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RESTORATION OF RESIDENCE AND OUTBUILDINGS AT 258 WAKESLEIGH ROAD BELLAR

REPORT ON STRUCTURAL DEFECTS AND RECOMMENDATIONS FOR REMEDIAL WORK

1.0 Residence Veranda

The veranda to the east of the living room ,dining room and bedroom 1 is elevated above the garden/lawn to the east by up to 600 mm . The veranda edge foundation wall acts as a retaining wall to the fill upon which the veranda floor is constructed .

The veranda floor to the southeast and east of the living room , east of the dining room and east and northeast of bedroom 1 has settled differentially between the exterior walls to the rooms and the veranda edge foundation wall . There is widespread cracking and vertical dislocation of the veranda floor and significant settlement , outward rotation and cracking of the veranda edge foundation wall .

The veranda roof eaves timber and cast iron filigree beams are supported off cast iron columns standing on the veranda edge foundation wall . The veranda roofs have settled at their eaves due to the combination of the foundation wall settlement and rotation , detachment of the posts from the foundation wall and filigree and the deterioration of the structural integrity of the timber filigree .In addition to settlement at the eaves the roof has sagged at several locations due to dry and wet rot and borer damage to the timber rafters , purlins and T&G board backing to the pressed metal veranda ceilings .

1.1 Veranda Foundation Wall Construction

The wall is 230 mm thick brickwork , plastered on the outside , built off a nominal 340 wide x 75 mm thick header course of bricks founded at a very shallow depth in poorly compacted fill consisting of silty clay with abundant small sized Tillite rock fragments . The wall is penetrated at two locations , one each opposite windows W04 and W11, by horizontal barrel vaulted brick ventilation ducts that ventilate the subfloor zone below the suspended timber floors to the interior of the residence . The settlement , rotation and cracking of the foundation wall are as a consequence of it being inadequately thick , an inadequate foundation and it being founded on poorly compacted fill .

1.1.1 Veranda Foundation Wall Reconstruction

After the east veranda roof and the settled veranda floor have been dismantled the existing foundation wall is to be carefully dismantled , the bricks set aside for re-use , and a new 345 reducing to 230 mm thick English bond foundation wall built off a new 750 x 250 mm thick reinforced concrete footing spanning between and stooled off 1500 x 700 (on plan) mass concrete pads founded on insitu stiff clay/ very soft to soft rock . The pads are to be located at the changes in direction of the foundation wall and midway between such changes in direction (maximum of 2.5 m centres) . See drawing VFW/1 for details .

A nominal 180 dia glazed earthenware pipe with mortared spigot and socket joints was exposed adjacent to and below the level of the bottom of the foundation wall in the two trial pits excavated

against the veranda foundation wall opposite bedroom 1 .This pipe may be part of the original roof rainwater runoff collection and discharge system and must be exposed , checked for integrity and reintegrated into the original stormwater management system .Care to prevent damage to the pipe must be taken when excavating for and constructing the veranda foundation wall mc pads , rc footing and the wall .

In addition to the glazed earthenware pipe noted above there are two stubs of cast iron pipes visible at ground level which will have connected to downpipes from the veranda roof valley gutters either side of the steps from the veranda outside the dining room (half round impressions in the plaster to the corners of the foundation wall either side of the stairs are visible) .The probable connection of the cast iron pipes to the glazed earthenware pipe should be exposed and refurbished /replaced to re-establish the original stormwater management system . There are two plastered brick rainwater catchpits against the foundation wall , one each opposite window W05 and W10 . The source of rainwater into these catchpits is unclear and should be further investigated . The discharge pipe routing and connection of these catchpits must be exposed and refurbished /replaced so as to remain effective as part of the stormwater management system .

1.2 Veranda Floor Construction

The veranda floor to the east consists of butt jointed (no jointing material) 12 mm thick encaustic tiles bedded on nominally 20 mm thick cementitious mortar ontop frogless clay brick paving ontop poorly compacted silty clay fill containing abundant small rock fragments .

1.2.1 Veranda Floor Reconstruction (where the veranda has settled and cracked)

The existing floor is to be dismantled (tiles and brick paving) and the fill is to be excavated to spoil .The soil at the original ground level (before filling) is to be tested for clay content and the heave potential of such clay . Clay found to have a moderate to high heave potential is to be excavated out for a minimum depth of 1.0 m and replaced with an imported fine G7 material that is compacted in layers to 95 % Mod Aaashto . The top 100mm of new the filling is to be an imported G5 decomposed granite compacted to 97% Mod Aashto . The top of the G5 layer is to be finished at 10 mm below the level of the underside of the brick paving with a tolerance of + zero ,-10 mm. The recovered brick pavers are to be relayed on a nominal 10 mm clean , sifted (to remove particles greater that 3 mm) riversand bedding .

The pavers are to be bedded onto the sand layer with a vibrating plate compactor . The recovered tiles (cleaned of mortar) are to be layed onto a nominal 15 mm thick cement :lime : sand (1 : 1 : 9) mortar placed onto the water dampened brick paving .

The method of dismantling the existing veranda floor must be such as to recover the tiles and brick pavers intact . A suggested approach is to sequentially remove the fill below the brick pavers , then to loosen the brick pavers from the tile mortar and then to grind off the mortar from the recovered tiles.

1.3 Veranda Roof Construction

The roof covering is galvanized S profile corrugated steel sheeting of nominal 0.6 mm thickness on 50 deep x 75 mm wide Oregon Pine purlins at centres varying between 850 and 1100 mm supported by 105 deep x 50 mm wide Oregon Pine rafters at 610 mm centres spanning between the exterior wall and the timber or cast iron eaves filigree beam .

The pressed metal ceiling is nailed to a subgrid of Oregon Pine timber battens nailed to 12 thick x 150 mm wide Oregon Pine T & G boarding nailed to the underside of the roof rafters . The subgrid consists of 22 thick x 28 mm wide Oregon Pine battens at 305 mm centres parallel to the T& G and at 610 mm centres normal to the direction of the boards .

The valley and hip rafters are nominal 190 deep x 70 mm thick Oregon Pine members (some have been previously been replaced with Balau due to damage by borer activity) with 50 deep x 75 mm wide hip and valley false rafters.

The timber eaves filigree was originally intended to act as a Vierendeel Girder to support the rafters and transfer their loads to the supporting cast iron columns . The filigree consists of a 95 x 95 mm top chord , a 60 deep x 100 wide bottom chord and 35 x 35x 155 mm high verticals . Every 4th or 5th vertical has a 16 mm dia. dome head bolt passing vertically through it and both the bottom and top chords with a nut and washer ontop the top chord .This bolt is intended to enable bending moments to be transferred between the chords and allowing the members to act in combination as a Vierendeel Girder .The timbers are Oregon Pine ; the top chord bottom edges and bottom chord outer edges are chamfered 8 x 8 mm . A 192 high x 22 mm thick shaped timber facia board is attached to the outside of the top chord and a 25 mm dia half round bead occurs at the junction of the ceiling with the top chord .A 100 x 145 x 155 mm high timber blocking piece occurs between the chords at the cast iron post positions . Double curvature shaped timber pieces are attached to the sides of the bottom chords at the post positions .

1.3.1 Veranda Roof Remedial Works

The veranda roof sheeting and flashings are severely corroded and should be replaced . The replacement S profile (corrugated) steel sheets must have a minimum gauge (thickness) of 0.58 mm to suit the existing purlin spacings . The sheets are to have a Z275 galvanised coating before receiving the factory applied paint finish specified by the architect .The size , shape and gauge material of all the existing flashings , valley gutters and ridge cappings are be measured and recorded and samples kept for replication .The finish of the flashings is to match that of the roof sheets .

The veranda roof sheet removal and replacement should be done in sections . After removal of a section of sheeting the Engineer is to be called to carry out a detailed inspection of the timber rafters , purlins , T & G boarding and eaves filigree . Timbers structurally compromised by either wet /dry rot or borer /termite activity are to be replaced with equal sized Oregon Pine members with a minimum grade stress of 10 mpa . All replacement timber must be CCA treated .

Where the T & G boarding supporting the pressed metal ceiling has been structurally compromised and is to be replaced the pressed metal ceiling will have to be carefully dismantled to allow access for the replacement of the T& G boarding . A careful record of the location and orientation of the ceiling panels to be removed , rehabilitated as per the Architects specification and refixed , is to be kept by the contractor .

Where compromised members of the eaves filigree are to be replaced the veranda roof must be temporarily and effectively propped such that the filigree panel between posts can be removed , disassembled , compromised members replaced , reassembled , the panel reinstalled ontop the supporting cast iron posts and the rafters and facia refixed to it .Compromised top and or bottom chords of the filigree are to be replaced over their full length between supporting posts . All replacement timber is to be Oregon Pine with a minimum grade stress of 10 mpa finished to match the shape , size and detail of the existing .

The structural capacity of the existing timber filigree is adequate for spans up to 2900 mm between supporting post centres . The timber filigree to the south edge of the south veranda is supported off posts spaced between 3670 and 4050 m .All the members of these filigree panels are significantly overstressed under self weight and imposed loads . These panels are to be removed and an additional 105 deep x 95mm thick continuous Oregon pine piece glued and coach screwed (M10 x 150mm at 300 centres) to the top of the top chord . The veranda roof rafters that at present rest ontop of the filigree will have to be shortened and fixed to the side of the adjusted top chord via pairs of screwed and bolted angle iron cleats (see detail FR/1) .

The existing cast iron posts appear to have no positive fixing to the foundation wall on which they bear or to the underside if the filigree panels they support .This apparent lack of fixing could result in the veranda roofs being uplifted should they ever be subject to design (1: 50 year return interval) wind uplift forces .In view of all the posts to the south east , east and northeast veranda eaves needing to be removed during the reconstruction of the foundation wall and there being an opportunity for those on the south to be modified , when the roof is temporarily propped whilst the filigree top chord is upsized , all the above mentioned posts are to have a hot dip galvanized 16 mm diameter threaded rod dowels , 550 mm long drilled and epoxied 100 mm deep into the bottom and top centers of the

cast iron posts . The bottom dowel is to be epoxied 450 mm deep into a hole (18 dia) drilled down into the new or existing (on the south veranda edge) foundation wall and the top dowel is to pass through the full depth of the filigree panels bearing onto the top of the cast iron post and be secured with a 250 long x 70 wide x 10 mm thick galvanized plate and M16 galv. Nut (the plate must be cranked , where required , at the 135 degree corners to the veranda edge) .

2.0 Residence Floors

The timber floors to the living and dining rooms , entrance hall , passage 1 , lobby 2 , bedroom 1 and 2 are constructed with 25 mm thick x 150 mm wide T & G boards on 230 x 38 mm secondary joists at nominally 450 mm centres spanning onto 83 x 73 mm wide (tarred/creosoted) primary joists at nominal 1130 mm centres spanning across 230 x 230 mm brick piers at nominally 1060 mm centres .The brick piers are capped with galvanized sheet antguard . The void depth below the floor (measured from top of T&G to soil) is nominally 760 mm .

The floor timbers were visually inspected through trap doors in the floor in lobby 2 and in the dining room only . There was no evidence of borer or termite activity or damage to the limited number of the floor timbers inspected in the vicinity of the trap doors . Access trapdoors through all timbers floors to all rooms must be formed to enable a thorough and detailed inspection of all the timbers floors from below .

No significant structural cracking or settlement was observed in the tiled floors to the bathrooms , kitchen , bedroom 3 , study and passage 1 .

3.0 Residence Walls

3.1 Wall Cracks and other wall defects

3.1.1 Entrance Hall exterior wall
A vertical crack above the west sidelight to D01

3.1.2 Living Room
Cracks below W01 cill corners .
Cracks above W01&W02 lintel corners
Crack above D02 lintel corner west and threshold corner east .

3.1.2 Dining Room
Crack below W07 cill corner north
Crack above W09 lintel corner north
Cracks above D14 lintel corners

3.1.3 Bedroom 1 (occupied at time of inspection – many wall hangings obscuring the walls)
10 mm crack above south doorway (onto veranda) lintel east corner (doorway not shown on Architects drawing)
Crack , horizontal , near veranda floor between D04 and W13

3.1.4 Lobby 2
Severe dampness in northwest corner . Eminates from roof or valley gutter .

3.1.5 Bedroom 2
Probable vertical crack in party wall with bedroom 3 (wall clad with caulk)
Previously filled vertical cracks external east of D05 & north of W14 .

3.1.6 Bedroom 3 and Dress area
Crack , vertical full height , in party wall with bedroom 2 .
Crack above D19 lintel corner west
Crack , large , thru archway to west partition wall.
Cracks in east & west corners of party wall between dress and bedroom 3 , extend 1.5 m down from ceiling .
Previously filled vertical cracks external east of D06 and west of W15 .

3.1.7 Kitchen
Cracks , vertical , 2 No near ceiling in northeast corner .

3.1.8 Study

Previously filled vertical crack external north of D09 .

3.2 Wall Crack Repair

3.2.1 The Bedroom 1 10 mm doorhead crack may be as a consequence of settlement of the east wall in the vicinity of W10 . The reconstruction of the veranda slab in this area provides the opportunity to investigate the soil conditions at foundation level in this area and underpin the footing should the soil conditions be found to be the likely cause of the settlement and consequential cracking of the wall .

3.2.2 The crack through the west wall archway to bedroom 3 requires further investigation , Plaster on the soffit of the archway , either side of the crack , is to be removed to establish how the arch was built or whether it was cut into the wall at some stage after the original construction . The possibility of settlement of the north external wall between D06 and W15 is to be investigated .

3.2.3 The remaining cracks identified in 3.1.1 to 3.1.8 above are to be reamed , stitched and caulked all as specified in detail CR/1 .

4.0 Residence Roofs

4.1 Roof over Living Room/ Entrance Hall/Study/Bathroom 1

The roof covering is S profile corrugated steel sheeting of nominal 0.6 mm thickness on 55 deep x 75mm wide Oregon Pine purlins at 850/1000/1100 mm spacings supported at between 1330 mm and 1550 mm centres by roof "trusses" ,as shown on detail schedule RR/1 , spanning approximately 5.71 m north/south to wallplates and by 230 x 38 mm hip rafters and 112 x 75 mm intermediate (to the hips) rafters . The pitch of the roof is nominally 35 degrees .12 mm thick x 150 wide T&G boards are fixed transverse to the bottom chords of the "trusses" and support the pressed metal ceilings . All the roof timbers and boards are Oregon Pine .

There is evidence of borer activity in a number of the roof timbers . The depth of ingress of borer into the cross section of the timbers is generally shallow (as determined by probing with a sharp screwdriver) and the sample of timbers probed indicate at least 70 % or more of their core cross-sectional area is intact . Every roof timber and the T & G boarding must be carefully inspected when the roof sheeting is replaced (during the time between the old sheeting being removed and the new sheeting being installed) when there is adequate lighting . Temporay duck boards are to be positioned for safe movement . This inspection is to confirm the above noted findings from the limited number of members probed .Members found to have more than 30% of their core cross-sectional area damaged by borer activity will need to be replaced with matching size Oregon Pine timber . T& G boards found to have been infested with borer or suffering from dry or wet rot must be replaced .

4.1.1 Remedial works to the Living Room/Entrance Hall/Study/Bathroom 1 roof

The roof sheeting and flashings are severely corroded and should be replaced . Refer to 1.3.1 for the replacement roof sheeting and flashings specification .

The roof timbers are to be inspected and where necessary , as specified in 4.1 above , replaced .

The integrity of the nails fixing the purlins to the rafters is to be checked by extracting a sample of nails and inspecting them for loss of cross section due to corrosion . If cross section loss is found , additional nails of equal size are to be installed into the connections .

There is currently no mechanical fixing resisting upward wind forces on the rafters and preventing same from detaching from the "truss" bottom chords . Each such junction must be upgraded with a galvanized M12 x 200 mm long coachscrew installed diagonally down through the rafter into the bottom chord . Pre-drilling of 12 dia screw shank holes and 9 mm dia screw thread pilot holes are essential to prevent splitting of the timber .

The integrity and capacity of the nailed connections between the "truss" rafters , kingpost and bottom chord and between the intermediate horizontal tie , kingpost and rafters is uncertain and may have

been compromised by corrosion of the nails at the member interfaces . Each joints capacities must be assured by the addition of a M12 galvanised bolt washer and nuts . Long galvanised threaded rod with washers and nuts either end may have to be used for the multiple member hip and intermediate rafters junctions .Bolts must also be installed through the hip rafter/ceiling joist/ wall beam junctions in the roof above the walls housing windows W03 , W04 , W05 .

The tying down of the "trusses" and hip end rafters to the wallplates and the securing of the wallplates to the brick walls must be investigated once the roof sheets are removed and the existing connections are visible and can be assessed . Remedial work to upgrade or replace non existent tie-downs with galvanized threaded rod dowels is expected .

In view of the 12 mm T & G ceiling boards being incapable of safely supporting a workman , due to the boards spanning between 1330 and 1550 mm between the supporting "truss" bottom chords , two permanent 228 x 50 mm grade 5 S A Pine CCA treated duck boards should be installed ontop the "truss " bottom chords for the full length of the roof .

4.2 Roof over Bedroom 1 and 2

The roof construction is the same as that described in 4.1 above . Refer to schedule RR/2 for a layout of the roof timbers . The condition of the roof timbers and ceiling boards is similar to that described in 4.1 except that there has also been termite (white ant) damage to a bottom chord member and the bottom of a kingpost of a second "truss" . The ceiling T& G boarding is detaching from the "truss" bottom chords above both bedrooms .

4.2.1 Remedial works to the Bedroom1 and 2 roof

The remedial works for this roof are the same as described in 4.1.1 above .

In addition , the route by which the termites (white ants) are getting into the roof must be investigated and if found , measures are to be taken to prevent further access .

The T & G ceiling boards that are generally detaching from the "trusss" bottom chords may indicate borer or termite damage to the underside of the chords . The ceilings and T & G boards are to be dismantled to allow for a close inspection of the bottom of the chords . If borer or termite damage has occurred the damaged sections of the chords are to be cut away and replacement Oregon Pine pieces glued and screwed in position . Only sound T & G ceiling boards are to be refixed in position .

4.3 Roof over Dining Room/Entrance Hall/Passage 2/Lobby2

Refer to schedule RR/3 for a layout and cross section of the roof timbers .

The roof sheeting is as described in 4.1 above .

The 50 deep x 75 mm wide Oregon Pine purlins spaced at 1160 mm centres are supported by two 112 x 38 mm double pitched rafters , spaced 1310 mm apart , centred on the north/south dimension of the dining room and linked by a 230 x 38 ridge beam. Each double pitched rafter has a 112 x 38 horiizontal tie at 1460 mm above wallplate level .230 deep x 38mm hip rafters span between the apex junction of the aforesaid 112 x 38 double pitched rafters and the eaves wallplates . The hip rafters support inclined 112 x 38 jack rafters spaced at approximately 1150 mm centres .

230 x 38 ceiling joists at between 860 and 1150 mm centres span east/ west between wallplates ontop the dining room walls and support 12 mm x 150 wide T & G boards . Similar sized ceiling joists at between 880 and 1220 mm centres span north/south between the passage 2/lobby 2 wall and a tmber beam , of unknown size and condition (due to being inaccessible) spanning east /west across the entrance hall at the junction with the roof described in 4.1 above .

A clerestory light over lobby 2 penetrates above the ceiling level into the roof void . It is supported by timber beams spanning to wallplates ontop the lobby walls .

There is evidence of borer and termite activity in a number of the roof timbers . The depth of ingress of borer into the cross section of the timbers was found to vary considerably . One 112 x 38 rafter probed has had 30 mm of its depth compromised by borer activity . All timbers , including the T & G boarding and the wallplates ,must be thoroughly assessed when the roof sheeting is removed (for replacement) and the loss of member cross section determined relative to the members size ,loading and span .

4.3.1 Remedial works to the Dining Room/Entrance Hall/Passge2/Lobby2 roof

The roof sheeting and flashings are severely corroded and should be replaced . Refer 1.3.1 for the replacement roof sheeting and flashings specification .

All timbers found to be structurally compromised by borer and/or termite activity are to be replaced with same size Oregon Pine members .

The roof rafter assembly is potentially unstable under design wind forces .The restraint against uplift forces and lateral forces from the rafters at wallpate and the roofs ridge are inadequate partly because the ceiling joists are generally not coincident with or connected to the rafters and the rafter connections at the ridge beam and with the hip rafters is merely and inadequately skew nailed . All these junctions are to be upgraded with M12 galvanised coach screws or bolts of a length that passes through all the connected timbers .

The centre pair of double pitched 112 x 38 rafters are inadequate and are to be triangulated into a truss as shown in section 3.1 on schedule RR/3 .

The roof lacks north/south stability for differential wind forces .Vertical bracing is to be introduced below the ridge beam of the roof . See detail on schedule RR/4 .

The integrity of the nailed connections between purlins and rafters is to be checked as noted in 4.1 above and upgraded if corrosion has resulted in nail cross section loss .

The integrity of the T & G board nailing to the ceiling joists must be assessed . If the joist bottoms have been compromised and cannot hold the ceiling nails they are to be repaired as described in 4.2.1 .

The tying down of the rafters to the wallplates and of the securing of the wallplates to the walls must be investigated and deficiencies remedied as noted in 4.1.1 above .

4.4 Roof over Kitchen/Passage1/Dress/Bathrm2/Bedroom3

Refer to schedule RR/5 for a layout and cross section of the roof timbers .

The roof sheeting is as described in 4.1 above .

A galvanised box gutter is positioned between this roof and that over the adjacent entrancehall/passage 2/ lobby 2/bedroom 2 .Four 100 dia pvc horizontal discharge pipes pass through the roof void . One of the pipes has separated from a gutter spigot . The gutter is heavily corroded in places .

Access in the roof void is very limited , the clear height between the "truss" chords is nominally 1085 mm at its highest , therefore a detailed inspection of the condition of the timber members can only be done once reconstruction has commenced and the roof sheets are removed for replacement .Borer and/or termite damage to timbers was visible near the north end of the roof void .

There is no timber wallplate ontop the west wall supporting this and the veranda roof timbers . There was no evidence a truss or rafter tie-downs to the supporting walls .

There is a horizontal and a vertical geyser in the roof void . The two truss inclined web members of the truss immediately north of the vertical geyser are missing . The vertical geyser is supported by a pair of 76 deep x 110 wide timbers above the level of the truss bottom chord and stooled off the bathroom 2 north/south walls .

4.4.1 Remedial works to Kitchen/Passage1/Dress/Bathrm2/Bedroom3 roof

The roof sheeting and flashings and box gutter are severly corroded and should be replaced . Refer 1.3.1 for the replacement roof sheeting and flashings specification . The box gutter must be replaced with either a moulded fiberglass or bent plate stainless steel gutter with an inclined lip from the top of the west sidewall that passes over the roof purlin immediately adjacent the gutter .The existing 4 x 100 dia pvc discharge pipes must be replaced with a 400 wide x 110 mm high rectangular hollow section (RHS) discharge member made from a similar material to that of the new box gutter .This discharge RHS is to be supported at 600 mm centres by galvanized 50 x 8 mm thick flatbar gutter brackets turned up at its ends to form an inverted top hat shape which are hung with 8 dia galv threaded rods from overhead 75 deep x 50 mm wide Gr7 treated S A Pine bearers stooled up off the bottom chords of the trusses either side of the discharge RHS. The box gutter must be provided with a overflow wier at it north end that discharges onto the veranda roof.

The truss configuration and the vertically eccentric connection of the truss bottom and top chords at the box gutter end (where the top chord is curtailed and stooled off the bottom chord) is structurally unsound. A 125 x 38 mm Oregon Pine kingpost must be bolted into the trusses and all the member connections must be upgraded with M12 galvanised bolts with washers and nuts . The existing nominal 73 x 73 mm side mounted stool supporting the curtailed top chord at the gutter end must be replaced by a pair of 230 x 38 mm Oregon Pine stools that are twice bolted through each of the top and bottom chords with M12 galvanised bolts with washers . See details on RR/6 .

The connections of the hip end rafters are to be upgraded with M12 galvanised bolts or galvanized treaded rods with washers and nuts where available bolt lengths are inadequate .

The roof truss ends are to be bolted down to the supporting brick walls . See detail on RR/6.

The integrity of the nailed connections of the purlins to the trusses is to be checked and additional nails added should the existing be found to have been compromised by corrosion .

The integrity of the T & G ceiling board nailing to the truss bottom chords must be assessed . If the bottoms of the supporting timbers have been compromised and cannot effectively hold the ceiling nails such timbers are to be repaired as described in 4.2.1 above . The ceiling boards in the vicinity of the box gutter and the dislocated discharge pipe are to be investigated for wet rot and replaced where necessary .