

TBM Shove Bracket lifting system

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1.0 Introduction

For the TBM to be launched within the SCL Chamber a shove frame was required to act as a reaction frame to start the drive. The shove frame is a piece of temporary works comprising a rigid steel ring and large brackets which are attached to the SCL lining within the launch chamber. The shove frame is used to provide a reaction point against the TBM thrust pressure of the hydraulic rams so to move the TBM forward at the commencement of a TBM tunnel drive.

2.0 Methodology

The launch sequence at Carnwath Road required the TBM to push off a fabricated steel ring which was designed for a maximum allowable launch force per pair of rams which equates to 1728tonnes as there are 16 pairs of rams on the TBM. The steel ring required 32no. 400kg shove brackets to be mounted and fixed to the shotcrete lining between the TBM tail-skin and concrete segment due to stresses generated, GRP reinforced segments were used to build during the launch sequence.

For mounting the brackets and fixing them, the project required a safe system of works to achieve the building of the steel ring.

2.1. Design Approach

The design of the TBM shoving system require BMB to think of a handling system for the operative to lift up heavy duty brackets weighing approx. 400kg each. The shoving system was a similar design proven on other projects but the lifting operations were always difficult that had high risk activities during the installation works. The installation works required the management of the people/plant segregation in confined areas of the tunnel.



Photo 1.1 Installed brackets

Majority of the installation works for the shove frame system was a high risk for the programme of the project as particular key dates had to be achieved. The shove brackets were installed before the TBM Gentries 1, 2 and 3, due to the limited space within the tunnel.

The installation of each bracket (400kg) required some innovated thinking on how the brackets were to be bolted to the SCL lining. The brackets flat face side tolerances were so important in ensuring that the steel ring was practical flush to the flat face of the brackets. This require precision for the installation of these brackets.

While during the design phase for the shove frames, the engineering team had to ensure that a safety system of works for the operatives were in place when fixing the bracket in the tunnel. An idea was constructed by our mechanical superintendent (Mark Milnes) on a system that would be able to actually install the brackets while maintaining a plane alignment for the bracket face. The concept for the handling frame system was brought through the temporary works design process.

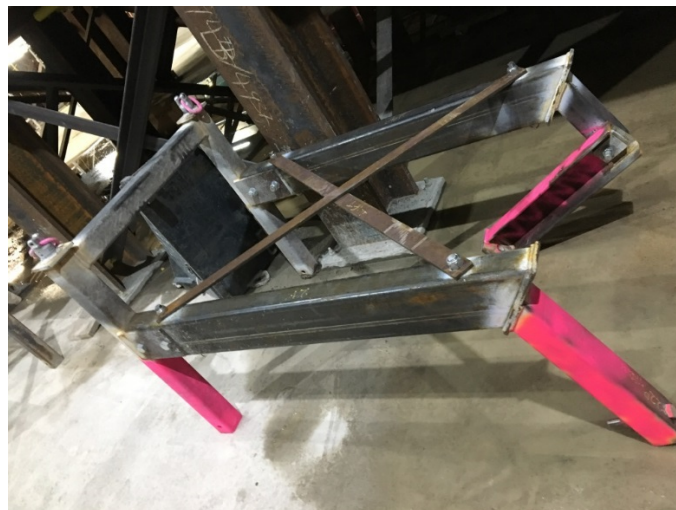


Photo 1.2 Handling Frame.

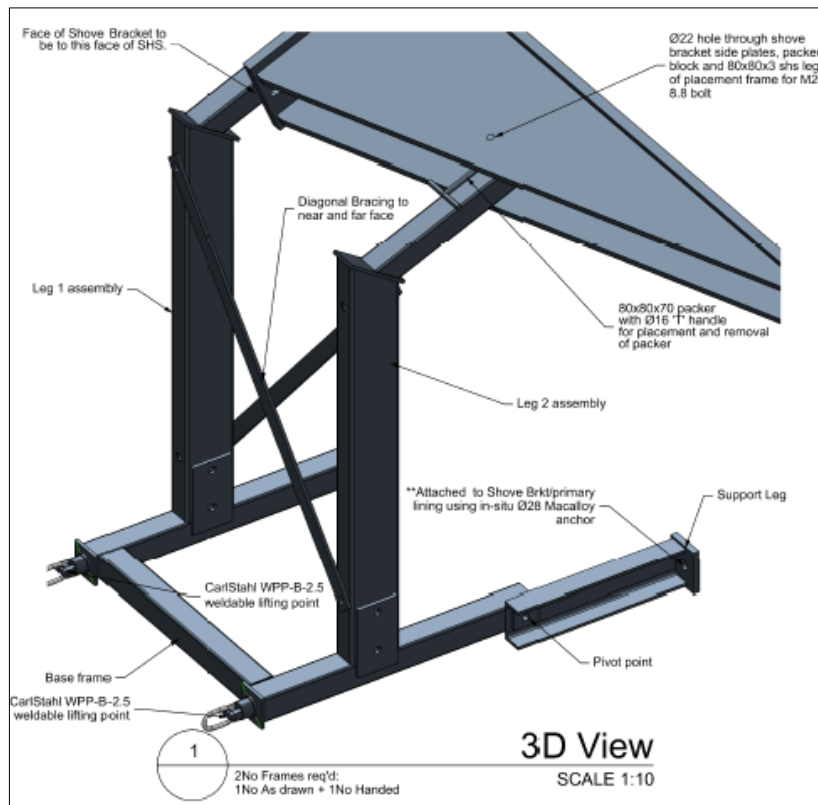


Fig 1.1 Computer model of the handling frame

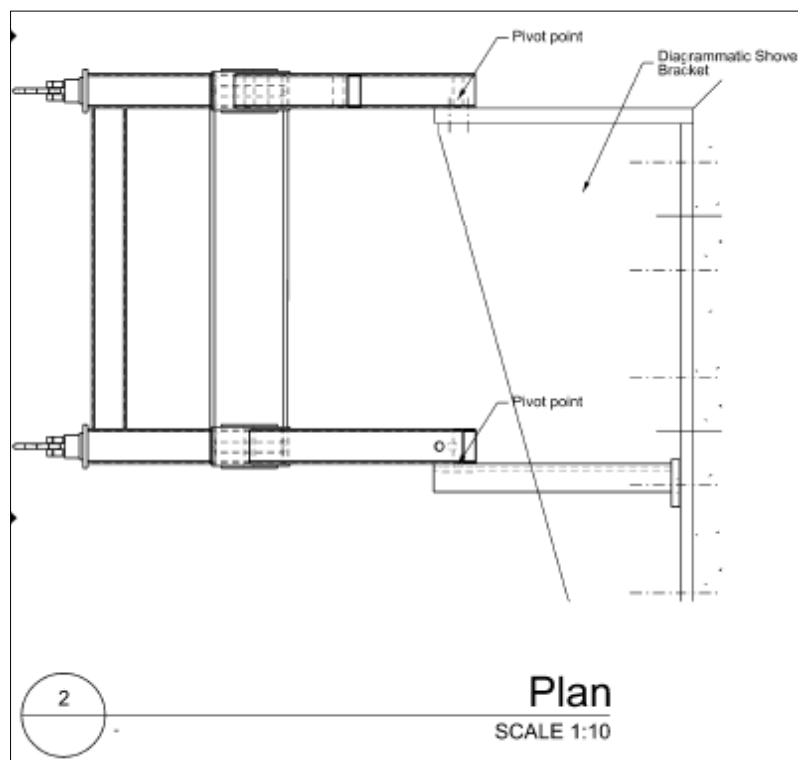


Fig 1.2 Plan view of the handling frame

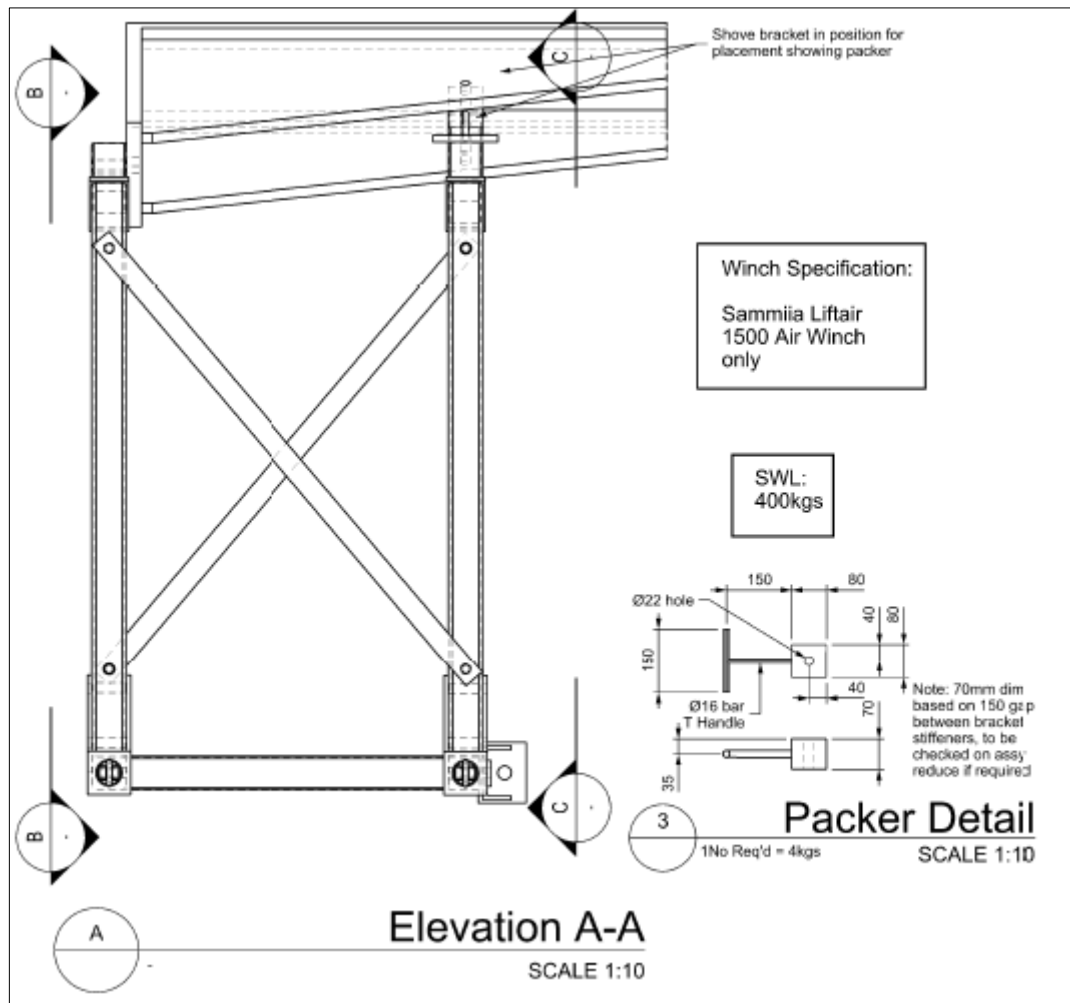


Fig.1.3 Elevation View of the Handling Frame.

2.2 Installation Sequence

The shove brackets were lifted into position by combining winches and pulleys in the crown of the tunnel. The brackets were attached to the handling frame during the installation phase so that the handling frame placed the shove bracket into its final position. The brackets were then elevated and placed into the required location where the operatives could mark the drill locations.

This process saved much time and provided a safe system of works for the gangs. As part of the handling frame design and an additional smart drilling template was developed to help with the drilling operations once the shove bracket bolt holes were marked out.

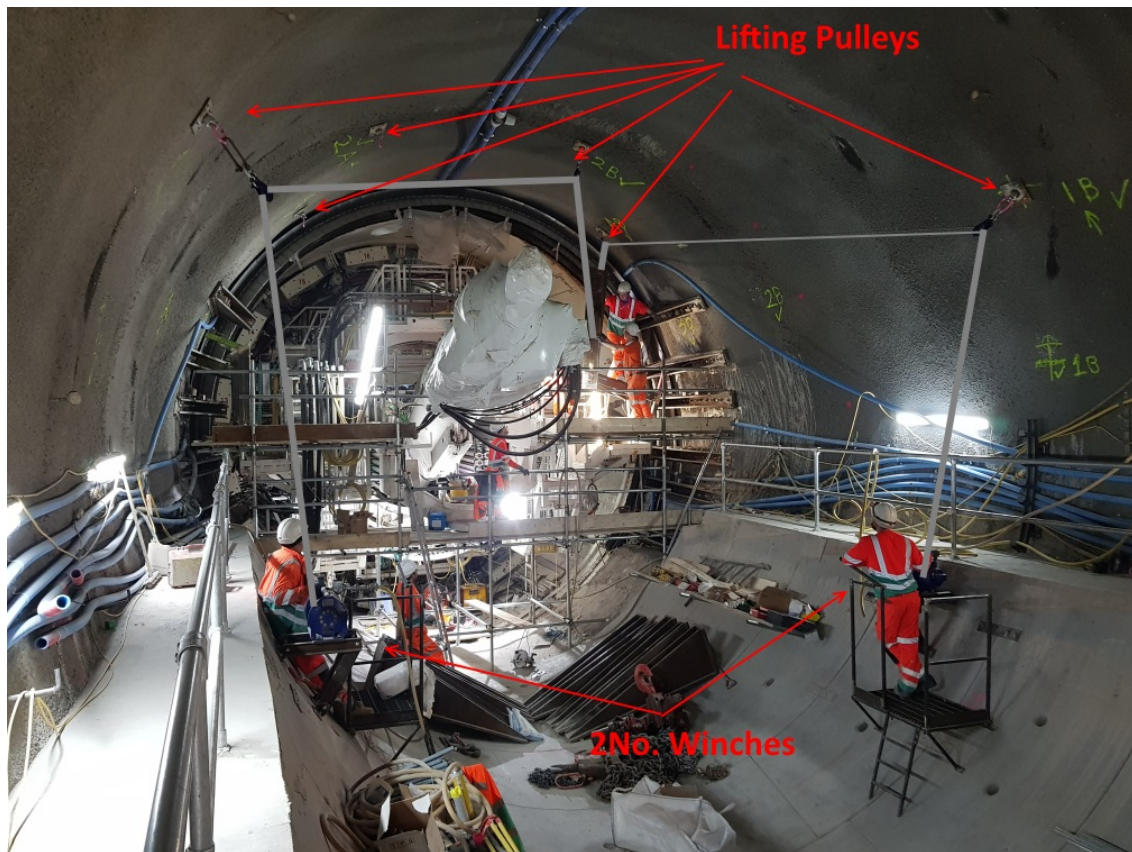


Photo 1.3 Winches & Pulleys used for lifting

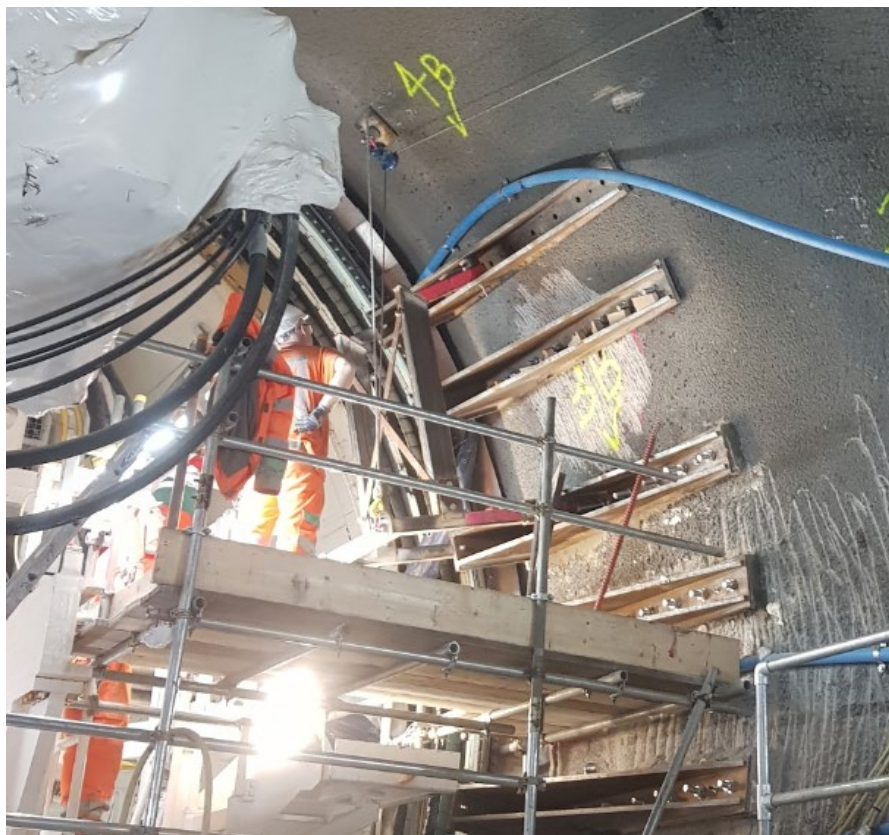


Photo 1.4 Bracket ready for marking out

The handling frame works by attaching one leg of the frame to a bolted down bracket and leaping over every 2nd bracket position. This will allow for accurate placement of the brackets for the operatives to mark out, drill and bolt up.

The holes drilling template was developed to ensure that accuracy was maintained and that the required holes diameters achieved. The template was used because bracket boltholes were at a small diameter which would make it extremely difficult for the drill bits to create the required diameter and depth for the shove bracket install.



Photo 1.5 Holes Drilling Template

The handling frame helped with marking out the bolthole positions along each bracket. Then again the handling frame was then used in finalising the last activity for the insertion of the bolts to the shove brackets.



Photo 1.6 Handling frame in operation while placing the bracket into position

The brackets were then temporarily fixed in place with small anchors before the bars could be placed. Hilti resin was then injected through a packer of conveyor belt to ensure filling holes in the crown and wedges had to be used to make sure that the bolts did not fall out when in the crown.

Conclusion

It shows that experience and the use of mechanical mechanism can provide clear benefits in reducing heavy lifting and putting operatives in difficult scenarios during certain activities. The operatives have done exceptional work while installing the 400kg brackets safely and precisely into position within tolerance. This shows that planning and collaboration between the mechanical and site operatives.

Acknowledgement

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