IMPACTS OF REMOTE LOW LEVEL SEISMIC EVENTS ON THE MONARO REGION NSW

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SUMMARY: Since the early 1800's earth tremors have been reported in the settled areas of the Monaro. Australian Newspapers have been reporting earth quakes in the (then) main Monaro town of Bombala from early times. Reports of eight seismic events in Bombala between September 1869 and February 1907 have been found during the preparation of this paper. An interesting feature of more recent events is that the epicentres generating the Bombala seismic damage, vary from 40 to 100 km away, from SW to NW of the town and range from 1.9 to 3.9 in magnitude (all magnitudes quoted in this paper are from the Richter scale). A Bombala building (St Mary's church) has suffered $240,000 worth of seismic damage in recent times and a homestead about 6km south and on the same fault line has suffered $150,000 worth of damage. The purpose of this paper is to make seismologists and structural engineers aware of the significance of small scale seismic events.

Key words: Monaro, Bombala, Wrench Fault, Berridale, Eucumbene, remote.

1 INTRODUCTION

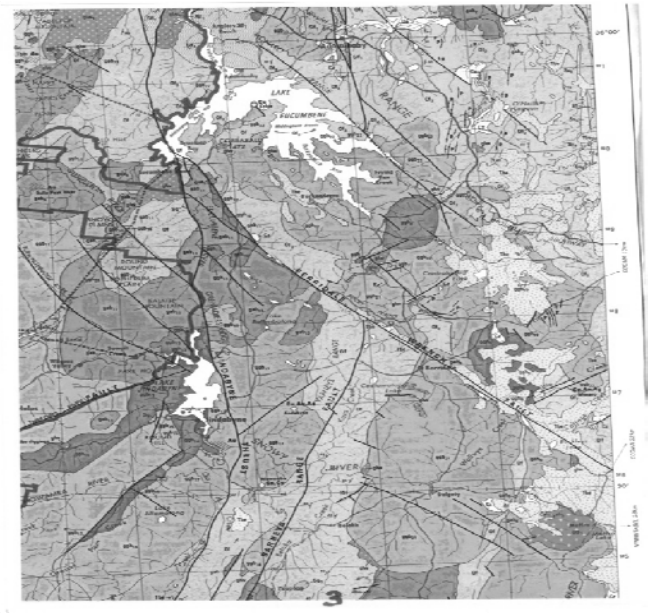
The Monaro Region of SE NSW is a high (approx 800m elevation) plateau of basalt, granite and shale having a distinct open character with prairie type tussock grasslands. It is about 200 km long North to South, beginning 50 km south of Canberra and spreading to 80 km wide where lying between the eastern coastal escarpment and the Snowy Mountain's foot hills. Tertiary basalt overlays obscure the evidence of fault lines in some areas but give other clues as to the presence of plate fracture lines. The presence of small undrained lake beds throughout the basalt country indicate the site of steam explosions caused by magma rising to meet the water table. The recognised fault lines can be tracked to some degree through the blank Tertiary basalt areas via the lake beds and volcanic cones. Predominately building damage from seismic events seems to occur over faults but in this case these faults are often at a great distance from the epicentre of the generating event. I am a practicing civil and structural engineer and have been located in the Snowy Monaro area since 1977. Part of my practice is to report on building cracking. Most Snowy Monaro buildings have stable foundations of granites and shales which do not initiate foundation cracking. Masonry cracking exhibits characteristics that point to its underlying causes. Cracking due to low level seismic action has largely not been recognised by engineers as has been revealed in the Bombala church case.

7mm displacement at Bombala Church Wall
Fig 1

Even width crack in Bombala Church Wall
Fig 2

Foundation induced cracking tends to create vertical wall cracks, widest near the foundation or near the top of the wall depending on whether the footing is sagging or being lifted upwards. On the other hand brittle walls affected by seismic cracking shows distinct signs of a sideways loading which tends to cause cracks radiating from the wall's centre of gravity in a diagonal pattern, or horizontal cracking or both. The reality of seismic damage from small scale events was confirmed to me in Cooma early in 2000 when one end of a stone barn behind a Hotel dropped to the ground overnight. That morning the radio reported the occurrence of an earth tremor in the district. The barn has since been totally demolished. An awareness of the existence of seismic damage in buildings, particularly from low level events, has led me to apply informed design solutions to mitigate further damages. In one case, a Lodge in Thredbo 2007 had experienced bathroom tiles popping off at bench level. Outside the wall a concrete slab had been poured as an infill between the lodge wall and a retaining wall. I discovered that a minor earth tremor had been recorded in the area around the date that the tile damage was noted. Thredbo is located on the Crackenback Fault. In my opinion the shaking earth behind the retaining wall transferred its hammer action to the Lodge wall via the horizontally suspended slab. The 40 year old foundations were considered sound. The design solution provided for the isolation of the infill slab from the Lodge wall. I was familiar with the stable foundation condition of the lodge and many others in Thredbo including the nearby lodge whose superstructure was demolished in a landslide.
White et al., 1977 identified major faults in the Berridale region. His diagrams show faults including the major Berridale Wrench Fault which appears to extend from the vicinity of the Eucumbene Dam wall to Disaster Bay south of Eden passing just north of Bombala on the way.

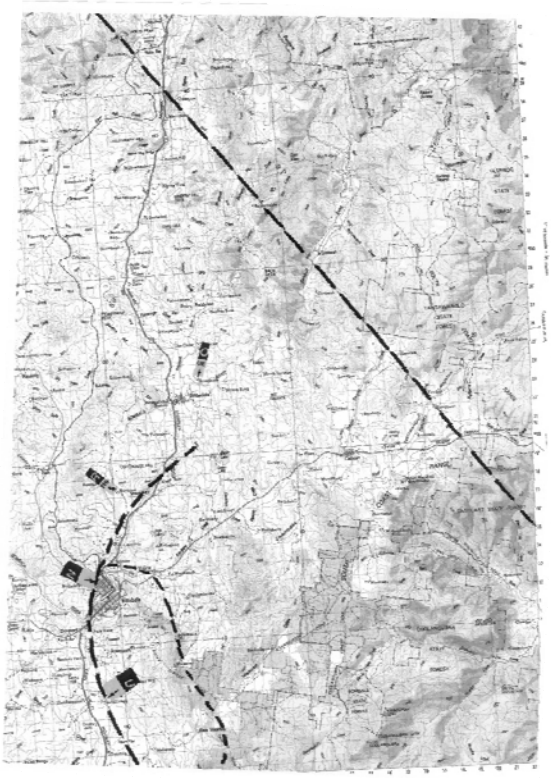
IN FEATURES AND HISTORY OF ACTIVITY OF MAJOR FAULT ZONES IN THE BERRIDALE REGION, SNOWY MOUNTAINS, SOUTHEASTERN AUSTRALIA- I. B. Lambert, CSIRO.
Lambert writes 'the biggest earthquake recorded in the area was on 18th May 1959 at magnitude 5, located 22km NW of Berridale and it was not obviously related to any of the faults known in the area.' As a layman it seems no co-incidence to me that the newly constructed dam probably played a part in triggering that earthquake. The dam construction was completed in 1958 and by early 1959 it was filling quickly. I find my view reinforced by the discovery recently of a pattern of intense seismic activity from the dam area co-inciding with the seismic shock which registered magnitude 3.6 and struck the Bombala Catholic church. The church's management then called in consulting engineers to report on bulging walls and cracking.



Lake Eucumbene and Berridale Wrench Fault
Fig 3

With respect to the Bombala location a geological map in Field Geology of NSW 2000 by Branagan & Packham shows two identified fault lines in that region converging on the northern end of the town of Bombala. The activity of the western most of these Bombala fault lines is the main subject of this paper. Six kilometres south of Bombala a homestead is located over this same western fault line. The homestead is currently having seismic damage repaired at a cost of $150,000 plus. It has been constructed on brick footings in a granular foundation material which I examined and determined to be non-reactive, volcanic rocks line

the garden beds. 500m to the North a volcanic lake exists of the type formed by magma reaching the water table. A prehistoric event of magma intruding to the water table via a crack in the crust probably caused a blast that formed a crater the size of a football field. The volcanic lake and a diagram in Branagan & Packham indicate to me that the homestead lies on this western fault line. Evidence can be seen of earlier repairs to seismic damage in the bay window gable structure of the homestead. The repairs to the gable do not line up with the original gable detail and there is also a global tilt in the alcove window. This indicates that the site has a history of being damaged by seismic activity as earlier repairs misalign with the original detail. In the town of Bombala sits the large brick Catholic Church built during the second world war and which was discovered in 2007 to have been ravaged by three seismic events, over the previous twelve years. It was then repaired. Three years later it was damaged again (ie two days after last Christmas) from a 1.9 event originating near the Cooma airport some 65 km away. The calculated amplitude of vibration in these circumstances would lie between 0.1 and 0.2mm where as the cracking observed indicates 3 to 4mm. Cracking was noted in there buildings in a row which had previously been repaired and painted. The Bombala Fault lines define a relatively small geological crust block where as the fault lines towards Cooma seem to encompass larger blocks. Could it be that the law of conservation of momentum cause energy in the larger block to excite the smaller Bombala blocks proportionally. Other domestic buildings in the church's street appear to be located over the same fault as is the church and the homestead to the south and Burnamah Homestead to the north. The location of the fault has been determined by overlaying geological drawings on topographic maps of the area. Minor damage has been caused to adjoining domestic properties in seismic events but the church has sustained serious damage and the homestead to the south has suffered significant damage. The homestead which is of double brick construction from the 1930's sits on a foundation which could compact with ground vibration, the nature of its damage was extensive with moderate wall cracking throughout the house. The churches damage was extensive wall cracking, unreinforced concrete floor cracking, sagging roof trusses and wall bowing. Old newspaper reports make interesting reading about the Australia wide interest in seismic events. There can be found many references to earthquakes in Bombala in the 1800's.One report says a terrific shock was felt at Burnimah last Wednesday night at twenty minutes to twelve, the concussion was so great that the house tottered on its very foundation and in one instance the vibration was such that it nearly pitched one individual out of his bed. Another correspondent writes from Currawong etc. with a similar story. Currawong is located about two kilometres north of the church on the same fault line and Burnamah is about five kilometres north near the same line. The following log of events shows150 years of regular seismic activity in the Bombala area. By the law of averages a bigger event should be expected and alertness and preparedness are warranted.



Bombala fault lines
Fig 4

2 EVENTS

Without being comprehensive the following reports of seismic events on parts of the Monaro give a picture of regular seismic activity mostly relating to the study area of Bombala, these were obtained via a search facility(the reader is invited to refer to the following for more detail: http://trove.nla.gov.au/newspaper/result?q=Earthquake%2C+Bombala):-
31/8/1869 “The Queenslander newspaper”...’(P2) A severe earthquake has occurred at Bombala...’;
1/9/1869 “ South Australian Register” ...’(P5) A severe earthquake and snow storm at Bombala...’;
1/9/1869 “ The Argus, Melbourne”...’A heavy shock of earthquake followed by snowstorm at Bombala...’;
8/9/1869 “ SMH” ...’(P5) shock of earthquake felt at Bombala followed by rumbling...’;
11/1/1872 “ New Zealand (P2) (Via Melbourne) Empire(Sydney)”...’Severe shocks of an earthquake were distinctly felt by the inhabitants of Bombala...’;
14/5/1885 “Launceston Examiner (P3)(and twelve other newspapers across Australia)”...’ A severe shock of an earthquake felt at Bombala and Candelo...’;
16/9/1885 “Cairns Post”...’(P2)A shock of an earthquake at Bombala last night...’;
15/9/1886 “South Australian Register”...’(P5) A slight shock of an earthquake felt at Bombala...’;
10/4/1887 “Illustrated Australian News, Melbourne”.. ’(P71) slight shocks were felt at Bombala...’;
5/2/1907 “Queanbeyan Age”...(P4) ‘A slight shock of an earthquake was felt at Bombala on Thursday evening...’;
18/5/1959 Near Berridale at Eucumbene Dam a 5.5 magnitude about the time of the first filling of the dam the construction of which was finished in 1958 ;
During an inspection (for renovations) of a homestead located 10km North of Bombala heavy building cracking was noted from a 1950’s event;
EARTH QUAKE EVENTS ON THE MONARO 2.0 OR OVER ON THE RICHTER SCALE, BETWEEN 1988 & 2007;
1988 3.1 on the Richter scale;
1989 3.2;
1991 2.2, 2.2, 3.0, 2.2;
1993 2.1, 3.0, 2.9, 2.3;
1994 3.1, 2.1, 2.0;
1995 3.3;
1996 3.5, 3.6, St Mary’s Catholic Church Bombala, engaged consulting engineers to investigate cracking in the walls of the church
Their findings gave a lot of detail about structural condition but did not recognise seismic damage.
1997 2.0, 2.0;
1998 2.8, 2.4;
1999 2.2, 3.0, 2.2;
2000 2.3, 2.7, 2.3;
2001 2.5, 2.9;
2002 2.1, 2.7, 2.9;
2003 3.0, 2.7, 3.0;
2004 2.4, the same engineers were asked to report on increases in the wall cracking in the Bombala Church and their findings found roof trusses were spreading but failed to consider this as a possible symptom of dynamic loading on the roof tiles from a seismic event ;
2005 2.3, 2.4;
2006 3.9, the priest in his residence next door was woken by the ground shaking late at night when he observed new cracks in the church walls . The churches insurance company engaged G.O.Engineering Consultants Pty Ltd to investigate the cracking and report on the churches

claims. The report concluded that the current church damage was due to three separate seismic events in 1996, 2003 & 2006: - Foundation conditions of this 60 year old building were investigated and classed as moderately reactive. Wide concrete aprons surround the church and trees are set well back. Foundation movement was not considered to be an issue.
2007 2.2;
(Events not listed in this gap);
2010 1.9,epicentre near Snowy Airport at Cooma, extensive cracking occurred again in St Mary's church walls, concentrated in the same major locations as before with the damage being apparent in a SE-NW line through this EW facing church.

The above study of seismic events recorded over the past one and one half centuries in the Snowy Monaro has here focussed on the Town of Bombala (current population around 2,000) , because of the significant and repeated damage being caused in recent years to St Mary's Catholic Church. The epicentres causing the local shaking were located 40 to 100km away in various directions.

Some of the 2007 wall repairs to St Marys
Fig 5

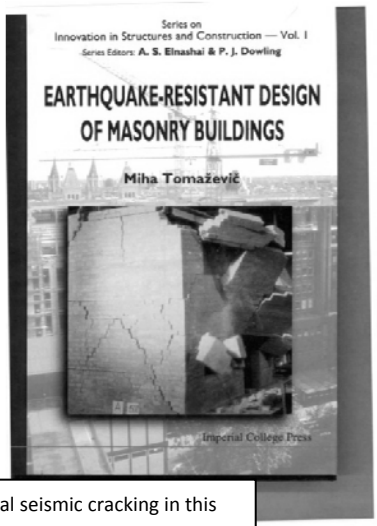
CONCLUSION

The point of this paper is to raise awareness of the scale of damage that can occur from small seismic events between 2 and 5 magnitude and to raise that awareness into developing actions and remedies that can reduce the scale of loss from these and potentially larger events. For example the modifications recommended for the lodge in Thredbo would remove repeated hammer and anvil actions to the bathroom wall and mitigate the danger of a wall collapse from a larger event. If the roof tiles were to be removed from St Mary's roof and replaced with light weight materials there should be less reaction to a seismic event and less danger to occupants from heavy tiles falling on them. Procedures of what to do in an earthquake should be permanently on display in the church and other susceptible buildings. Engineers in general should be made aware of the particular nature of seismic cracking patterns and seismologists should be careful not to play down the potential effects of minor seismic events. To coin a phrase from the RSL:-

THE PRICE OF SURVIVAL IS ETERNAL AWARENESS AND APPROPRIATE REACTION


COOMA-MONARO
Express
The Score...
INSIDE TODAY
EXCLUSIVE
Earthquake set to rock Cooma-Berridale region
MOVIES
Harry Potter fans descend on Cooma
PAGE 3
COMMUNITY
Countdown to Yamaga for Lions Club adventure
PAGE 7
Torah Brightens up our day
BUY LOCAL, BUY LOWER
$699
19

Recent call to awareness in local newspaper
Fig 6



Note the typical seismic cracking in this university test
Fig 7

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