Cultural Heritage Investigation of Historical Steel-Framed Building on the Property of PPC Slurry Operation, near Mafikeng, North West Province

For

Pretoria Portland Cement Co. Ltd.
Slurry Operation
Mafikeng
North West Province

By

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1. Executive Summary

This report provides a detailed case analysis of the industrial archeological history of a steel framed building clad in corrugated steel sheeting. It is situated in the main lime kiln factory area of the PPC Slurry Operation (on the farm Slurry 96 JO), sited north east of Mafikeng. It follows a Phase 1 Cultural Heritage Survey conducted by Francois P Coetzee in 2008, (Coetzee 2008).

As the building does not conform to certain current SABS building codes for such a structure it has been deemed necessary to demolish the building. An investigation was carried out by a firm of consulting civil engineers who have acted in that capacity for the Pretoria Portland Cement Company Ltd since 1968. The results of their findings were that the building needed to be strengthened by additional steel bracing. The work was not carried out due to the high costs involved in the modification. It was felt that as the building no longer formed a safe structure and the costs were prohibitive to make it so, that the only alternative was to demolish it.

It was assumed that the structure was at least older than 60 years. The Heritage Impact Assessment brief required the surveying of the building with particular reference to its construction and historical significance if any, so that an application to SAHRA could be made for a demolition permit. Archival research has been limited due to a date for the construction of the building. Having said this however possible sources for the steel used in the construction and certain engineering design features have led the authors to certain conclusions about the age of the building and its possible origins.

Local sources of data on the building were investigated and Messrs Junkoon and Associates of Johannesburg provided a detailed drawing of the structure. Additional information on the possible age or history of the building was gained through personal communication with Mr Frank Whitely, Associate Director of the company. Further work on a possible date of manufacture, or a possible manufacturer, were sourced from the Internet and the results of these searches is included in the report.

A physical and photographic survey of the building was conducted in early November 2012 by both authors. The report presents the results of the survey and draws conclusions as to the possible age of the building.

The building has been determined to be older than sixty years and such structures are protected under the National Heritage Resources Act (Act No 25 of 1999, Section 34). Due to the built structure being older than sixty years a copy of this report will be lodged with South African Heritage Resources Agency (SAHRA).

2. Background to the study

2.1 Introduction

FP Coetzee (Department of Anthropology and Archaeology) conducted a Phase 1 HIA investigation in March 2008 for PPC Slurry. The investigation focused on surveying the cultural heritage remains consisting of surface archaeological and historical remains in the area of land that the PPC Slurry operation has mining rights, as well as any potentially historical buildings within the factory located north-west of Mafikeng, North West Province. PPC Slurry Management has requested an additional Heritage Impact Assessment (Phase 2 investigation) of the historical steel-framed building (listed as Site 8) as they intend to apply for a demolition permit for the building which is potentially older than 60 years.

2.1.1 Terms of Reference

The terms of reference of the current study are as follows:

- conduct a site survey of the building known as the ‘tool store’ located next to the lime kilns in the production area of the PPC factory on the farm Slurry 96,
- provide a detailed description of the building and all its features,
- provide drawings/sketches and a photographic record of the building,
- research the history and possibly determine the date for the building, and
- provide a written report on the findings and submit it to SAHRA together with an application for a demolition permit.

2.1.2 Nature of current activities

The PPC Slurry cement production plant was the second such plant to be commissioned by PPC, and began its operations in 1916, it has been in continuous operation since then. PPC has been in existence since 1892, initially as Die Eerste Cement Fabrieken Bpk. It was founded by Edouard Lippert along with Hermann Eckstein and J.B. Taylor of the firm H. Eckstein & Co. in 1892. They began

operations at the Hercules plant in Pretoria, which is still in operation. In 1908 the Company changed its name to Pretoria Portland Cement Co. Ltd (see Coetzee 2008).

2.2 Legislation regarding archaeology and heritage sites

SAHRA (national agency), and the PHRA's (provincial authorities) are mandated to protect, conserve and manage the cultural resources of South Africa. It is therefore obligatory to adhere to resource legislation contained in the Government Gazette of the Republic of South Africa (Act No 25 of 1999) as many heritage sites are threatened daily by development. Environmental legislation requires impact assessment reports as part of Environmental Impact Assessments (EIA's) of which most Heritage Impact Assessments (HIA's) form part.

HIA's should be done by qualified professionals, with adequate knowledge to (a) identify all heritage resources including archaeological and paleontological sites that might occur in areas to be developed and (b) make recommendations for the protection or mitigation of the impact of the sites.

2.2.1 National Heritage Resources Act (NHRA) (Act no 25 of 1999)

According to the NHRA (Act No 25 of 1999, Section 34) a historical site is "any identifiable building or part thereof, marker, milestone, gravestone, landmark or tell older than 60 years". This clause is commonly known as the "60-years clause". Buildings are amongst the most enduring features of human occupation, and this definition therefore includes all buildings older than 60 years, modern architecture as well as ruins, fortifications and other historic settlements.

The NHRA makes an archaeological impact assessment as part of an EIA and EMPR mandatory. No archaeological artefact, assemblage or settlement (site) may be moved or destroyed without the necessary approval from the **South African Heritage Resources Agency (SAHRA).** Full cognisance is taken of this Act in making recommendations in this report.

The guidelines as provided by the **NHRA (Act No. 25 of 1999)** in Section 3, with special reference to subsection 3, and the Australian ICOMOS Charter (also known as the Burra Charter) are used when determining the cultural significance or other special value of archaeological or historical sites.

It should be kept in mind that archaeological deposits usually occur below ground level. Should archaeological artefacts or skeletal material be revealed in the area during construction activities, such activities should be halted, and a university or museum notified in order for an investigation and evaluation of the find(s) to take place **(*cf*. NHRA (Act No. 25 of 1999)**, Section 36 (6)).

Please note that Section 44 of the Act makes it mandatory to complete a Conservation Management Plan (CMP) if the site is going to be used for public enjoyment, education, research and tourism, which include:

- The erection of explanatory plaques and interpretative facilities
- Training and provision of guides
- Mounting of exhibits
- Erection of memorials
- Other means necessary for the effective presentation of the heritage site

3. Methodology

3.1 Ground site survey

The site was visited for two days in November 2012. After a visual analysis of the building it was decided to carry out the following surveys:

- Internal and external photographic record.
- Measurements and detailed analysis of the method of construction.
- Close inspection of the steel structure looking for possible manufacturing names or dates.
- A follow up with the firm of consulting engineers to PPC for possible historical data (See 3.2).

- An Internet and archival search of possible sources of steel manufacturers of the structure (See 3.3).

Measurements were taken using 30m and 5m tapes and where possible the structural steel used in the construction of the building was measured.

A total of 167 photographs were taken of the building – both internally and externally. These were subsequently edited and a representative sample of the photographs of the building are included in the back of the report.

3.2 Follow up with PPC's Consulting Engineers

The decision to do this follow up was twofold:

1. To obtain any drawings of the building if possible.
2. To obtain any historical data that they may have in their files.

3.3 Internet and archival searches

An internet search of similar structures coupled with possible manufacturers of the structure or the steel in order to arrive at an approximate date for the structure. A limited search did provide some evidential clues as to possible manufacturers of the structure but they are circumstantial at best.
The most important find was the digital version of a book by W. Bates; *Historical Structural Steelwork Handbook.* Using this source it was possible to bracket date the structural steel used in the building. Contact with local historical societies and the archives in Scotland also provided some additional information.

4. Fieldwork and description of the site and its features

4.1 Visibility, constraints and general description of the area

Apart from restricted access to the plant through a locked gate, which forms part of the PPC Slurry security structure the building is reached from the main offices by

walking through the plant in a westerly direction. The building, although technically a stand-alone structure does abut a more modern covered storage area – the motor store. However there is no apparent structural linkage between the two buildings. There is a roadway on two sides of the building (north and east) and a new building is under construction on its southern side. It was noted that the west end of the building did not have any form of structural steel and that the cladding was attached to a wooden structural framework. This point is discussed further below. The building was freely accessible for the duration of the field work.

4.2 Ground survey

A large part of the visual survey was photographic in nature with the specific purpose of recording the external and internal characteristics of the building from all possible directions. Specific photographs are included in the detailed description of the building. A physical measuring programme was also carried out as follows:

1. Measuring of the spacing of the I steel section columns.
2. Measuring of the various steel sections where it was possible to reach them.
3. Measuring of the size and thickness of the steel corrugate sheeting.
4. Measuring of the wooden sections on the west wall.
5. Measuring of the brick supporting buttresses on the north, east and south external walls.
6. Close inspection of the steel structure for possible names or evidence of origin of the steel or manufacturer.
7. Copies of two drawings were provided by PPC Slurry:
    a) General site plan of the Slurry Factory (Appendix 1)
    b) Tool Store building marked-up showing the proposed additional steel work to strengthen the structure so that it conforms to SABS 0162-3:1984. (Appendix 2)

4.3 Results of the follow up with PPC's civil consulting engineers

A meeting was arranged with Mr Frank Whitley (Associate Director) of the firm Junkoon and Associates (Pty) Ltd, Parktown, Johannesburg. A clean copy of the Tool Store Building drawing, produced in 2007 at the time of the possible

strengthening of the structure was provided along with part of an engineer's potential hazard report some of which refers to the building which is identified as a 'Tool Store' and is referred to under features 384-387 (Appendix 3).

Mr Whitely stated that he knew of the Tool Store at PPC Slurry since his involvement with the various PPC plants from 1968. It was apparently next to the original kilns which have since been removed and he stated that the wooden structural timbers were present then. He agreed with the assessment of the one author (GR), that it seemed as if the original building had been longer and was possibly originally located on a different site altogether. If the structure was relocated to the Slurry plant when the plant was built in 1916 it may have been then that the wooden structural frame was added. The assumption is that the original building was longer than the present structure and that for some reason it was shortened when reconstructed at the Slurry plant.

He also clarified the need to strengthen the structure stating that as the original structure was of a bolted construction and had no welded components anywhere, it was in conflict with modern structural steel codes of construction. The biggest problem being it lacked sufficient cross bracing for windage. The point was raised that three of the cross braces present were not even bolted together anyway. It lacked sufficient roof bracing tying both the trusses and gable ends of the structure together and furthermore had insufficient roof purlins and rafters to support the corrugate roof sheeting. He also pointed out the lack of tie plates at the lower side of the vee braces of the roof trusses, a feature which would add to the cross wind strength of the roof.

One outstanding feature of the design to any structural or mechanical engineer is the fact that virtually all of the connections are made with a single bolt point whereas modern structures would have anywhere from 3-6 bolts per attachment point. This design feature is part of the evidence that the structure is much older than was thought. What is clear is that the original bolted structural steel framework was designed in an age when building codes, if they existed at all, where less restrictive. This point is taken up again when the possible age of the structure is debated.

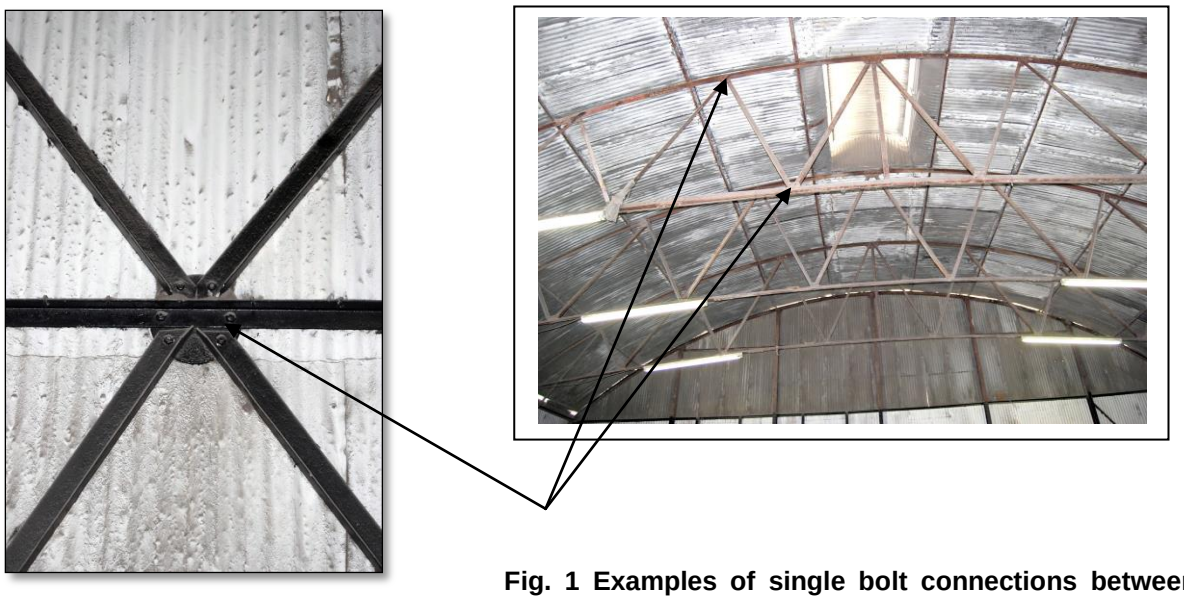

Fig. 1 Examples of single bolt connections between steelwork

Another clue to the fact that the structure was relocated from another site is the brick foundation. It shows no signs of modification since being built. In other words the wooden structural gable end was already in existence when the building was re-erected. Mr Whitely agreed with this conclusion and added that in the board room of the Slurry plant there is an early aerial photograph of the plant and the 'Tool Store' building can be clearly seen 'as is' in the photograph. Unfortunately he did not know the age of the photograph.

4.4 **Internet and archival searches (results)**

During the internal survey two of the pieces of structural steel were found to have the name of DALZELL in raised letters. It was formed during the hot rolling process of the steel angle section. No other names or identification marks were found. A search of the name Dalzell produced several sites which identified the name as that of a well known Scottish steel maker. They are still in existence in Motherwell Scotland but now form part of the TATA steel group. What is of significance is that they were in existence from around 1881 and were one of the largest steel makers in Scotland, eventually becoming part of the British Steel Corporation in 1967 (see 8.1.1).

Fig. 2 Rolled raised letters showing the name DALZELL

From a search of information on Dalzell came a suggestion from Mr Colin Findley of Scotland that we investigate a company called Motherwell Bridge Co Ltd. This was done on the internet and a picture of a very similar building to the PPC Slurry one was found on a web site. It is of course purely circumstantial evidence and there is no way of knowing if Motherwell Bridge Ltd built the Slurry structure. However, the age of the 'Motherwell Bridge' structure at 'early 1900' does appear to tie in with certain aspects of the Slurry structural steel. The 'off sets' on the girts and cross bracing, is a feature which the one author (GR) felt was more likely of late Victorian or Edwardian manufacturing practice - see the descriptive analysis of the structure in Section 5.

5. Description of the building, its construction and possible age

5.1 Dimensional description

The building measures 15.25 m long x 18.3 m wide. This strange contradiction to the normal method of describing the longest dimension as the length of a structure will be explained below. It is a nominal 4.2 m high at the lowest point of the curved roof and 9.1 m at the highest point. Note that although metric measurements are used in the report the dimensions are clearly originally imperial. For example the actual pitch between columns is 3.050 m which converts to 10 feet exactly.

The roof is of an arch construction as can be seen in the attached drawing (Appendix 2) and in a number of the photographs. A series of curved trusses joined with purlins

where the truss bracings meet, provides the only structural steel component of the roof.

The building is clad externally in corrugate steel sheeting which is approximately 2 - 2.5 mm thick. This is also an indication of the age of the structure as corrugate sheeting manufactured today is generally of the order of 0.4 - 0.8 mm thick. It is quite possible that the only real structural integrity for the roof and wall of the building is the interlocking action of the corrugate sheeting. This interlocking action is possibly giving the building a degree of lateral wind resistance and strength. This point was raised with Frank Whitley in the discussions in his office and he concurred with the hypothesis. It is also discussed further under Section 6.

5.2 Foundation description

The steel structure is built on a raised foundation consisting of a brick foundation with buttresses aligned with the steel columns of the structure. The base of the columns is covered by brickwork in a low bund wall of 3-8 courses above the internal floor level. The external wall varies from 1.0 - 1.7 m above the hard standing area profile surrounding the building. Of interest is the brickwork which has been laid to an English bond configuration rather than the more modern stretcher bond (Fig 3).

Fig. 3 External wall showing brickwork in English bond.

During the meeting with Frank Whitley the cracks in the foundation wall brickwork were discussed. The cracks display a typical lateral movement on the brickwork by following a general 45-degree line upwards from a point most commonly around 3-4 courses above the current ground or tarmac surface level. It was agreed that they are:

- Very old- the staining and dirt within the crack lines displayed this fact. It can be assumed therefore that the structure is now stable.
- Most probably has minimal impact upon the integrity of the foundation, but it could be strengthened if necessary.

Fig. 4 Handmade bricks used in the foundation walling.

5.3 Determination of the age of the building

The steel used in the construction of the building matches imperial sizes. For example the I section columns measure nominally 180 x 97 mm or 7 x 3.75 inches and the windage cross braces are made from rolled steel angle (RSA) 82 x 82 x 8 mm or 3.25 x 3.25 x 0.31 inches and the girts or horizontal sections between columns measured 70 x 70 x 10 mm or 2.75 x 2.75 x 0.43 inches. It was not possible to measure steel sections higher than 2.5 metres, but a visual analysis suggested that most of the structure was of the three sizes mentioned. The use of Imperial sizes for structural steel section was phased out in the late 1960s to early 1970s when metrication was adopted in the United Kingdom. However the sizes mentioned do not conform to any of the sizes available or specified in the last imperial version of the British Standard for rolled steel sections – BS 4 1962.

A search was conducted to try and ascertain when such sizes were made and when they ceased to be manufactured as it was hoped that such information could be used

to date the structure. The results of the search have led to the conclusion that the building is considerably older than was thought.

In section 4.3 it was suggested that certain elements in the design indicated that the steel structure could be as old as the late Victorian period of the 1890s. One of the reasons for this suggestion is the method of joining girts and cross-braces to the columns. To ensure that the corrugate cladding sits perfectly flush with the outside faces of both the column and the angle sections, the latter have been mechanically deformed such that bolted end of the angle section is dog-legged where it comes into contact with the inside of the flange of the column. The one author (GR) also a mechanical engineer has never seen such a method used and it almost certainly would not have been done since 1914 as the cost would be prohibitive. It is however more typical of the level of detail performed by Victorian engineers and manufacturers.

Fig. 5 Single bolt connection of a girt.

Fig. 6 Single bolt connection of a girt.

Fig. 7 Single bolt connection of a cross-brace.

Pictures illustrating the off-set of the angle sections where it connects with the internal flange of the columns.

5.3.1 Could the steel be from late Victorian times?

The hypothesis is firmly supported by the search for manufacturing dates of the steel sections used in the structure. A publication by W. Bates - *Historical Structural Steelwork Handbook* and published in 1987 provided substantial data on the steel sections. Modern British steel sections are metric and this was begun in the early 1970s. Prior to 1900 there was no British Standards Institution and many manufacturers manufactured sections to suit designer's requirements. By 1887 a degree of standardisation of acceptable sections for structural steel was beginning to be formed and it seems that most steel manufacturers followed general guidelines proposed by Dorman Long & Company (Bates 1987).

The table for steel sections of 1887 in the book by Bates lists the three Imperial steel sections found in the building. However when the British Standards Institution was created in 1900 it began work on a standard for structural steel and this was published as BS 4 in 1903. It makes no mention of the 7 x 3.75 inch joist section and the nearest section is the 7 x 4 inch section which became the standard until 1921 when it was briefly replaced by a 7 x 3.5 inch section only to return to the 7 x 4 inch size in 1932 and it remained so until metrication in 1972.

The two rolled steel angle sections of 3.25 x 3.25 x 0.31 and 2.75 x 2.75 x 0.43 inches have a similar disappearance after 1903. They can be found in 1887 but when the new standard dealing with rolled steel angle and channel sections BS 4 amendment of 1906 was released, the two sections were not in it. The standard sections for angles were listed as:

- 2 x 2
- 2.25 x 2.25
- 2.5 x 2.5
- 3 x 3
- 3.5 x 3.5 inches.

Once again these sections were retained from 1906 until metrication in 1972.

These facts lead the authors to the conclusions that the original building most probably dates from the 1890s. How does this fit in, with what is known about the structure and what could its origins be? It has been established that Dalzell manufactured the rolled sections and it has been established through further research that two possible companies that were located relatively close to Dalzell's steelworks in the town of Motherwell in Scotland could have been possible manufacturers of the structural steelwork for the PPC building. They are Alexander Findley & Co Ltd (established 1888) and Motherwell Bridge Co Ltd. (established 1898). Both were firms of structural engineers involved in the manufacture of factory buildings and bridges. Motherwell Bridge exported bridges and other structures to South African Railways in the early part of the 19th century. (C. Findley: pers. com.) It is known that Alexander Findley also exported industrial structures. Both were also known to manufacture structural steel in 'kit form' for assembly on site. (C. Findley: pers. com.)

Assuming that one of these companies exported the structural steel in the 1890's was it's possible destination one of the gold mines of the Corner House Group – owner of Die Eerste Cement Fabrieken Bpk., or could it have been sent out for the first cement factory at Hercules in Pretoria, still one of PPC's plants in 2012? If this scenario is accepted, it could explain the foreshortening of the building to its existing length and the modification of the one gable end and the wooden structure at the gable end. It is therefore proposed that the original 1890s structure was probably longer than the width and that during reassembly at its current location it was shortened and also modified with the additional of the timber framework. However, the true story will probably not be found after all of these years, save to say that the evidence outlined above demonstrates that the original building predates at least 1900 and probably dates between 1890 and 1895 when there was a peak of investment in industry and gold in the Transvaal Republic. Such a date would possibly eliminate Motherwell Bridge Ltd. as the possible supplier and favour Alexander Findley Ltd.

Additional features of the building are the vent structure in the roof to allow for rising hot air to vent to atmosphere. It is impossible to say if this was a standard feature of the design or a requirement for South African conditions. It is clearly not a later

modification though. From the photographs below one can see that the 18m width of the building was designed as a clear-span structure. Many modern factory buildings have adopted this type of structure but it comes at a substantial cost because of the need for a stronger roof structure. Such a span was probably very much ahead of its time if the 1890s is accepted as the date of the building.

Fig. 8 View of the north-facing façade with inside the air vent on the top of the roof.

Fig. 9 View of the air vent from the building.

Fig. 10 View of the clear-span structure of the building looking towards the West gable.

5.4 Description of the timber structural members on the west gable wall

The possible reasons for a building having a steel structure for most of its construction but with a timber framework at one (western) end, is discussed above in the section 5.3.1. Due to variations in cross section of the timber only nominal sizes can be given. They are rounded to the nearest metric equivalent but would almost certainly have been imperial sizes of timber. The columns are 215 x 75-85 mm thick. The girts average at 115 x 75 although some were measured at nearer to 120 x 80. The same applies to the two long diagonal cross braces seen in Figs. 10, 11 & 14.

It was not possible to measure the upper diagonals but it is assumed that they are of a comparable cross section. What is not apparent is any form of mechanical

attachment of the timber members to each other or a mechanism of holding the timber columns to the base timber plate. One would assume that bolts are used but none are visible. Some of the timbers show evidence of cracking/ageing and hence the integrity of the timber is questionable

What defies logic is the lack of suitable cross bracing, especially above the point at which the diagonal braces meet the columns. There are two shorter diagonal braces, but they are only effective to the quadrant of the frame in which they are attached. The top three levels of panelling have no diagonal cross bracing and so most probably rely on the integral strength of the attached corrugate sheeting for lateral strength and wind resistance.

Finally a comment on the wooden structural frame at the western gable end of the building. This is clearly not part of the original metal structure of the building although it was probably added when the overall length was shortened. It probably arrived in this modified state at the Slurry plant.

Fig. 11 View of the timber structure gable end end looking south-west.

Fig. 12 View of the timber structure gable looking north-west.

Fig. 13 One of the main timber columns with timber girts.

Fig. 14 A column with a diagonal timber brace. There was no obvious means of mechanical connection between the timbers.

Fig. 15. Irregular cutting of the roof sections support the hypothesis that the structure was cut and shortened

If one assumes that the building was, first, originally located either at a gold mine or the Eerste Cement Fabrieken site in Pretoria and, secondly, it was longer than it is now, then the question arises what were the requirements when the Slurry plant was designed and built in 1916? A proposed scenario is that the structure was in partial use at a gold mine and 'cut in half' as steel was at a premium during 1916 because of the demands of the War. The one half of the structure with its new timber framework could have been transferred to Slurry. The remaining section of the building probably also received a timber framework. The current gable end therefore most probably dates from 1916. The timber sections are substantial but the authors could not ascertain how the timbers are held together as no bolts were visible. This raises another concern for safety during any proposed demolition.

6. Discussion and Evaluation

Various sources of evidence suggest that the steel structure currently being used as a tool store at the PPC Slurry plant is older than 60 years (in fact probably older than 100 years) and is therefore protected under the NHRA (Act no. 25 of 1999, Section 34). The structure also represents a specific period in steel construction and might even be a unique - if not the only – surviving example of pre-1900 steel structure design that was possibly delivered in kit form. Easy to assemble and disassemble these 'kit' structures could be exported and erected easily and economically. This might also be indeed the reason why this structure was originally erected at an unknown location and later partially reassembled at Slurry. Although no known important historical event, architect or designer were linked to the structure it does, in itself, represent a specific period in steel manufacture and design. It is therefore rated as: Medium Significant (Provincial level).

7. Recommendations

7.1 Possible solution to saving the building for posterity

During discussions with Frank Whitley regarding the age of the building he felt that if possible and with this new evidence perhaps PPC management would reconsider demolishing it, but rather save it for posterity as an 1890s structure. In a brief discussion with him, possible solutions to strengthening the steel work without necessarily impacting on the look of the original steel work could be worked out and by painting the original steelwork one colour and additions a different colour the original could be recognized. Naturally, strengthening to conform to modern SABS standards is necessary and the cost involved could be high but the benefits could be seen to be conforming with PPC's heritage and environment protection policy. Clearly the eventual decision would have to be based on an engineer's assessment and cost proposals.

7.2 The alternative of demolishing the building and the potential risks

The alternative and the one for which this study was commissioned is to conform to the National Heritage Resources Act (Act no 25 of 1999) in the recording of the design and features of the structure prior to applying for a demolition permit from the South African Heritage Resources Agency.

Although it is not part of the archaeological brief, it is a concern of the one author (GR) that having investigated the structure very closely he is now aware of how potentially dangerous the demolition of the building could be for any personnel involved in such demolition. In the description of the structure it was mentioned that various cross bracing members are missing or not correctly bolted in situ. Such a state makes the structure inherently unsafe once the corrugate sheeting is removed. It is also a belief that the current structure is strongly supported by the sheeting and during its removal the structure could become unstable. It is strongly recommended that if demolition is carried out, that it be done on a phased basis directed by and under the control of a structural or mechanical engineer. Such a demolition would have to be well planned beforehand so as not to put lives at risk or additionally close-by structures such as the cooling water pump station, the motor store or the transformer and new building under construction to the south of the tool store building. It is clear that there is no cross bracing on the eastern end sidewalls and the timber cross bracing is suspect at best.

8. Bibliography and references

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Murray, R.J. (compiler), 1992, Building on our Strengths 1892-1992. Johannesburg: Pretoria Portland Cement Co Ltd.

Houston, T. 1997, *Motherwell Bridge – The first hundred years 1898-1999*. Motherwell: Motherwell Bridge Co Ltd.

8.1 Web sites

The following web sites were accessed on 28-11-12, where they are cited in the text the unique number below is used.

Dalzell Steel Company

8.1.1 http://www.britishlistedbuildings.co.uk/sc-48315-motherwell-park-street-dalzell-steelworks

8.1.2 http://en.wikipedia.org/wiki/David_Colville_%26_Sons

Motherwell district

8.1.3 http://www.britainfromabove.org.uk/asearch?name=MOTHERWELL&gazetteer=MOTHERWELL&DISTRICT=MOTHERWELL

Alexander Findley & Co Ltd

8.1.4 http://195.153.34.9/catalogue/person.aspx?code=NA19126&st=1&

Motherwell Bridge Co Ltd

8.1.5 http://www.britainfromabove.org.uk/image/spw035966

8.1.6 http://www.britainfromabove.org.uk/image/spw020637

9. General Acknowledgements

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Mr Frank Whitely – Associate Director, Junkoon and Associates (Pty) Ltd, Parktown, Johannesburg.

Mr Colin Findlay who once worked for Delzell Steel Co Ltd is involved in gathering data on the history of the Lanarkshire Steel Industry. He can be contacted at cfindlay@worldonline.co.uk.

10. Photographic Record

Selection of photographs inside and outside of the building with captions.

The following eight photographs Fig 16 to Fig 23 represent a clockwise pan of the inside of the building.

Fig. 16 View looking to south-west corner.

Fig. 17 View looking to north-west corner.

Fig. 18 North-west corner, note the lack of cross bracing on the north wall. The same is visible in Fig 14.

Fig. 19 North wall by doorway. The rectangles on the wall are timber frames of earlier windows.

Fig. 20 North-east corner, note the bund wall.

Fig. 2 East gable end.

Fig. 22 South-east corner with double door. Note the missing lower cross braces.

Fig. 23 South-west corner which ties in with Fig 16. Note the lack of cross bracing

Fig. 24 West gable end with timber structural frame.

Fig. 25 English bond brickwork on the internal bund wall.

Fig. 26

Fig. 27

Fig. 28

Fig. 29

Fig. 30

Figs 26 – 30 show the detail of the roof truss steelwork. What can be seen is the complete lack of any cross bracing for windage and the roof sheeting appears to be a structural unit between the trusses and purlins.

Fig. 31 View looking north.

Fig. 32 View looking north-west.

Fig. 33 View looking south-west

Fig. 34 View looking south

Fig. 35 View looking west.

Fig. 36 View looking south-east.

Fig. 37 View looking south-east

Fig. 38 buttresses on south-east corner

Fig. 39 Buttresses on the north-east corner.

Fig. 40 Buttresses on the north wall.

11. Appendices

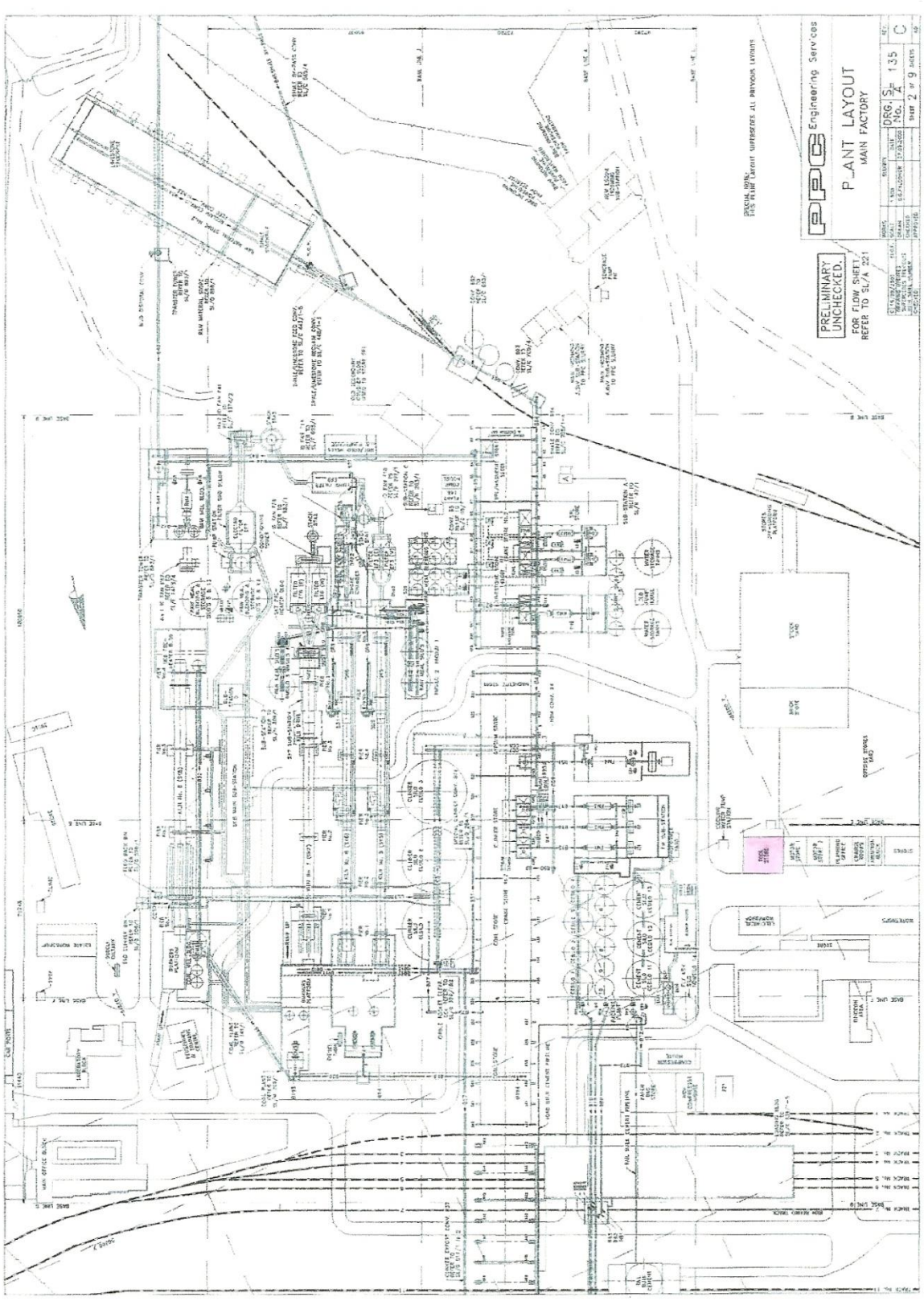
10.1 Pretoria Portland Cement Co Ltd (PPC) Slurry plant layout.

10.2 Slurry Plant ‘tool Store’ building plan showing structural recommendations.

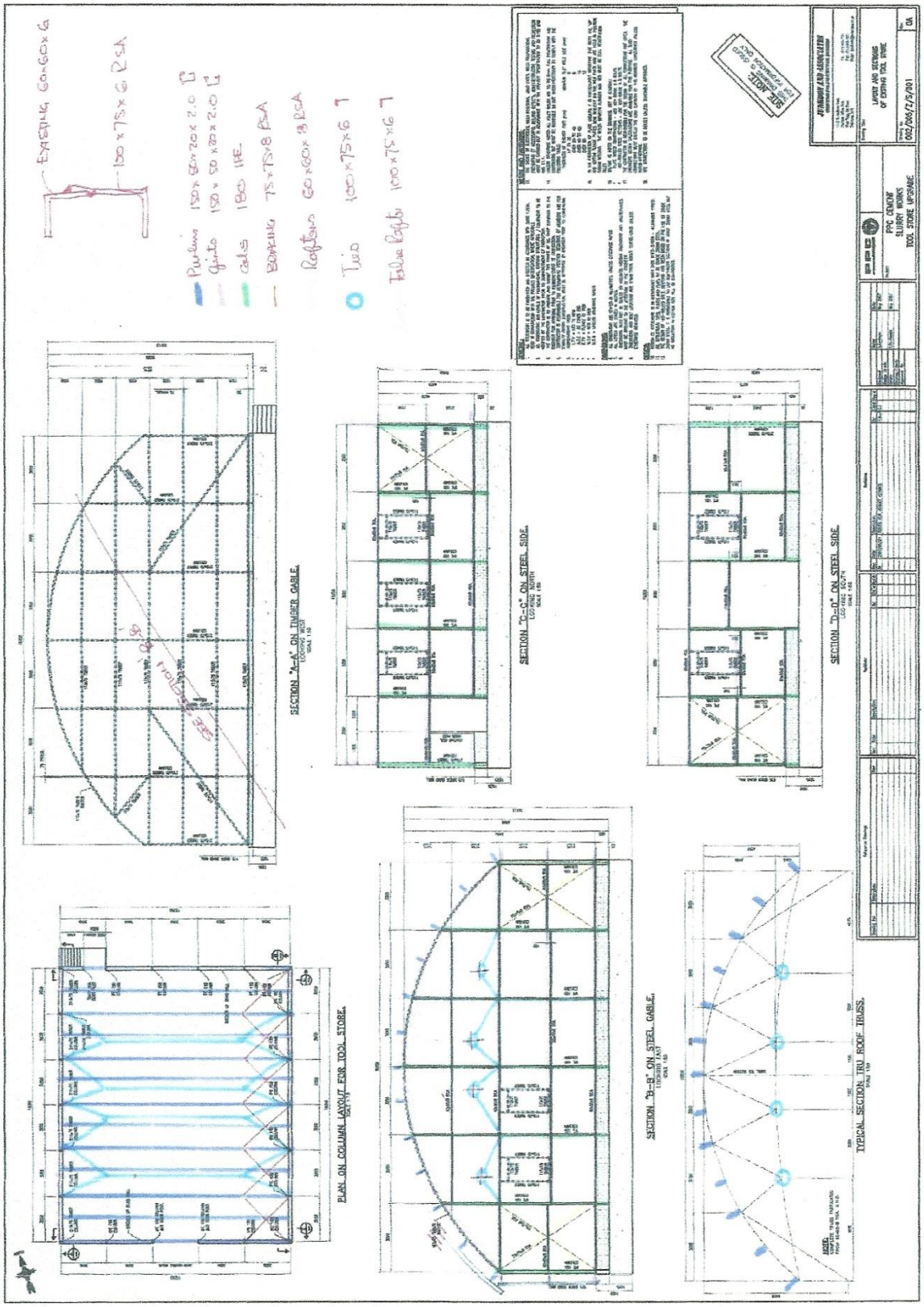
10.3 Part of Slurry Plant structural audit and referencing the Tool Store feature 384-387.

10.4 Except from a book on Motherwell Bridge Co Ltd.

10.5 Drawing showing dimensional details of external foundation buttresses.



APPENDIX No 1



APPENDIX No 2

PRETORIA PORTLAND CEMENT COMPANY LIMITED
SLURRY WORKS - PLANT CIVIL AND STRUCTURAL AUDIT
CONTRACT 002/013/CS01

ITEM No.	BUILDING DESCRIPTION	POTENTIAL HAZARD	RISK	RECOMMENDED ACTION
360		Roof brace cut out on S/E corner for pipes (photo 331)	R1	Replace bracing. Introduce alternative system if required.
361		New sheeted wall on north side very poor. Girts installed upside down, no sag rods between girts etc. Girts also exceed their permissible effective length and will not carry design wind load (photo 332)	R2	A design audit is required to determine minimum support requirements for the sheeting. Modify or stiffen as per findings.
362	**Cement Rail Outloading Silo**	Generally complete and good condition.	-	
363		Numerous holes burnt in bottom flanges of members for lifting (photo's 333 & 334)	R1	Repair by plating overall holes to restore original cross-sectional areas.
364		New road weighbridge being built on south side for fly ash outloading.	-	No action required.
365		Canopies on east and west side for opening and closing tankers, have no longitudinal vertical bracing (photo's 335 & 336)	R1	Investigate bracing system and introduce new bracing according to findings.
366	**Fly Ash Silo**	Not in use but generally complete and good condition.	-	No action required.
367		Bases of all steelwork buried in hardened material and not inspected.	R2	Clean, inspect and report on condition.
368	**SPL Store at SK8 Coal Mill**	Side protection barriers consist of H section – but full of water and corroding (photo 337)	R2	Drill drain holes and apply corrosion protection system. Maintain.
369	**Electrical Workshop**	Generally complete and good condition.	-	No action required.
370	**Fitters Workshop**	Generally complete and good condition.	-	No action required.
371	**Boiler Makers Workshop**	Generally complete and good condition.	-	No action required.
372	**Loco Shed at east-end**	Generally complete and good condition.	-	No action required.
373	**Lean-to on north side**	Roof bracing incomplete (photo 338)	R2	Introduce additional bracing to ends of canopy to complete system.
374		Lifting lug attached to bottom flange of rafter (photo 339)	R1	Remove attachment. Investigate capacity of the rafter and introduce purpose made lifting arrangement based on the capacity of the rafter.
375	**Vehicle Maintenance Workshop**	Complete and good condition.	-	No action required.
376	**Tyre Store**	Complete and good condition.	-	No action required.
377	**Battery Room**	Complete but no acid protection evident.	R2	Investigate paint system and introduce acid proof paint.
378	**Compressor Room**	Complete and good condition.	-	No action required.
379	**Oil Store**	Crawl has SWL 500Kg but 2t trolley (photo 340). Crawl attachments appear inadequate with numerous attachment bolts missing (photo's 341 & 342) Outside knee-brace/tie-back bolted to block work only? (photo 343)	R1	Investigate crawl capacity and anchorage system – upgrade or stiffen as per findings.
380	**PPE Store**	Locked and not inspected.	R3	Inspect and report on findings.
381	**Bolt Store**	Complete and generally good condition – platform for PPE above good.	-	No action required.
382	**Main Store**	Generally complete and fair condition – roof insulation loose and falling off (photo 344)	R1	Remove loose insulation and replace with new sheets.
383	**Motor Store**	Complete and generally fair condition.	-	No action required.
384	**Tool Store**	Structure poor with numerous bracing members loose or missing (photo's 345 – 348)	R1	Repair/replace all missing bracing members.

APPENDIX No 3

PRETORIA PORTLAND CEMENT COMPANY LIMITED
SLURRY WORKS - PLANT CIVIL AND STRUCTURAL AUDIT
CONTRACT 002/013/CS01

ITEM No.	BUILDING DESCRIPTION	POTENTIAL HAZARD	RISK	RECOMMENDED ACTION
385		No roof bracing present.	R1	Investigate bracing system and introduce bracing as per findings.
386		No longitudinal bottom chord ties.	R1	Investigate bracing system and introduce bracing as per findings.
387		Timber posts on west gable have failed and are extremely poor (photo's 349 – 351)	R1	Repair/replace timber members with steel members.
388	**Store Yard**	3t service crawl in yard does not have any bracing in N/S direction (photo 352)	R1	Provide additional bracing/stiffening in N/S direction to impart stability to the structure.
389	**Gas Store**	Very light "car port" type structure – no bracing.	R2	Investigate and add bracing as required.
390	**Lean-to from Old Bins**	Very good condition (photo 353)	-	No action required.
391	**Conveyor Store Lean-to**	Extremely poor structure with lots of damage to bottom chord members. Numerous bottom chord splices have also failed (photo's 354 – 357)	R1	Repair/replace all damaged members. Check all welds and connections and repair as needed.
392		Structure is also totally unbraced.	R1	Investigate bracing and introduce new bracing as required.
393	**Brick Store**	Generally complete but outside bracing missing from tower on south side of store (photo 361)	R1	Introduce new bracing as required.
394	**Logistics Workshop**	Inspection pit wall has failed due to lateral pressure on outside face of wall (photo's 358 & 359). Floor slabs also appear to be unreinforced.	R1	Original wall was built using bricks/block work. Re-build pit wall using reinforced concrete to cater for lateral pressure caused by vehicular traffic. Cut back floor slab to sound concrete and re-cast using HT mesh 395 in the top of the slab.
395		Roof bracing systems are incomplete and do not extend to the eaves (photo 360)	R1	Introduce bracing to complete the system.
396		No longitudinal ties to bottom chord of roof trusses (photo 360)	R1	Introduce longitudinal ties at brace node points to cater for reversal of forces in roof trusses due to uplift.

CHAPTER 1

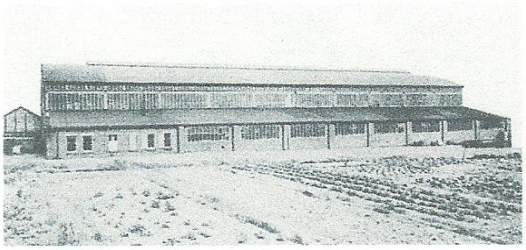
What's in a Name?

MOTHERWELL BRIDGE. It is a robust, confident, no-nonsense name. A hundred years ago, when the founders coined it, they were making no concessions to a world which would have been hard put to point out Scotland on the map, far less to a small, but growing, Scottish town in the centre of Lanarkshire. By and large the world was largely ignorant of a county which had blossomed forth as the hub of a Scottish iron and steel industry whose impact was felt across the British Empire and beyond.

But times change.

Some twenty years ago, and not for the first time, members of the Board of Motherwell Bridge debated whether or not to change the company name to something which more fittingly reflected the group's modern day activities. In a way, the name, Motherwell Bridge, appeared to be something of an anachronism.

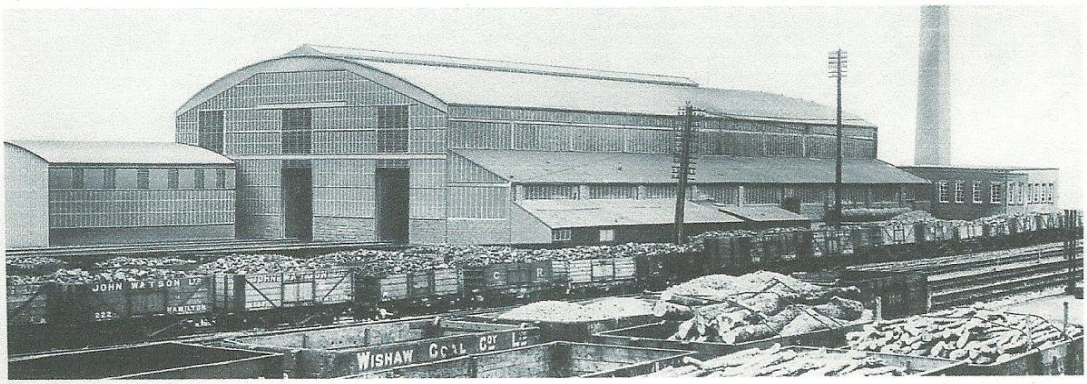
To be sure, the company headquarters were still on its original site off the Motherwell-Bellshill Road, beside a metal footbridge over the main Glasgow-London railway line; its vast sheds still rang to the sound of heavy to light engineering. But the Group had long since moved out of its original business of making steel bridges.
As a Group, through a mixture of acquisitions and the development of new skills, it had expanded to embrace a wide range of core businesses far beyond its origins.



WEST VIEW OF MOTHERWELL WORKS. Another shot taken in early 1900 of the West view of the Bridge Works as it was between 1898 and 1910. The original office block is to the left hand side of the main fabrication shop with the prominent windows.

In the 1980s it was then, as now, one of the most important engineering groups in Britain; its activities spanned the globe. It had something like 3,000 personnel working for it, servicing industries in a score or so of countries. Its core businesses included a wide range of highly diverse activities encompassing manufacturing, engineering services, distribution, and information systems - the last mentioned making use of ground-breaking hi-tech computer software programmes.

Oil, gas, petrochemicals, food processing, paper mills, pharmaceuticals, the aerospace industry, steel and water - all had sought out Motherwell Bridge for its experience and expertise in engineering, design and construction.
In project engineering, it was, and remains, the United Kingdom's leading constructor of storage tanks and gas holders. In the nuclear industry, where once its skills provided key parts of Dounreay and Hunterston power stations, its know-how was again about to be in demand, this time in the field of nuclear decommissioning.



EAST VIEW OF MOTHERWELL WORKS. Photograph taken in early 1900 of the East end of the Bridge Works as it was prior to 1910. In the foreground can be seen the main railway lines from Glasgow to London and the various sidings for the coal, iron and steel industries.

APPENDIX No 4

APPENDIX No 5 Dimensional details of external foundation buttresses

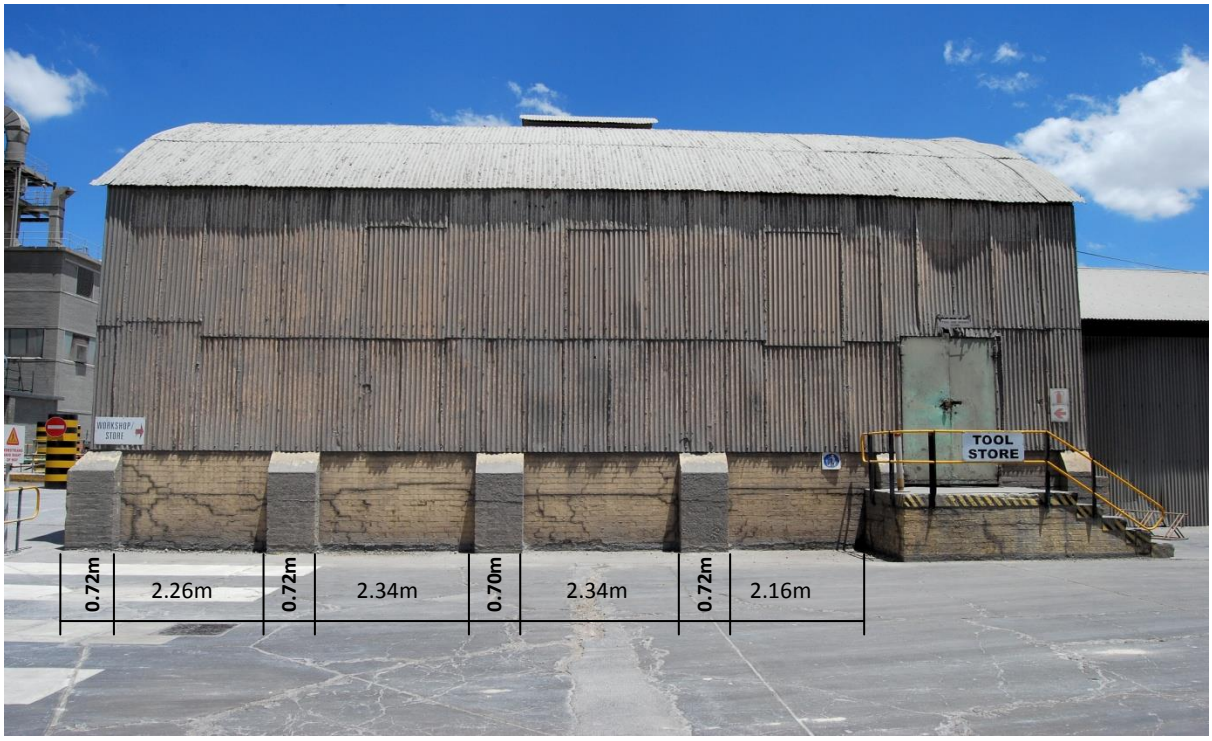


Fig. 39 North wall buttress spacing

Fig. 39 East wall buttress spacing