STEPHEN P McELROY and
ASSOCIATES Pty Ltd.
Civil and Structural Engineering Design, Project Development and Management,
Feasibility Studies, Professional Management Support Services, Construction Services,
Planning Services.

Structural Engineer's Report

Tabulam SES Building

Lot 2 DP 791509

Client: Kyogle Council

April 2010

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1.0 Introduction

Stephen P McElroy & Associates Pty Ltd have been engaged by Kyogle Council to provide a structural assessment of the SES building at Tabulam. The site is located on a 1211m^2 site legally described as Lot 2 DP 791509 in the Parish of Tabulam and has frontage to the Bruxner Highway.

The investigation was to assess several potential structural defects reported by the local SES Controller. These included:

- Cracks in the block work over the rear roller door
- Cracks in the walls and floor of the west side of the building
- Termite infestation which has destroyed much of the softwood trimmings in the building and may have reduced the strength of structural timber components

The investigation is to determine:

- Whether there are structural defects or the damage is cosmetic only
- Suggested remedial works which need to be carried out and the urgency of the works
- Estimated costs of the remedial works.

2.0 Methodology

A site inspection was undertaken at 3pm on Monday 22 March 2010 when the SES Controller Mr Neville O'Malley assisted Steve McElroy in the work.

The limits of the investigation are that it is a visual investigation and no soil sampling or laboratory testing of soil was undertaken. No sampling of the existing foundations was done but excavation was undertaken on a part of the strip footing foundation. Sub-surface investigation in the form of two dynamic cone penetrometer (DCP) tests was carried out to determine the strength of in-situ material beside the existing foundations of the building. No structural calculations have been undertaken.

Visual assessment of the white ant damage was undertaken and the roof void above the office area and the ceiling support structure was inspected for structural adequacy.

The building was surveyed externally for obvious signs of cracking and movement with the only area of concern along the western wall. The rear roller door was also inspected where it was found that the brick support structure over the door was severely deflected.

3.0 White Ants and Ceiling Structure

The visual inspection revealed white ant damage in the architrave of the office door and in the battens and quad, which covered the fibre cement sheet joins in the ceiling. There is no evidence of damage in the cement sheet ceiling and there was no noticeable sag in the ceiling indicating that the white ant damage is non-structural.

Photo 3.1 – White ant damage in door architrave

Photo 3.2 – White ant damage in ceiling cover strips

To ensure that the ceiling structure was sound, an inspection of the roof cavity above the ceiling was undertaken where there was no evidence of white ant damage in any of the structural hardwood.

The white ants were treated in August 2009 by Swaggard's Pest Control and a re-inspection is due in November 2010.

At the time of the inspection there was no evidence of white ant activity in the building.

4.0 Rear Roller Door

Inspection of the opening over the rear roller door revealed the following defects:

- Cracks on both sides of opening which extends from the outside corners of the opening to the top level of the brick courses
- Crack in mortar in all bottom blocks and there is at least a 20mm deflection across the top of the doorway in the brickwork at mid-span
- The six blocks at the head of the doorway are clearly failing – this is the result of the incorrect use of blocks and inadequate reinforcement – these should have been special header blocks which are designed for use as lintels and have additional reinforcement to account for tensile forces in the bottom of the lintel
- No cracks are evident in the foundation at the base of the door or in the lower brickwork, which indicates that foundation movement has not been a contributing factor to the failure of the doorway structure.

Photo 4.1 – Rear roller door indicating failure locations

Photo 4.2 – Rear roller door indicating 20mm deflection and cracked mortar

Photo 4.3 – Close up of rear roller door indicating cracked mortar

Without the use of a temporary support placed by the SES members at mid-span, the failure of the lintel over the roller door would be imminent.

5.0 Cracks in West wall

Cracking was identified at two locations under windows in the western wall and to a minor extent inside the building on the concrete floor. This type of cracking occurs due to foundation movement where the corners of the windows act as hinges and the cracks in the wall open up at these points.

To determine the reasons for the foundation movement two Dynamic cone penetrometer tests were undertaken and a test pit was excavated at the foundation to the base of the strip footing.

The investigations clearly showed that the preparation of the building pad on the western side was inadequate and that the footing depth was also inadequate for a masonry building on poor soil.

The building pad is elevated 380mm above the surrounding natural surface and the test pit excavation revealed that the site had not been stripped of topsoil prior to placing 180mm of yellow sandy clay fill. Thus the strip footing was founded on topsoil below the layer of sandy clay which has little bearing strength.

The DCP test taken directly beside the footing at the failure site(Test Site #1) indicated a CBR of between 2% and 3.75% at the bottom of the footing and a bearing strength of between 48kPa and 60kPa, well below the required 100kpa for domestic construction.
The low CBR values are indicative of poorly drained soil of poor load-supporting capacity.

6.0 Sub-soil Investigation

The investigation was carried out in order to categorise the site in terms of the reactivity and the bearing capacity of the sub surface soils. The term "Reactivity" refers to clay soils, which are prone to heave and shrink movements with natural or induced changes in soil moisture content. Bearing capacity relates to the strength of the soil to withstand applied downward loads from the structure without consolidating and compressing.

The site work consisted of excavating one test pit adjacent to the foundation of the building near the site of the cracked wall (Site #1) to enable a soil profile to be assessed. Two Dynamic Cone Penetrometer tests were also undertaken to assess the relative strength and compaction of the in-situ subsoil. Site #1 was directly beside the wall of the building at the potential failure site and Site # 2 was 5m away in an area, which seemed to have less fill over the natural surface.

The site inspection revealed that the proposed site was on fill, which had not been adequately compacted, nor had topsoil been removed prior to the placement of the yellow sandy clay fill. This has resulted in a 200mm band of topsoil which overlays a 180mm band of yellow sandy clay fill. The sandy clay overlays the in-situ topsoil on which the strip footing of the building is founded. There is no evidence of landslip on the site but the local drainage on the western side of the site is poor and is retained on the surface for extended periods along this side of the building. This will have some effect on the ability of the soil to support building loads.

The subsoil is expected to exhibit low moderate swell/shrink and moisture suction capacities but due to the poor methodology of preparing and filling the site for the building pad, the site can only be Classified as ‘P’. The overall profile may be classed as unstable uncontrolled fill in accordance with AS 2870 – Residential Slabs and Footings, and we would recommend a classification of Class ‘P’ (Uncontrolled shallow fill).

Photo 6.1 – Location of test pit showing topsoil removed

Photo 6.2 – Base of footing at bottom of tape bearing on moist topsoil

7.0 Recommended works

The following works are recommended:

- Replacement of all damaged architrave, ceiling cover strips and quad in the building with treated pine mouldings
- Provision of supplementary support for the rear roller door concrete block header course with a rectangular hollow section galvanised steel frame
- Underpinning of the western wall with hit and miss strip footings

The method of underpinning recommended is a tried and proven practice, which has been used on many buildings over the last 25 years in the Kyogle and Casino areas. This involves providing underpin columns which extend 1.0m to 1.5m below the bottom of the existing strip footing and extend 1m along the existing strip footing. Generally, the columns are at least the width of the existing footing but as a minimum 400mm is recommended. The column strips are placed at spacings of 1.5m to 2m along the existing strip footings so that there will be underpin columns at all external corners, which will extend for 1m and then a space of no more than 2m when another underpin column will be placed. This is continued on the external walls of the building, which have shown signs of cracking.

After the works are back filled, the subsided brickwork is jacked up and supported on steel plates and a high strength grout is injected between the steel plate and the top of the footing. Any cracks in the external brickwork are grouted and coloured if necessary. Any internal damage caused as a result of the re-levelling of the building or as a result of the subsidence of the building can also be repaired and repainted.

8.0 Estimate of costs

Item No	Description of works	Unit	Qty	Rate	Amount
1	Underpin existing foundations	No	6	$1,500	$9,000
2	Repair brickwork and internal linings	Item	5%	$9,000	$450
3	Internal architrave repairs	Item	1	$1,500	$1,500
4	Fabricate supply and fit bracing frame for rear roller door (90 x 90 x 5.0 Duragal SHS steel)	Item	1	$3,500	$3,500
5	Engineers reports and investigation	Item	1	$2800	$2800
6	Contingencies	Item	10%	$17,250	$1,725
				Sub total	$18,975
				GST	$1,898
				Total	**$20,873**

Table 8.0 – Estimate of cost for repair works

9.0 Conclusions

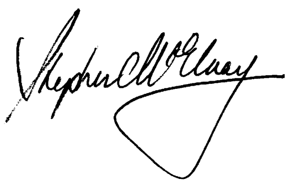
Visual inspection of the building and an examination of the soil under the strip footing indicates that substantial settlement and probable failure of the strip footings supporting the structure on the western wall has occurred. Dynamic cone penetrometer tests indicate that the subsoil on which the strip footings are founded has poor bearing capacity and inadequate strength to support the life time service loads applied by the building to the subsoil under the western wall. A further concern is the poor drainage of the area adjacent to the western wall within the adjacent lot. The bearing capacity of the soil would be improved at times of wet weather if drainage on the adjacent lot were improved.

With the excessive movement of the strip footing structure, it is probable that the concrete has failed in some sections and no longer can act as a monolithic beam to support further ground movement. It is also possible that the ability of the strip footing foundation to support normal service loads has been reduced. Although sudden failure of the wall will not occur, the placement of under-footing columns as described in Section 7 of this report is recommended. This will provide adequate strength to counter any applied loads or unstable ground conditions likely to occur over the life of the building.

The lintel over the rear roller door has failed and it is only a matter of time before the lintel and the brickwork above suddenly collapses. This will not cause failure of any other part of the structure as the lintel only supports the wall load directly above and no roof members rely upon its strength. A lightweight steel frame constructed of 90 x 90 x 5.0 SHS would be adequate to support the brickwork above the roller door opening.

Finally the white ant infestation appears to have been adequately removed with no evidence of structural damage to the building. Further re-inspection as proposed in November 2010, is strongly recommended.

Author:



Steve McElroy BE(Civil), Grad Dip ME, FIPWEA
Principal Engineer.

3 May 2010

Attachment 1

Subsoil Investigation Results

Client:	Kyogle Council	Date Logged:	22 March 2010
Project:	SES Building	Logged By:	Stephen McElroy
Location:	Lot 2 DP **791509** Tabulam NSW	Test No:	#09/42
		A/C Ref:	#09/42

TEST PIT LOG Site **No 1**

Excavation Method:	Hand Auger	Surface Reduced Level:	00
Ground Water Struck:	Nil	Groundwater Level:	Not struck

Depth (mm)	**Soil Description/Location**	USC Symbol	Moisture Content	Plasticity	Consistency/ Relative Density	Pocket Penetrometer (kPa)	Sample/Test CBR Value
00	Topsoil						
200	Topsoil		M	NP	S/VL		
380	Yellow sandy clay		M	L	S/M		
500	Topsoil		W	NP	S/VL		

MOISTURE CONTENT	PLASTICITY	CONSISTENCY	RELATIVE DENSITY	PLAN/REMARKS
D = Dry M = Moist W = Wet PL = Plastic Limit LL = Liquid Limit	NP = Non Plastic T = Trace VL = Ver y Low L = Low M = Medium H = High VH = Very High EH = Extremely High	VS = Very Soft S = Soft F = firm St = Stiff Vst = Very Stiff H = Hard Fb = Friable	VL = Very Low L = Loose M = Medium D = Dense VD = Very Dense SAMPLE OR TEST D = Disturbed Sample	Last rain 1 month ago

Dynamic Cone Penetrometer Test Results

Job	Tabulam SES Building	**Tested by**	Steve McElroy	**Date**	22/03/10
Weather conditions	Fine - 25 degrees Celsius				

Location	**Site #1** CBR	**Site #1** kPa	**Site #2** CBR	**Site #2** kPa				
Depth to test	00	00	00	00				
Blow No	Cumulative depth from underside of hammer to surface datum level							
0	1030		1080					
5	615	725 (4)	890					
10	380	420 (9)	730	775 (9)				
15	225		525					
20	110	115 (20)	440	470 (18)				
25			390					
30			355					
35			315					
40			280					
45				165				
50								
55								
60								
65								
70								
75								
85								
90								
95								
100								
105								
110								
115								
120								
125								
130								

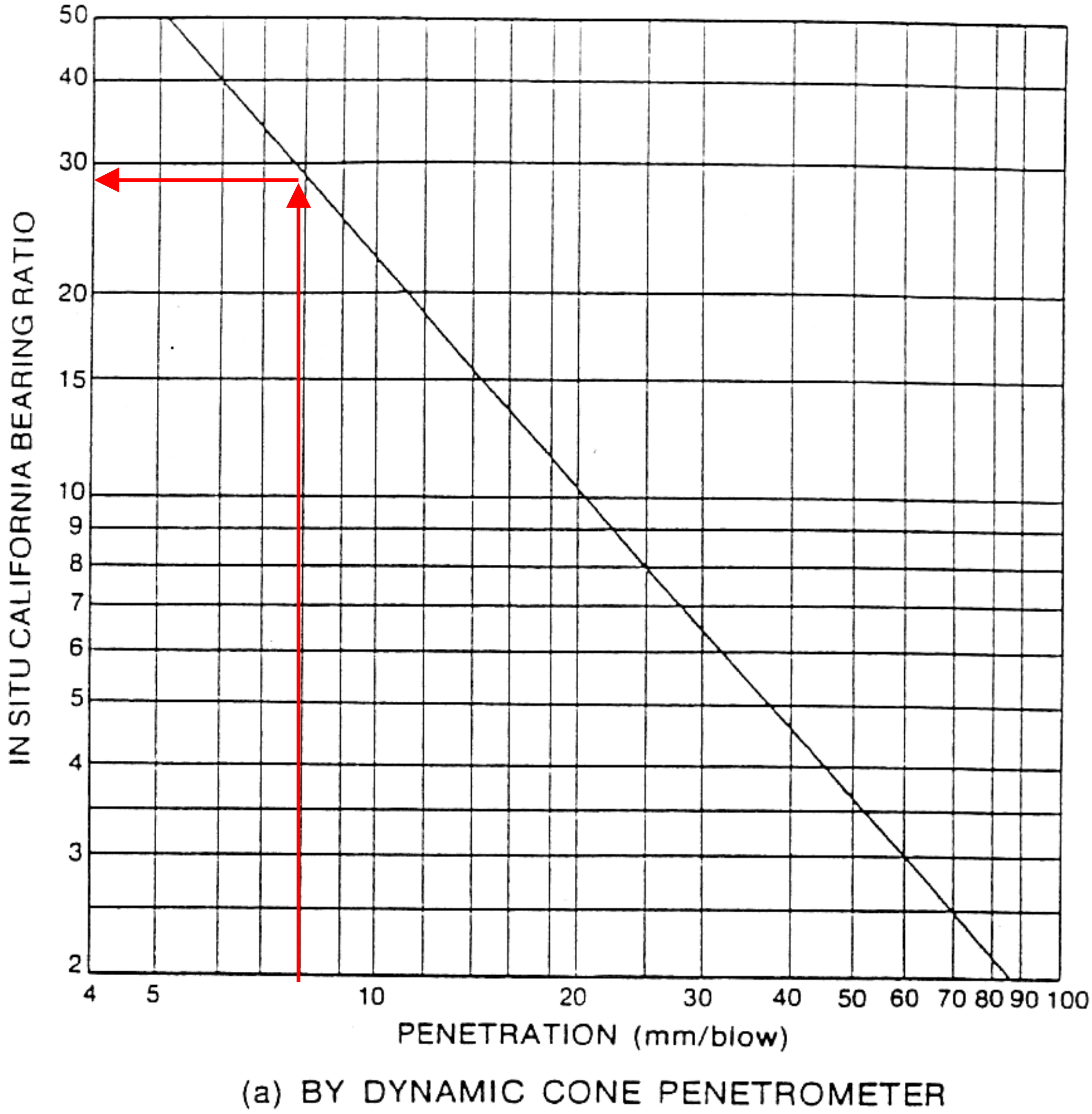
Site No	**Site Comments**
1	Test taken directly beside footing in line with 2nd window from road – top 500mm appears to be soft fill. Last 500 mm wet topsoil
2	Test similar position at 3rd window – appears to be less fill
	Last rain 1 month ago.

CBR Values at Specific Depths

Depth from existing surface	CBR Values from Dynamic Cone Penetrometer tests							
	Site #1	Site #2						
50								
100								
150								
200		5						
250								
300								
350		6						
400	2							
450								
500								
550		4.5						
600								
650	3.75	13						
700		23						
750		35						
800	6.25	29						
850		35						
900	8.75							
950								
1000								
1050								
1100								
1150								

Unconfined Compressive Strength of in-situ Clay

Site #1			Site #2		
Depth Below Surface	Clay Strength	Consistency	Depth Below Surface	Clay Strength	Consistency
305	48	Soft	305	110	Stiff
610	60	Medium	610	110	Stiff
915	137	Stiff	915	349	Very Stiff



Source: Australian Standard AS 1289.6.3.2 – 1997

Sample Calculation of CBR:

In this example the dynamic cone penetrometer test results in 80mm penetration into the subsoil for 10 blows. This calculates to 8mm per blow. Referring to the chart above, a line is drawn from the 8mm/blow mark on the horizontal axis to intersect with the graph and another line is projected horizontally to the vertical axis giving a CBR of 29.

Definition of CBR

The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardised in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Strength of Clay

Penetration Resistance (N) (blows per 305mm)	Unconfined Compressive Strength kPa	Consistency
1	<24	Very soft
2	24	Soft
3	36	
4	48	
5	60	Medium
6	72	
7	84	
8	96	
9	110	Stiff
10	123	
11	137	
12	151	
13	165	
14	178	
15	192	
16	205	Very Stiff
17	218	
18	231	
19	244	
20	257	
21	270	
22	283	
23	297	
24	310	
25	323	
26	336	
27	349	
28	362	
29	375	
30	388	Hard
31	401	
32	414	
33	427	
34	440	
35	453	
36	466	
37	479	