ZENITH

Repairs to Internal Steel Liner Support Steelwork within a Reinforced Concrete Chimney Windshield

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Introduction

This paper reviews the background, philosophy, repair scheme, scope and methodology used in the inspection and internal refurbishment of the balance ropes and counter weights supporting two steel liners in a reinforced concrete chimney windshield. Zenith's previous technical paper presented at CICIND in Niagara on the Lake, Canada, concentrated on the external FRP repairs carried out on this particular chimney.

Background

This particular structure (figure 1) was constructed and commissioned in 1984 and has suffered from the absence of a proactive inspection and maintenance plan. In recent years the asset management and the local authorities have actively pursued a shift in attitude from reactive to proactive maintenance. Zenith was engaged to provide inspection criteria to determine a 'benchmark' condition in order to engage future inspection and maintenance.

Figure 1

Inspection Philosophy

The inspection criteria produced by Zenith was taken from the CICIND publication 'Manual for Inspection and Maintenance of Concrete and Brickwork Chimneys' and some additional information taken from various past experiences. The inspection philosophy was to engage a partially destructive inspection of critical and less critical items including flue duct inlets and supports, steel lining performance, gas seals, expansion joints and surface coatings. The detailed inspection impacted on the off-stream timeline. The asset management considered the off-stream duration and pursued a second option. The second option was based on a nondestructive visual examination of all accessible components. The reduced scope limited the conclusions that could be drawn from the inspection but suitable to allow a basic 'benchmark' result to be formulated. The final scope required a visual examination only of the critical and less critical components.

Internally there are 2 No steel chimney liners, one to the North and one to the South. These are accessed by a series of ladders and rest landings. The internal liners have expansion bellows and a support system which are supported on a wire rope and reeve system with counter balance weights (figures 2 & 3).

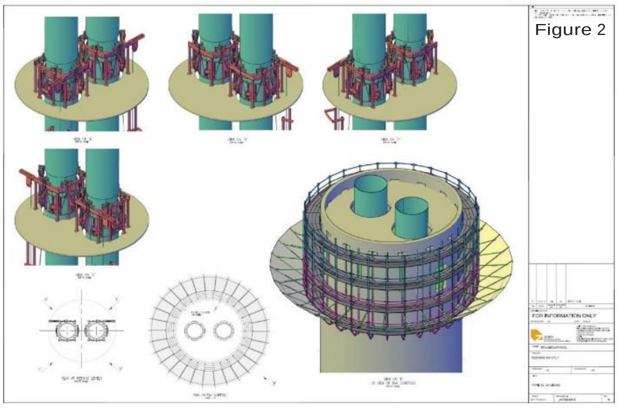


Figure 2

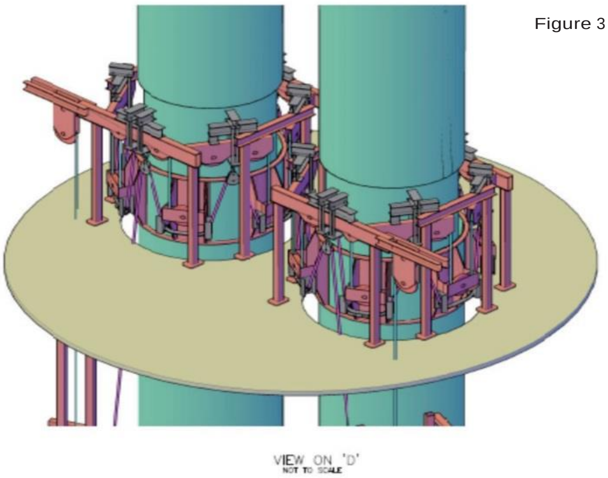


Figure 3

Findings

The wire rope counter balance mechanism (figures 4,5 and 6) was found to be in a state of disrepair and unserviceable. Extensive corrosion was noted throughout the mechanism particularly at the lower levels. The corrosion was at a state where the replacement of the ropes and the rope eyelet supports were deemed essential.

An aggressive atmosphere was noted within the annulus. The presence of a prevailing up draught was due to the large void width between the concrete windshield and the steel chimney liners. A large cross variation in temperature was recorded which had allowed the dew point to vary across the void resulting in condensation settling on the wire ropes.

Due to the lack of maintenance, it was proposed that protection of the wire could reduce the effect of environmental attack and extend the life of the ropes. This lack of maintenance, with no protection, has contributed to corrosion acceleration.

The corrosion reduced with height as the void decreases in width, but light corrosion was found to be endemic. To avoid the need for maintenance in the near future it was proposed that the entire rope system within the chimney should be replaced. The up draught was being accelerated by the fact that the external gantry access doors were defective or were completely missing, creating external voids in the windshield. Alternatively if the upper levels of ropes were to have been retained, the swaged socket connections should be examined and replaced, if required, and all ropes and pulley systems should be thoroughly lubricated.
It was recommended that all doors through the concrete windshield should be reinstalled or replaced with an adequate locking system. This was deemed essential to reduce the up draught thereby causing the corrosion in the wire ropes.

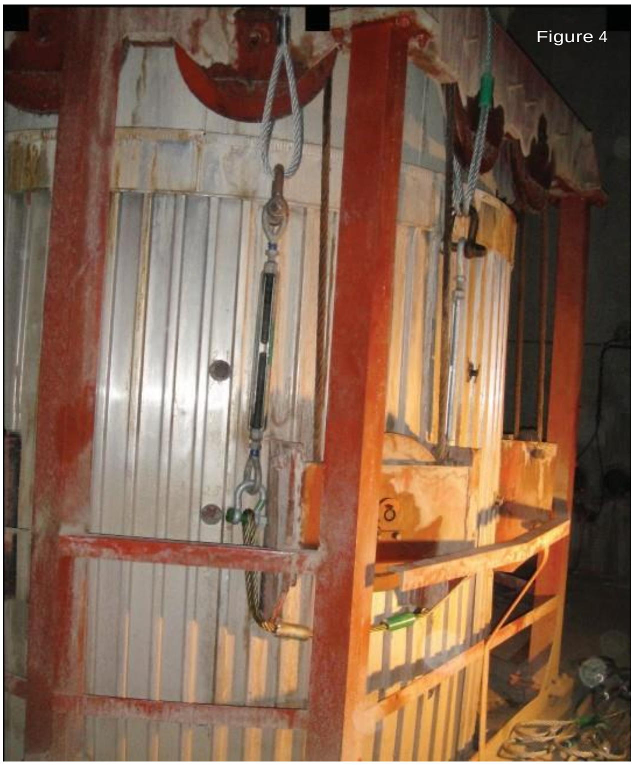


Figure 4


Figure 5


Figure 6

Applicable Codes of Practice & Regulations

Management of Health & Safety at Work Regulations
Provision and Use of Work Equipment Regulations
Construction (Design and Management) Regulations
Construction (Health, Safety & Welfare) Regulations
Lifting Operations and Lifting Equipment Regulations
Work at Height Regulations

British Standards, European Norms and More:

BS 5974	Temporarily installed suspended scaffolds & access equipment.
BS EN 12811-1:2003	Temporary works equipment. Scaffolds. Performance requirements and general design
BS EN 12811-2:2004	Temporary works equipment. Information on materials
BS ISO 4308-1:2003	Cranes and lifting appliances. Selection of wire ropes.

Governing Factors

- **Environment**

The repair scheme proposed was to limit any off-stream time to a minimum. This repair scheme could be completed on-stream however during the execution of the project one of the flue liners was off-line.

Repair Scheme

The wires to the balance system were failing and required changing out with an additional system installed to reduce single point of failure.

Methodology

In order to safely carry the objectives, the following methodology was implemented.

1. Climb to desired working level and carry out the following. Radio communication to be used between stack head internal and ground level. All operatives to wear full body harness.

2. Using winch system to the stack internal hoist to the floor level desired all equipment to carry out the following tasks.

3. Rescue equipment for all works including breathing apparatus to be located on each floor at all time with rescue abseil equipment.

4. At each working level ensure that all operatives have adequate lighting to carry out the works required.

5. At each point of loading install around the balance system access scaffold to insure the safe installation of all brackets

6. See red arrows below (figure 7) for the brackets to be installed around the upper and lower reeve.

7. Install snatch blocks to the brackets previously installed to the upper and lower frame work. See blue arrows below (figure 7).

8. Once all tackle installed reeve wire from its termination point to the newly installed point around the reeve and out to the floor level.

9. At the floor level were the wire comes out the reeve core hole through the floor to allow wire to pass through at this point and drop down to the below floor level to were the counter balance is situated.

10. Lock existing counterweight into position with hardwood blocks and steel shims at the brake location.

11. From the existing counter weight use Fuller Rope Tensometer to determine the exact weight of the counter balance prior to disconnecting.

12. Install temporary counterweight as per the original loads to rope to secondary system and apply additional load to transfer load from existing system. This can be achieved by installing adjustable rigging screw SWL 5 tons to allow the tension to be transferred to the new balance system.

13. Release existing rope from the existing counterweight and remove.

14. Record counterweight level and operational temperature then lower the counterweight to landing level.

15. This can be achieved by installing 5 ton chain pull directly over the counter weights and securing nylon strops to the under side weights basket and lower to floor level.
    a. refurbish the brake arrangement and test,
    b. Test to involve hoisting the counterweight to a determined height and releasing to determine travel distance. Provide crash mat below.

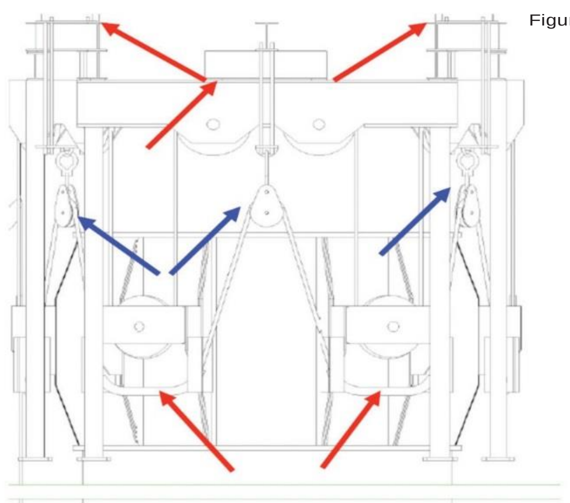
16. Return counterweight to recorded level.

17. Install new rope to existing reeved arrangement. Free end for connection to counterweight to be terminated with a rigging screw rated to 5T SWL. Connect to the counterweight following a level of pre-stress to reduce impact of rope elongation.

18. Transfer chimney load back into the original system, use rigging screw to position counterweight into recorded level for operating temperature.

19. Connect new secondary rope to new support frame connected to the counterweight. Use in line rigging screws, rated to 2.5T SWL, to remove elongation effects of wire rope but not to support load.

Figure 7



Future Maintenance

The future inspection criteria have been developed to include inspection of the modified region of the chimney and development of a proactive maintenance scheme to ensure the longevity and performance of the structure.

Acknowledgements

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