Perilya Handrail Testing Device

Perilya Broken Hill Limited - NSW Winner of the Metalliferous Innovation Award

Perilya Broken Hill Ltd operates the Southern Operations lead, zinc and silver mine with both underground and surface operations. Underground infrastructure can place equipment and structural steel in a moist and corrosive environment. Surface facilities are subject to the variations of a desert climate. Some specific areas are exposed to the humidity of water based treatment processes.

Construction of steelwork to the appropriate standard gives assurance that it is fit for purpose when it is newly constructed and installed. However the corrosive nature of the operating environment and the variability of these conditions make it extremely difficult to identify steelwork that has degraded over time.
For any testing to be useful it should;

- not destroy the handrail
- track the gradual reduction in strength in a quantitative manner
- be reproducible
- be easy to apply

A search within Mining and Heavy industry in an attempt to identify a practical engineering and effective non destructive test has not been successful. The requirements of a competent handrail are documented in Australian Standard AS 1657-1992 but testing equipment or testing methods are not readily available or recommended and only an outline of a test procedure is shown. An inspection protocol where handrails and uprights were tapped with a hammer to confirm solid or competent steel had become a poor substitute for a quantitative measure and was made even more suspect when applied in noisy environments by a wide range of people.

The Problem
The problem is to develop and implement a practical and robust testing regime to track handrail condition highlighting those handrails that require repair and confirming those that are still 'fit for purpose'.

The handrail testing system as per AS1657-1992 Appendix B – B3 (b) states " a ***means*** of applying to the guard rail post a force of 550N" is required. As stated the **means** is the problem we have encountered because the testing apparatus and a suitable process are not defined. This is where a design was required to make an apparatus to ensure compliance with standards.

The Solution
The obvious way forward was to understand the requirements of Australian Standard AS 1657-1992 and to search the literature and knowledge base of the engineering community for a readily available solution. None was available.

A series of problem solving sessions with a range of stakeholders progressed a number of ideas to the stage where a prototype could be constructed.

The "Final Stage" was the design, manufacture and use of a handrail and stanchion testing apparatus in the surface area. This handrail testing apparatus was also designed for the use in underground environment. The only further change may be poly two pack painting or power coating to prevent corrosion.

Risk Management
Several risks had to be considered;

1. Risks to ongoing business without a testing program
   a. Lack of inspection – if assumed that handrails look fine, this can be deceiving. Internal corrosion of hollow stanchions can occur. Also rust "creep" occurs, where personnel become so familiar with areas they don't see the obvious signs of corrosion (rust) occurring to the point that the structure becomes weakened.
   b. Measurement of physical dimensions may not detect the impact of rusting as the rust expands and hides the degradation of the metal.

2. Risks related to handrails that aren't made to AS 1657-1992
   a. Measurements can show discrepancies in rail heights and stanchion widths to the standards, but fail to show whether the force required for meeting standards is achieved.
   b. Differing sizes of materials can be used to construct a handrail, but if it is not to Australian Standards it needs to be put through a procedure of applying forces to stanchions and rails to confirm suitability.

3. Risk related to hitting hand rails as a test method
   a. Hitting handrails is a deceptive method of checking a handrail. It allows for human intervention and interpretation. Eg forces applied by hitting with a hammer can vary between person dependant on strength and build
   b. Hitting with a hammer doesn't allow for recording of a reference measurement; it is only a subjective estimation.

Implementation

The handrail tester was developed as a result of a finding from an incident on site that identified a need to test handrails to a standard. Australians Standards have a formula for testing handrails but do not define a method. Trying to find testing equipment in the industry turned out to be fruitless.

Therefore after a number of requests from different engineering companies to find or design a tester, Rosetta Stone Operations Pty Ltd (Nick and John Colancia) and John Braes (Perilya BH Ltd) discussed requirements and a tester was developed.

Requirements discussed were as follows

1. Testing equipment had to be light weight for person testing to carry, as most handrails require stairs to access platforms or floors
2. Testing equipment must be easy to use
3. Testing equipment must be accurate
4. Testing data must be recordable
5. Attachment of tester must be designed for Johnsway mesh, chequer plate and cement floors and walkways

Design Achievements for the above are as follows (See photos 1-6)

1. Testing frame was made from aluminium, standard portapac units and gauge used
2. Testing equipment has a chart and deflection chart supplied (see Appendix 1)
3. Testing equipment uses a pressure gauge and stopwatch
4. Testing data is entered on data sheets for future reference (see Appendix 2 and 3)
5. Tester has been designed to use hook bolts for Johnsway and chequer plate, loxins, and a vacuum base for concrete

Consultation

Consultation on the design was sourced from various engineering consultants and professional parties. URS was originally asked to design or find a handrail tester. They had no luck finding a tester and the design concept proposed was too bulky for practical use.

Rosetta Stone Operations Pty Ltd also had problems finding a handrail tester, but with consultation came up with a lightweight and practical solution. Internal Perilya operational department users were consulted within the design phase and a few variations were made to the design.

Presentation of the Handrail tester has been made to the Perilya site OH & S committee.

Benefits/Effects

The major benefit gained from the handrail testing system is seen in the following areas;

1. establishing a quantitative test procedure that is
    a. reproducible
    b. able to provide a baseline reading for 'as installed' railings
    c. can be tracked over time
2. establishing 'condition criteria' that determines and prioritises maintenance response.
3. elimination of unpredictable handrail failure
4. reduction in cost to replace handrails that comply to testing, but not meeting material size specification. Currently hand rails are replaced on site due to failure to meet size specification rather than failure to meet loading requirements.

Transferability

Within our operation we are looking to develop the testing equipment, the process and the understanding of the information collected. At some point in the future we will be ready to share our work with the mining industry and meet a need that has been recognised for sometime but has not yet had a practical solution.

The testing of handrails in any situation will be able to apply this technology.

Operational Testing

An example of the data collected from the No 3 Grinding Section in the Concentrator is shown in Appendix 3. To date approximately 40 individual tests have been scheduled with six unable to be tested due to the position of the handrail, five tests giving permanent deflect that was well within the acceptable limits and one indicating a non-compliant condition due to its height rather than permanent deflection under load.

Testing of the testing equipment and process is continuing on the surface with plans to implement it in the underground environment.

Innovation and Originality

The mining industry has traditionally relied on the skills and experience of its people to assess the suitability of handrails using qualitative and often visual techniques. This innovation provides a robust testing procedure for safety critical infrastructure. It can be relied upon to produce a quantitative quality measurement and can be used proactively by a range of users to produce a repetitive and meaningful result.

Failure of a handrail and the fall of an employee from height will result in significant injury. The avoidance of only one such incident will justify the effort and expense of developing and implementation of the Handrail Testing System.

Photo 1- Handrail Tester

Photo 2- Handrail Tester being used to test a handrail

Photo 3 - Handrail Tester fixing to Johnsway mesh

Photo 4 – Handrail tester pushing on handrail to apply correct force in the horizontal plane

Photo 5 – Handrail tester pushing on handrail to apply correct force in the vertical plane

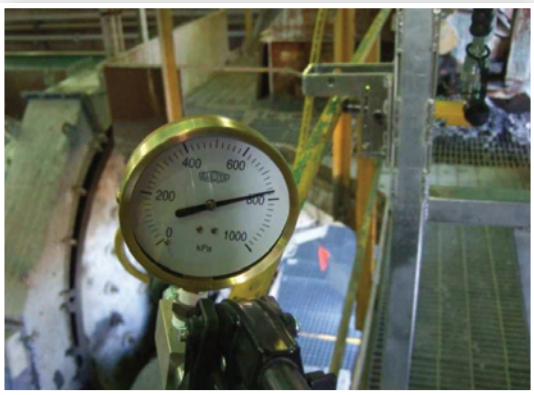
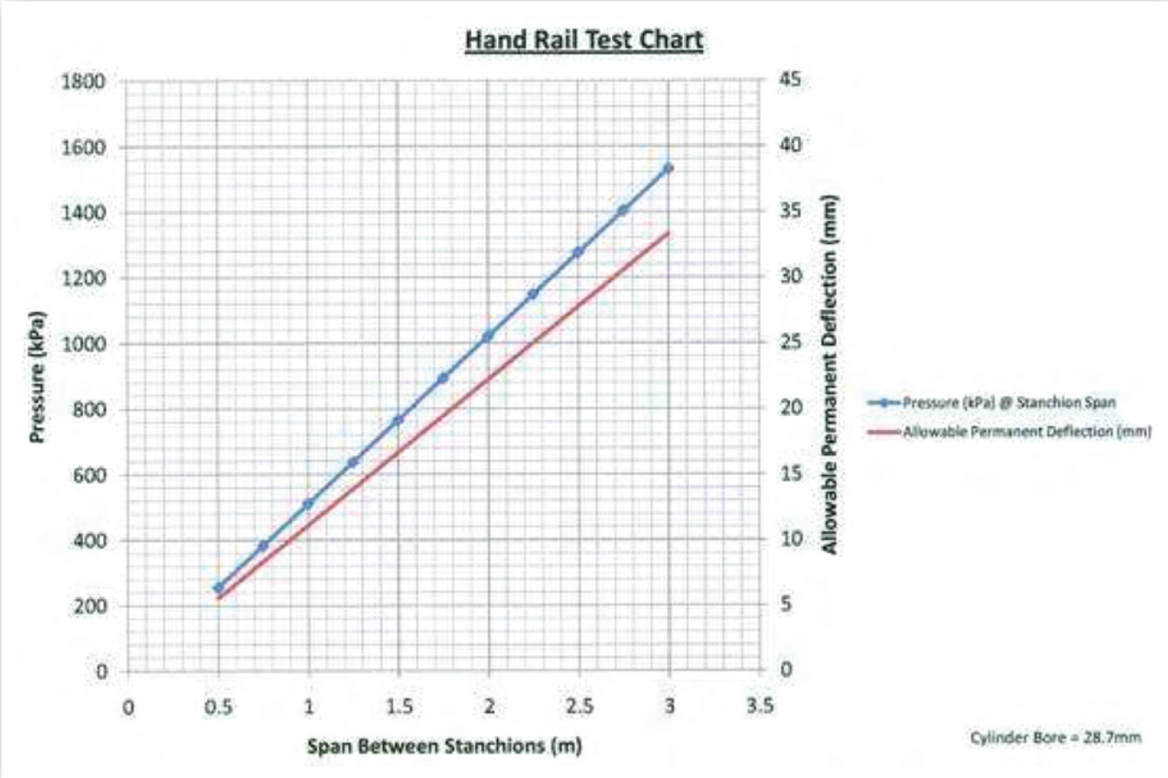


Photo 6 – Gauge to indicate that handrail tester is applying correct force

Appendix 1 – Handrail Test Procedure and Data

Handrail tester Chart Showing pressure and allowable deflection



Handrails defection as per AS1657-1992 Appendix C

Stanchion Pressure is 740 kPa   Deflection measure – AS1657-1992 Appendix B

Procedure for use of Handrail and stanchion testing apparatus is as follows;

1. Bolt to steel or vacuum to cement base the handrail tester
2. Adjust the cylinder in position of the rail to be tested
3. Measure deflection using a straight edge prior to testing (if bent and out of spec stop test and bunt area off for repair)
4. Measure length between stanchions and rails.
5. Pump out cylinder till correct pressure is reached from table
6. Hold for 60 seconds and release pressure
7. Measure deflection using a straight edge.
8. Deflection must fall within limit on the chart (1/90 of the span between two supports)
9. Record on data sheet. If deflection is out of specification to chart, bunt area and report in Maximo to initiate a work order for repair. If handrail is compliant no work order is required.

Costs to Date

Design of Handrail Tester	$11,645
Manufacture of Handrail Tester	$ 1,750
Hydraulic Testing Equipment	$ 1,803
Total	$15,198

Appendix 2– Handrail Tester Audit Sheet

Handrail Audit - Using AS1657-1992

Names	
Date	
Location	

If a handrail or stanchion doesn't meet AS1657-1992 the handrail tester must be used referencing Appendix B and C

*Note Should the top rail not meet minimum height requirements then Handrail will be deemed not conforming

*Note any handrail not conforming to be bunted and APO signs erected

Tradesperson												Planners
Equipment	Position	Time	Anchorage/Bolting/ Welding & condition of posts, stanchions	Fixed ladders/ stairways condition & attachment condition (ie rungs, treads)	Walkway/ Platform condition	Handrail height meets min Standard	Handrail mid-rail present	Kickplate present	Appendix B Guide Post (Stanchion) Test	Appendix C Guard Rail (Handrail) Test	Compliance	Workorder initiated
						Yes/No	Yes/No	Yes/No	Deflection (mm)	Record Deflection (mm)	Pass / Fail	Yes/No
						Yes/No	Yes/No	Yes/No	Record Deflection (mm)	Record Deflection (mm)	Pass / Fail	Yes/No
						Yes/No	Yes/No	Yes/No	Record Deflection (mm)	Record Deflection (mm)	Pass / Fail	Yes/No
						Yes/No	Yes/No	Yes/No	Record Deflection (mm)	Record Deflection (mm)	Pass / Fail	Yes/No
						Yes/No	Yes/No	Yes/No	Record Deflection (mm)	Record Deflection (mm)	Pass / Fail	Yes/No
						Yes/No	Yes/No	Yes/No	Record Deflection (mm)	Record Deflection (mm)	Pass / Fail	Yes/No
						Yes/No	Yes/No	Yes/No	Record Deflection (mm)	Record Deflection (mm)	Pass / Fail	Yes/No

Appendix 3 – Handrail Testing Data

Handrail Audit - Using AS1657-1992

Names	D Parker
Date	10/9/10
Location	NO 3 Grinding section

If a handrail or stanchion doesn't meet AS1657-1992 the handrail tester must be used referencing Appendix B and C

*Note Should the top rail not meet minimum height requirements then Handrail will be deemed not conforming

*Note any handrail not conforming to be bunted and APO signs erected

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Equipment	Position	Time	Anchorage/Bolting/ Welding & condition of posts, stanchions	Fixed ladders/ stairways condition & attachment condition (ie rungs, treads)	Walkway/ Platform condition	Handrail height meets min Standard	Handrail mid-rail present	Kickplate present	Appendix B Guide Post (Stanchion) Test	Appendix C Guard Rail (Handrail) Test	Compliance	Workorder initiated
No 6 B/Mill Discharge	Nth 1		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	W 1		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
No 8 cyclone feed pump	N/W 1		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	N/W 2		ok	ok	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	S/W 1		ok	ok	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	S/W 2		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	S/W 3		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	S/W 4		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	S/W 5		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No
"	S/W 6		ok	N/A	ok	Yes/No	Yes/No	Yes/No	Record Deflection (mm) 0	Record Deflection (mm) 0	Pass / Fail	Yes/No

K HICKEY 27/9/10