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23 April 2014
473791

NMBM Electricity and Energy Unit
PO Box 369
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Attention: Mr I Pattinson

Dear Sir

BRICKMAKERS KLOOF SUBSTATION-STRUCTURAL ASSESSMENT REPORT

1. Introduction and Terms of Reference

SRK were appointed by the NMBM on 14 February 2014 for the civil and structural design and construction services pertaining to the repairs and maintenance of the Brickmakers Kloof Substation. The Substation is situated in Brickmakers Kloof Road. The building appears to be more than 60 years old and is considered a heritage building. See photograph 1 below.

A site inspection was carried out on the 21 February 2014 in which the scope of repairs and maintenance aspects were assessed.

During this inspection it was observed that structural defects were evident at the interface between the roof slab and the supporting brickwork. It was concluded that a more in depth inspection be carried out to determine the underlying causes and prepare designs for its repair.

Photograph 1-Western elevation of sub-station building

The purpose of this report is therefore:

- To evaluate the structural integrity of the building and determine the extent of the repairs;
- To propose remedial designs for approval; and
- To conclude and provide the necessary recommendations.

2. Building Structure

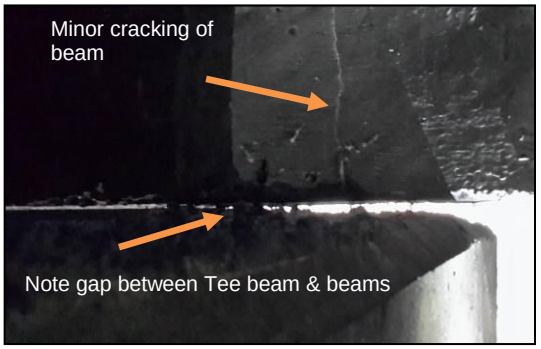
The substation building is a rectangular structure with approximate dimensions of 20m and 9m respectively. The building is approximately 6 m high. An open substation yard area adjoins the building along the western boundary with supporting cubicle walls.

The building comprises of 280 mm wide loadbearing brickwork supporting a reinforced concrete roof slab. This slab is supported on a concrete ring beam which is integral with the roof slab. A supporting concrete structure comprising of two columns and a T beam is found within the building. The structure was built to support the concrete roof whilst repairs were being undertaken to repair the eastern support wall. Brick buttresses support certain sections of the load bearing walls.

3. Investigation Approach

A meeting was arranged for the 1 April 2014 to conduct a further inspection on the roof structure and eastern load bearing wall. The NMBM Electrical Department provided an extension ladder to assist with the investigation.

The site was attended by Mr Douglas Finn of NMBM with Messrs W Badenhorst and K Uderstadt of SRK Consulting. It was decided initially to investigate the internal T beam/column section to evaluate if bearing exists with the roof structure and then to assess the external facades of the substation building.



Photograph 2: Note gap between beams ~ 10 mm

4. Observations

In order to evaluate the structure, the following aspects were investigated:

- Internal Tee Beam support mechanism;
- Internal concrete/brickwork defects;
- External defects; and
- External - other areas of concern.

See sketch 4.1 for building plan layout below.

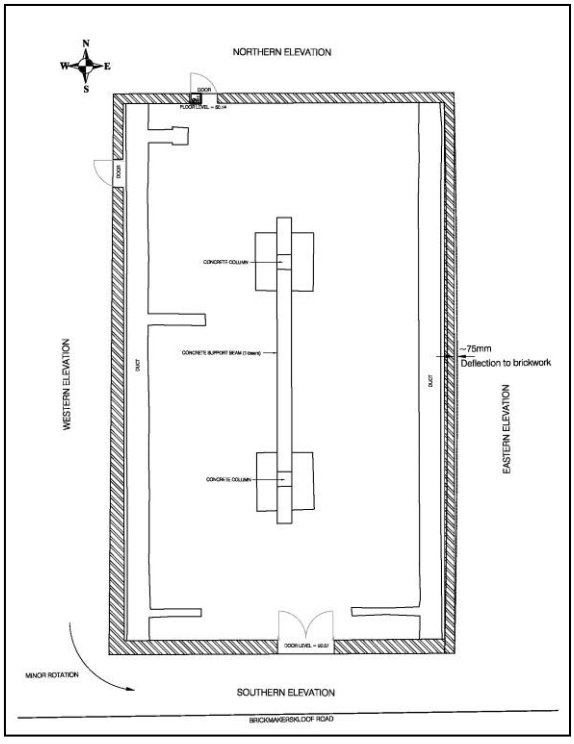


Figure 4.1-Layout plan of building

4.1 Internal Inspections

Tee Beam Support Mechanism

Inspections were carried out on both ends of the Tee Beam support mechanism. In both cases it is evident that this structure does not support the concrete roof structure. From observations it appears that the gap varies by ~ 10 mm to 20 mm respectively. See photographs 2 and 3 respectively.

Photograph 3- Note gap between beams ~ 20 mm

It was also observed that hairline cracks are evident on the supporting roof beams.

Internal concrete/beam defects

An inspection was carried out on the south western corner of the building. It appears that a horizontal crack has developed and displacement occurred between the concrete and brickwork interfaces. A slip joint exists between these interfaces comprising of two layers of pvc/hardboards sheets.

4.2.1 External Defects

Eastern Load bearing wall

From observations, it is clear that the eastern support load bearing wall has buckled in the vertical plane. This deformation is noted between the concrete and brickwork interfaces notably at midspan. A horizontal shift of ~75 mm appears to have developed at midspan. It was further observed that only one slip joint exist between these two interfaces. See photograph 4 and 5 respectively.

Photograph 4-Eastern Elevation-Note Defect

Minor shifts were also noted at the southern/western corner of the building

Foundations

From observations, it is clear that there is no evidence of settlement of the foundation. No cracking was noted on the external brickwork facings on the eastern elevation.

Photograph 5- Note 75 mm movement

5. Evaluation

5.1 General

From the investigations undertaken, it is clear that excessive displacement has occurred between the concrete and brick work interfaces along the roof beam. This is most prominent along the eastern elevation of the building. From discussions held with NMBM it is apparent that part of this wall was repaired after one of the switch gear mechanisms exploded. This happened some 8-10 years ago. Although this wall is standing, and appears marginally intact, with time most of its lateral restraint will have been compromised and therefore will lead to ultimate failure. With the additional internal tee beam not transferring direct axial support to the roof slab, the structure could be further compromised.

5.2 Calculation

If the load bearing wall is considered to be a vertical beam, the maximum deflection must not exceed 1/360. As measured onsite, this wall has deflected ~ 75 mm, with the vertical height ~ 6 m, the maximum allowable deflection has been exceed by a factor of 4.5. As this is the case, this element exceeds its serviceability threshold. See photograph 5.

5.3 Accommodation of Movement

Vertical movement joints are not apparent within the load bearing brickwork walls. Seasonal movement and age of structure have increased stresses within the brickwork resulting in horizontal movement.

The absence of vertical joints has allowed the structure to deflect resulting in the serviceability of the structure being compromised.

Typical expansions for masonry units is ~ 0.6 mm per m. Based on the building dimension of 15 m this equates to a movement of 10mm. In this case, it is clearly exceeded.

6. Conclusions

Based on the above evaluation, the following conclusions can be drawn:

- From inspection, the roof structure does not bear on the Tee beam mechanism;
- The eastern load bearing wall has partially failed;
- Inadequate expansion joints contributed to the resulted in the defects exhibited;
- Defective horizontal slip joints along the eastern elevation resulted in the defects exhibited; and
- The eastern load bearing wall will have to be demolished and replaced urgently;

7. Recommendations

The long term serviceability of the load bearing wall (eastern elevation) is unsafe for its deemed purpose and should be repaired as soon as possible. It is recommended that the wall be replaced and stabilised with two concrete columns equally spaced and formed integral with the roof ring beam. A slip joint is to be provided between the internal Tee beam and caulked up to ensure load transfer. Expansion joints must be provided between the new concrete and brickwork interfaces. All defective slip joint must be repaired.

Prepared by

SRK Consulting - Certified Electronic Signature

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473791/41750/Letter Report
3704-8414-924-UDER
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