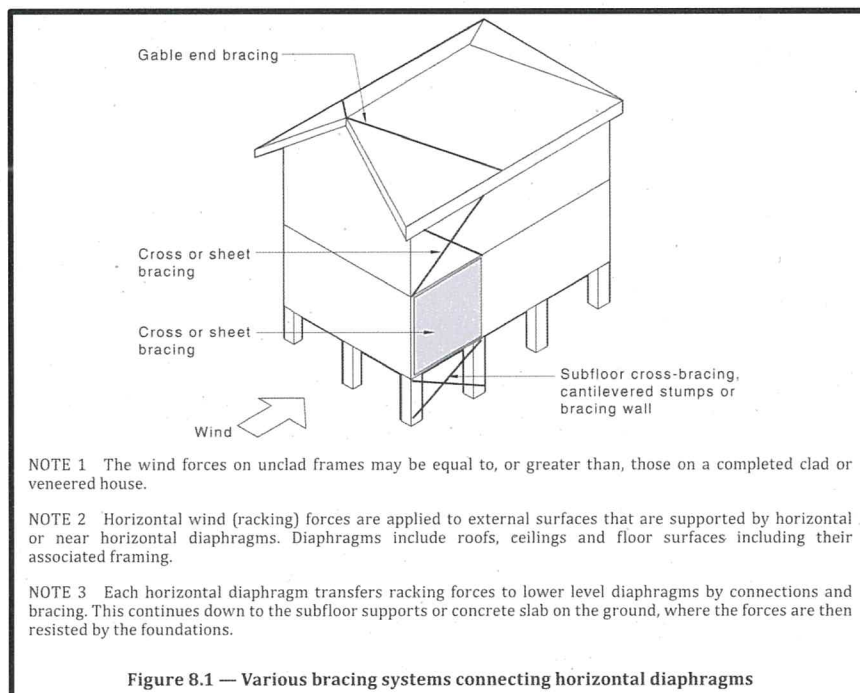


Figure 4.2 - Extract from AS 1684.2:2021 showing the bracing systems connecting horizontal diaphragms.

4.14 Wall bracing recommendations provided in AS 1684.2:2021 include:

"8.3.6 Wall bracing

8.3.6.1 General

Walls shall be permanently braced to resist horizontal racking forces applied to the building.

Wall bracing shall be designed to resist racking forces equal to or greater than the forces calculated from clause 8.3.4.

The total capacity of bracing walls shall be the sum of the bracing capacities of individual walls.

See Table 8.18 for the capacity of structural bracing walls, and Section 9 for fixing requirements..."

8.3.6.2 Nominal wall bracing

Nominal wall bracing is wall framing lined with sheet materials such as plywood, plasterboard, fibre cement, hardboard or similar materials with the wall frames nominally fixed to the floor and the roof or ceiling frame.

The maximum amount that can be resisted by nominal wall bracing is 50 % of the total racking forces determined from Nominal wall bracing shall be evenly distributed throughout the building. If this is not the case, the contribution of nominal bracing shall be ignored.

.....

8.3.6.3 Structural wall bracing

Structural wall bracing is purpose-fitted bracing, being either sheet or cross-timber or steel bracing. Table. 8.18 gives the specific capacity for each metre length of various structural bracing types.

.....

8.3.6.6 Location and distribution of bracing

Bracing shall be approximately evenly distributed and provided in both directions....

..

Bracing shall initially be placed in external walls and, where possible, at the corners of the building.

...

8.3.6.7 Spacing of bracing walls in single storey or upper storey of two storey

For Single storey or upper storey or two storey construction, the maximum distance between braced walls at right angles to the building length or width shall not exceed 9000 mm for wind classifications up to N2, For wind classifications greater than N2, spacing shall be in accordance with Table 8.20 and Table 8.21 for the relevant wind classification. ceiling depth and roof pitch.

NOTE Ceiling depth is measured parallel to the wind direction being considered.

...

Where bracing cannot be placed in external walls because of openings or similar situations, a structural diaphragm ceiling may be used to transfer racking forces to bracing walls that can support the loads. Alternatively, wall frames may be designed for portal action."

- 4.15 The building inclination/leaning (measured at different locations), which is significantly more evident towards the west end of the structure, indicates the lack of adequate building bracing in the south-north direction to resist horizontal loads.

Event related damage

- 4.16 During the visual non-intrusive inspection, it was not possible to verify the configuration and condition of the bracing provided to the walls of the building. However, if adequate bracing had been provided (and maintained) to the structure, the inclination/leaning would not have occurred during a wind event, unless the wind speed during the event exceeded the minimum design wind speed. In this instance, the wind speed which may cause damage would be in excess of 90 km/hour (25m/s).
- 4.17 Note that if the building bracing was not suitably designed/constructed and maintained, a wind event with a wind speed less than the design wind speed but resulting in (or triggering pre-existing) damage would be considered only a contributing event; with the wind not being the proximate cause of damage.
- 4.18 Accordingly, the storm events occurred on 2, 7 and 8 January 2024 are not the proximate cause of damage to the subject roof structure.

Cause of damage

- 4.19 The damage to the building, which occurred during the contributing 2 January 2024 wind event, has been caused by the lack of adequate building bracing in the south-north direction to withstand horizontal wind (racking) forces.
- 4.20 Due to the lack of adequate bracing in the south-north direction, the racking forces applied at roof level have not been adequately transmitted to the footings leading to excessive inclination/leaning of the building, which is more evident towards the western end of the structure.
- 4.21 Noting that the subject building, understood to have been constructed circa 1900, has been subjected to several wind events of significant magnitude during its lifespan, it is expected that the bracing provisions (in particular towards the western end) previously worked to prevent damage due to the application of horizontal loads resulting from numerous wind events through the history of the building. However, given the age of construction (+120 years), it is expected that the natural decay of timber members/connections and cladding (exacerbated by the termite

damage to building elements, previously reported circa 2017) has reduced the bracing capacity of the building walls. Note that the lack of adequate weatherproofing protection to the timber framing of walls is also expected to have contributed to accelerating the natural decay process of the timber wall members and, therefore, reducing the building's bracing capacity [3-5].

- 4.22 The bracing capacity of the subject building in the south-north direction was reduced to a point in which the structure failed under a wind event with a design wind speed lesser than the minimum recommended design wind speed.

Structural integrity

- 4.23 The inclination/leaning at west end of the building has resulted in a horizontal displacement at the top of the western wall of approximately 235mm towards the north. The displacement has resulted in significant deformation and damage to the western framed wall.
- 4.24 Note that there are no internal walls (or wall frames designed for portal action) in the south-north direction in the west half of the building. The bracing capacity of the western half of structure relied completely on the western wall which has been deformed and damaged. As such, the stability of the structure relies now on the temporary propping installed during the make-safe works.
- 4.25 Accordingly, the structural integrity and stability of the subject building has been compromised following the contributing wind event.

Extent of remediation works

- 4.26 To reinstate the building and prevent future similar damage, adequate bracing provisions (designed and approved by a structural engineer) will be required following the demolition and removal of a significant extent of timber framed walls and external and internal cladding. Potential bracing provisions to be adopted would have to adequately transfer racking loads from the roof plane to the building footings.
- 4.27 Note that although no damage to the subfloor structure has occurred as a result of the contributing event, it is evident that the subject building as a whole has been subject to on-going long-term building movements due to the contributing factors discussed in the pre-event building condition section of this report. Hence, it would be reasonable to expect that building movements and associated future damage will occur if only localised repairs to walls and roof elements are carried out, i.e., the footings remain in place. In such case, it would be likely that the repair contractor may not be able to provide a warranty for the repaired part of the building.



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- 4.28 In addition, given the age of the building and the extent of required remediation works, the relevant building surveyor may require the entire building, including its footings, to upgrade to modern building codes and regulations. In this regard, the Victorian Building Regulation 233(2) requires that, where building work represents more than 50% of the original volume of the building, the entire building must be brought into compliance with the current regulations and standards. Due to the age of the construction, the observed and previously reported dilapidation/damage to timber members and timber stumps and the presence of the site factors contributing to the building movement, it is [REDACTED]'s opinion that substantial upgrade works to the structure (including the footings) will be required to comply with the current regulations and standards.
- 4.29 In view of the foregoing, due to the nature of the pre-existing damage, the damage reported following the contributing wind event and the expected requirement to upgrade the building to modern building codes and regulations, it would be more economically feasible for the whole building to be demolished and reconstructed. The new building will be required to be designed by suitably qualified building professionals and reconstructed in its entirety in accordance with the requirements of the National Construction Code (NCC) and the latest Australian Standards.

Scope of works

- 4.30 A scope of works for storm damage has not been prepared as the reported storm events are not the proximate cause of damage.

5.0 Conclusion

Event related damage

- 5.1 The storm events occurred on 2, 7 and 8 January 2024 are not the proximate cause of damage to the subject roof structure.

Cause of damage

- 5.2 The damage to the building, which occurred during the contributing 2 January 2024 wind event, has been caused by the lack of adequate building bracing in the south-north direction to withstand horizontal wind (racking) forces.
- 5.3 Given the age of construction (+120 years), it is expected that the natural decay of timber members/connections and cladding (exacerbated by the termite damage, reported circa 2017) has reduced the bracing capacity of the building walls leading to excessive inclination/leaning of the building, which is more evident towards the western end of the structure.

Structural integrity

- 5.4 The structural integrity and stability of the building has been compromised following the contributing wind event. The structure's stability relies now on the make-safe works propping.

Extent of remediation works

- 5.5 To reinstate the building and prevent future damage, adequate bracing provisions (designed and approved by a structural engineer) will be required. Potential bracing provisions to be adopted would have to adequately transfer racking loads from the roof plane to the footings.
- 5.6 Building movements and associated damage will occur if only localised repairs to walls/roof elements are carried out, i.e., the footings remain in place. In such case, it would be likely that the repair contractor may not be able to provide a warranty for the repairs.
- 5.7 Due to the nature of the pre-existing damage, the damage reported following the contributing wind event and the expected requirement to upgrade the building to modern building codes and regulations, it would be more economically feasible for the whole building to be demolished and reconstructed. The new building will be required to be designed by suitably qualified building professionals and reconstructed in its entirety in accordance with the requirements of the National Construction Code (NCC) and the latest Australian Standards.

Scope of works

- 5.8 A scope of works for storm damage has not been prepared as the reported storm events are not the proximate cause of damage.



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Appendix A

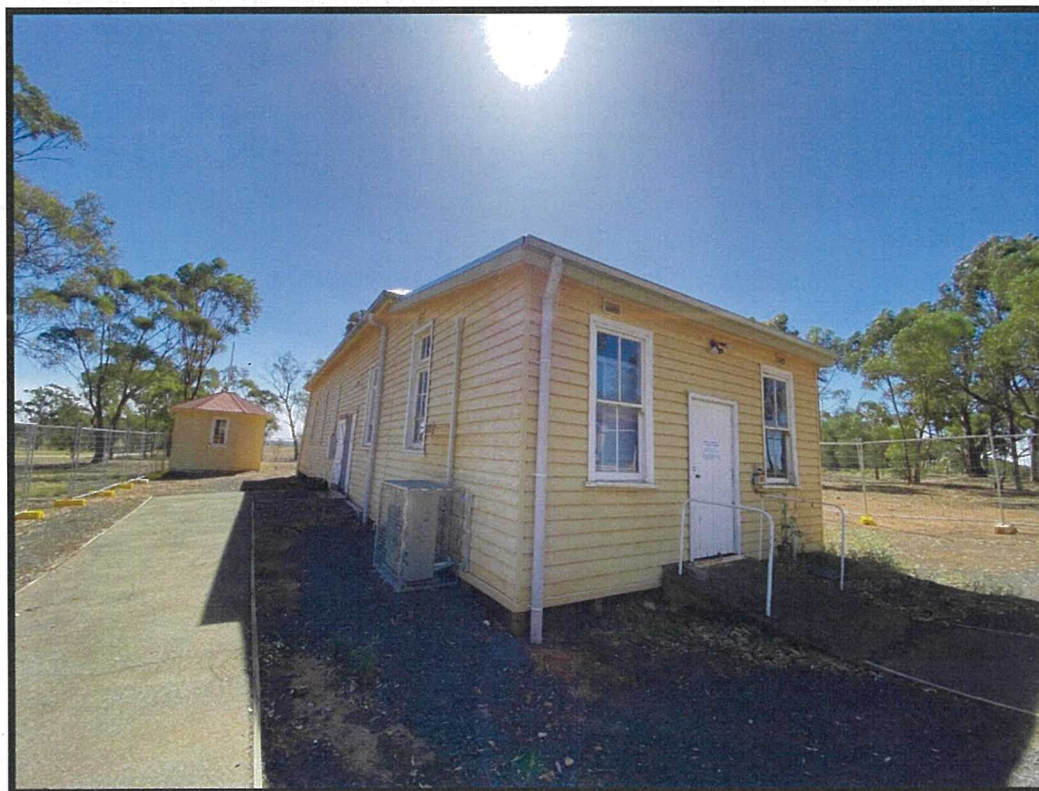
Photographs

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Photograph 1 – The west end of the building is leaning towards the west by 3.2° (56mm/m). Temporary bracing has been installed as part of the make safe works. Note the unsealed ground immediately adjacent to the building perimeter.



Photograph 2 – Overview of the southeast corner of the building. Note the unsealed ground immediately adjacent to the building perimeter.

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Photograph 3 – Timber splitting to the weatherboard cladding.



Photograph 4 – Typical splitting, detachment/misalignment to the weatherboard cladding.

██████████

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██████████

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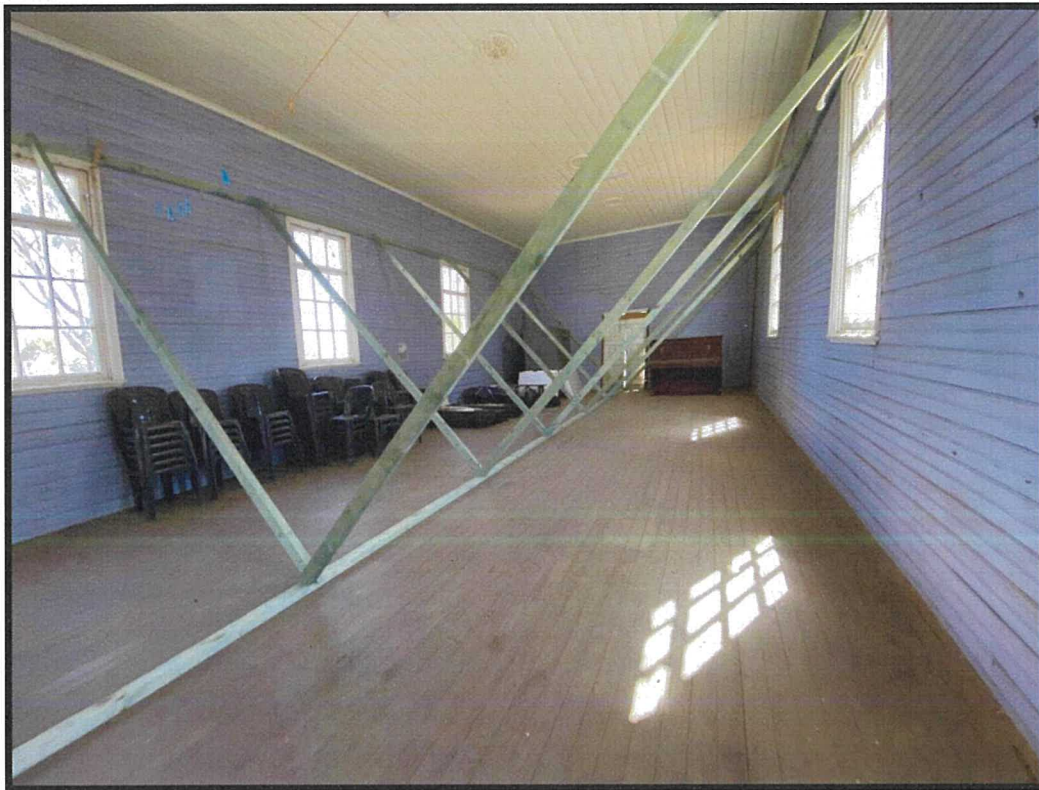
Photograph 5 – Typical dilapidation to the window frames along the building perimeter. Note the timber splitting and sealing dilapidation.



Photograph 6 – Typical cracked dried soil surface adjacent to the building perimeter.

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Photograph 7 – The west end of the building is leaning towards the west by 3.2° (56mm/m). Temporary bracing has been installed as part of the make safe works.



Photograph 8 – Deformation of the western wall.

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Photograph 9 – The west end of the building is leaning towards the north by 3.2° (56mm/m).



Photograph 10 – Minor staining to the exposed timber stud at the north end of the western wall of the building.



Photograph 11 – Staining to the exposed timber stud adjacent to the door frame of the on western wall of the building.



Photograph 12 – Exposed timber stud adjacent to the door frame of the on western wall of the building.

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Photograph 13 – Typical detachment/misalignment of the internal lining boards of the wall on the east side of the stage.



Photograph 14 – Typical detachment/misalignment of the internal lining boards of the northern wall.



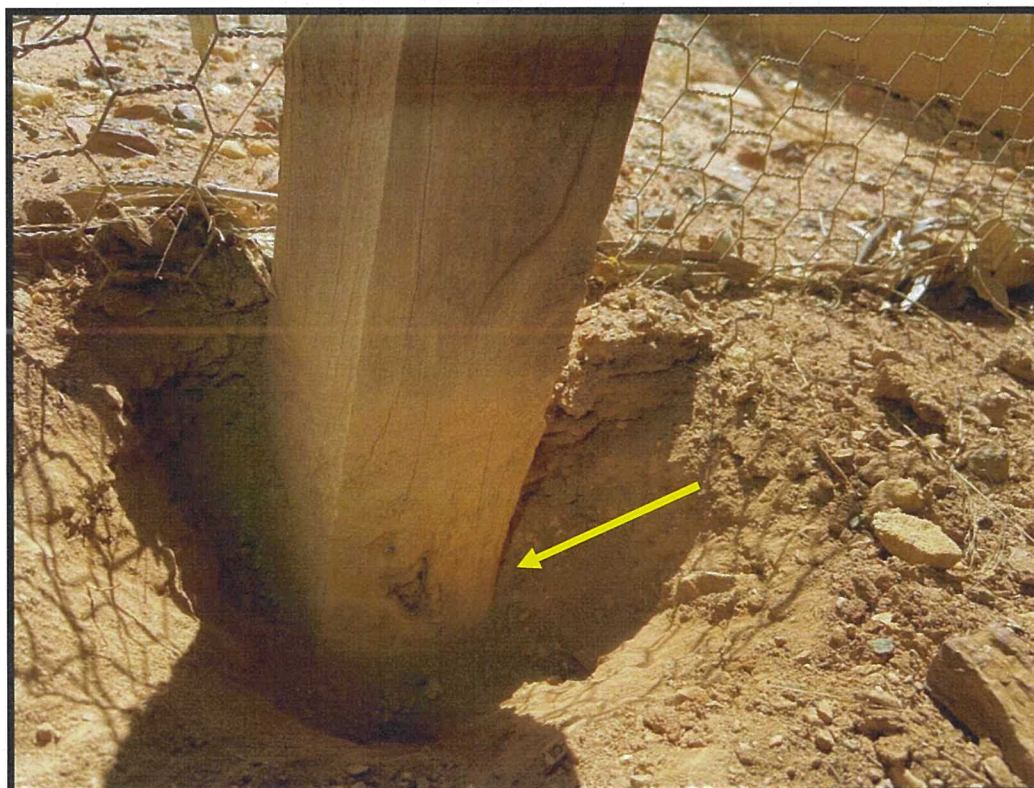
Photograph 15 – Typical pre-existing splitting to the internal lining boards of the northern wall.



Photograph 16 – Detachment of the timber cornice and cracking to the ceiling boards on the north end of the hall.



Photograph 17 – Variation of ground surface levels in the subfloor space.



Photograph 18 – Loss of material to a perimeter timber stump.



Photograph 19 – Decay to a perimeter timber stump.



Photograph 20 – Minor decay to an internal timber stump.



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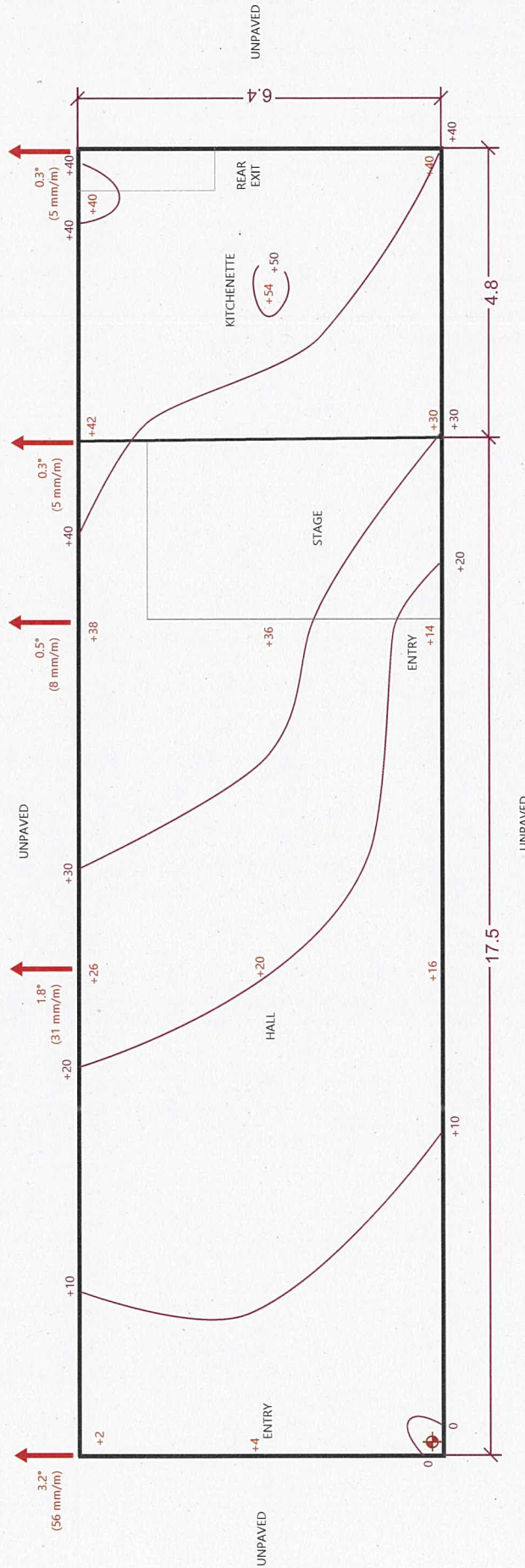
Appendix B

Floor plan

Floor level survey



HEIGHT OF PERIMETER WALLS: 4.2m



LEGEND

- FLOOR LEVEL SURVEY DATUM (ZERO)
- FLOOR LEVELS (mm)
- DENOTES APPROXIMATE CONTOUR

DIRECTION OF BUILDING INCLINATION/LEANING

