HILTI MI-SYSTEM PERFORMANCE UNDER DYNAMIC LOADS

Abstract: Dynamic loading conditions often exist in a structure whenever movement of objects or loads is present. Moving of people or forklifts, expansion and contraction due to temperature changes or even blowing of wind can cause dynamic loading condition on any supporting element. The repetition of loading over a significantly higher number of repetitions (order of 10^5 to 10^7) can cause premature* failure of supporting members. This paper reports the observations and results of a dynamic loading test conducted on Hilti MI-system components.

Introduction

Hilti MI-system is a modular system for medium to heavy loading conditions specially suited for use in applications in industrial projects. One of the most common applications of MI-system is to provide supports for pipes and cable trays. Pipes being metallic and present outdoors undergo thermal expansion and contraction due to climate changes. Although pipes are supported using sliding supports, the friction between pipe shoes and steel members causes lateral loads on supports. Over a long period of time, frequent variations in temperature cause dynamic loading conditions on supports. Hence, the support system must be checked for such loading scenarios. This paper addresses the performance of Hilti MI-system under such loading conditions.

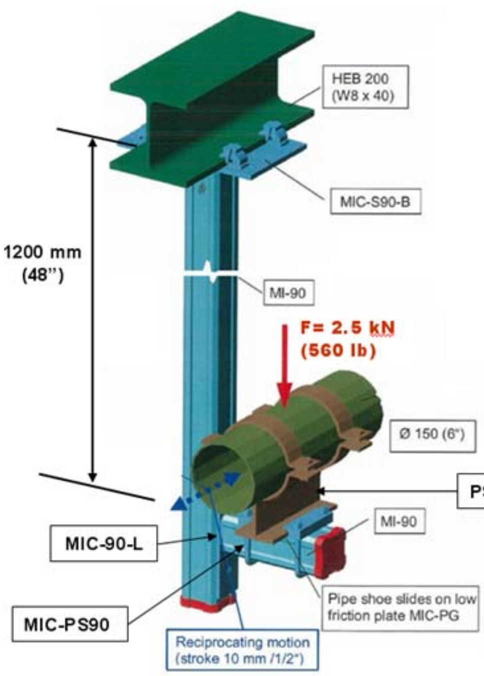
Testing Setup

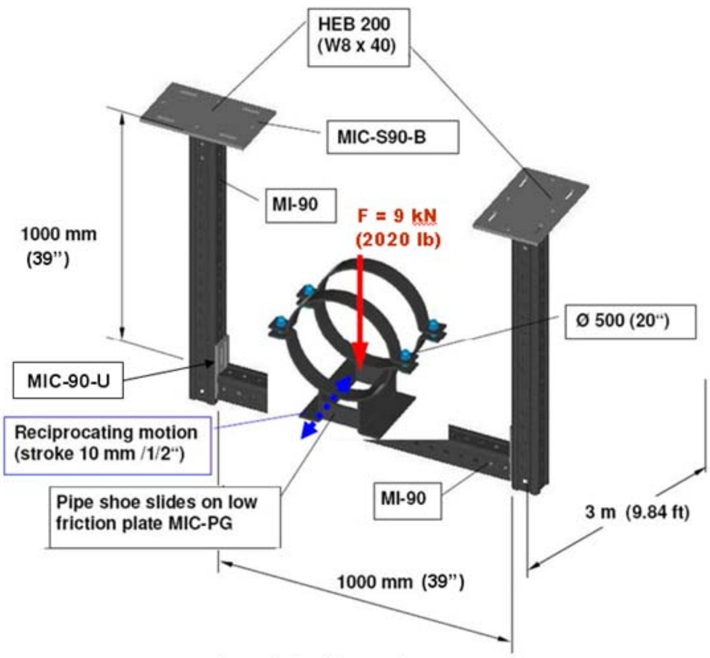
Two tests were conducted. Following are the parameters of each test.

Test #	Test 1	Test 2
Fig.	**Fig. 1**	**Fig. 2**
System	Two L-frame supports made out of MI-system	Two U-frames made out of MI-system
Frame spacing	2.5 m (~8'-2")	3.0 m (~9' 8")
Frame Dimensions	1200 mm (~4'-0") high with a cantilever of 250 mm (~10")	1000 mm (~3'-3") high and 1000 mm (~3'-3") wide
Frame Supports	The frames are fastened to steel beams with MIC-S90-B connector.	The frames are fastened to steel beams with MIC-S90-B connector.
Support configuration	See Fig. 1	See. Fig. 2
Vertical Load	150 mm (6") pipe with a static load of 2.5 kN (0.562 kips) on each frame.	500 mm (20") pipe with a static load of 9.0 kN (2.0 kips) on each frame.
Vertical Load simulation	The vertical load application is simulated by hanging concrete slabs bolted to pipe by using two MI-PS2/1-150 pipe supports.	The vertical load application is simulated by hanging concrete slabs bolted to pipe by using three MI-PS2/2-500 pipe supports.
Pipe supports	The pipes are supported using MI-PS2/1 pipe shoes installed on guides with low-friction plate (MIC-PG).	The pipes are supported using MI-PS2/1 pipe shoes installed on guides with low-friction plate (MIC-PG).
Horizontal Load	a reciprocating horizontal load (cylinder stroke approx. 10 mm (3/8"), i.e. amplitude of 5mm (3/16"))	a reciprocating horizontal load (cylinder stroke approx. 10 mm (3/8"), i.e. amplitude of 5mm (3/16"))
Target # of cycles	1.0 Million cycles	1.0 Million cycles
Cycle form	Sinus curve	Sinus curve
Type of Control	Movement Control	Movement Control

A Schenck Hydroplus cylinder was used to generate longitudinal dynamic loading. The clamps were tightened using standard torque values as specified in Hilti standards. The torque wrench was calibrated for 9 - 230 N.m (6.6 - 169 ft-lb).

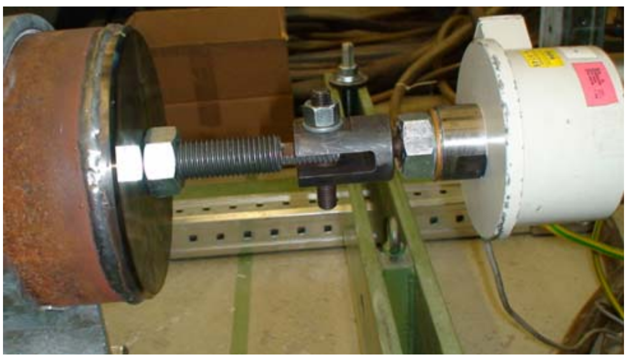
* Premature failure = Failure of a member prior to reaching its allowable stress level as measured under static loads.

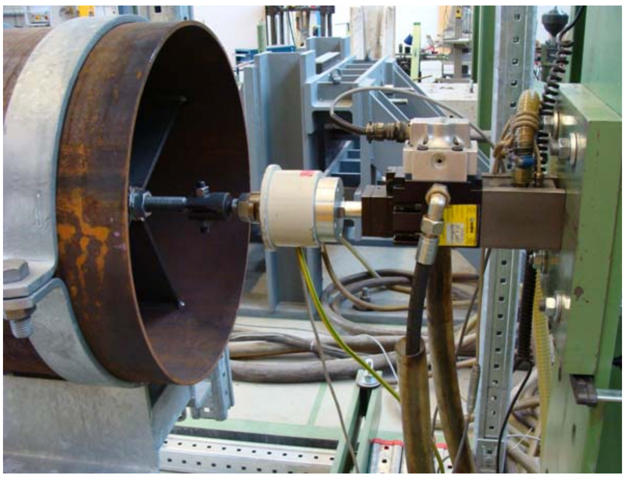




Figs. 1 and 2: Test #1 and Test #2 Setup.

Figs. 3 & 4: Test Setup for Test #1 and #2.





Figs. 5 & 6: Coupling between pipes and dynamometer for Test #1 and #2.

Test Observations

Test 1:

- The longitudinal pipe displacement caused sliding of the pipe support, MI-PS2/1, across the low-friction plate, MIC-PG. However, as the MI support was unbraced, it was also displaced longitudinally.
- The longitudinal force caused by hydraulic displacement in the system remained constant over the duration of 1 million cycles. See Fig. 7.
- At the end of the test (after 1 million cycles), the longitudinal force due to hydraulic displacement was measured as 1.2 kN (0.27 kips) in compression and 0.9 kN (0.20 kips) in tension.
- Other than normal wear as expected, no parts of the MI support system failed after 1 million cycles. See Fig. 9.

Test 2:

- Initial movement of the system due to longitudinal hydraulic cylinder was identical to Test 1 observations.
- The longitudinal force remained reasonably constant over the duration of 1 million cycles.
- At the end of the test (after 1 million cycles), the longitudinal force in compression dropped from 5.5 kN (1240 lbs) to 2.5 kN (560 lbs), while the longitudinal force in tension rose from 1.5 kN (340 lbs) to 2.0 kN (450 lbs). See Fig. 8.
- Other than normal wear as expected, no signs of defects were observed until end of the test (till 1 million cycles). See Fig. 10.

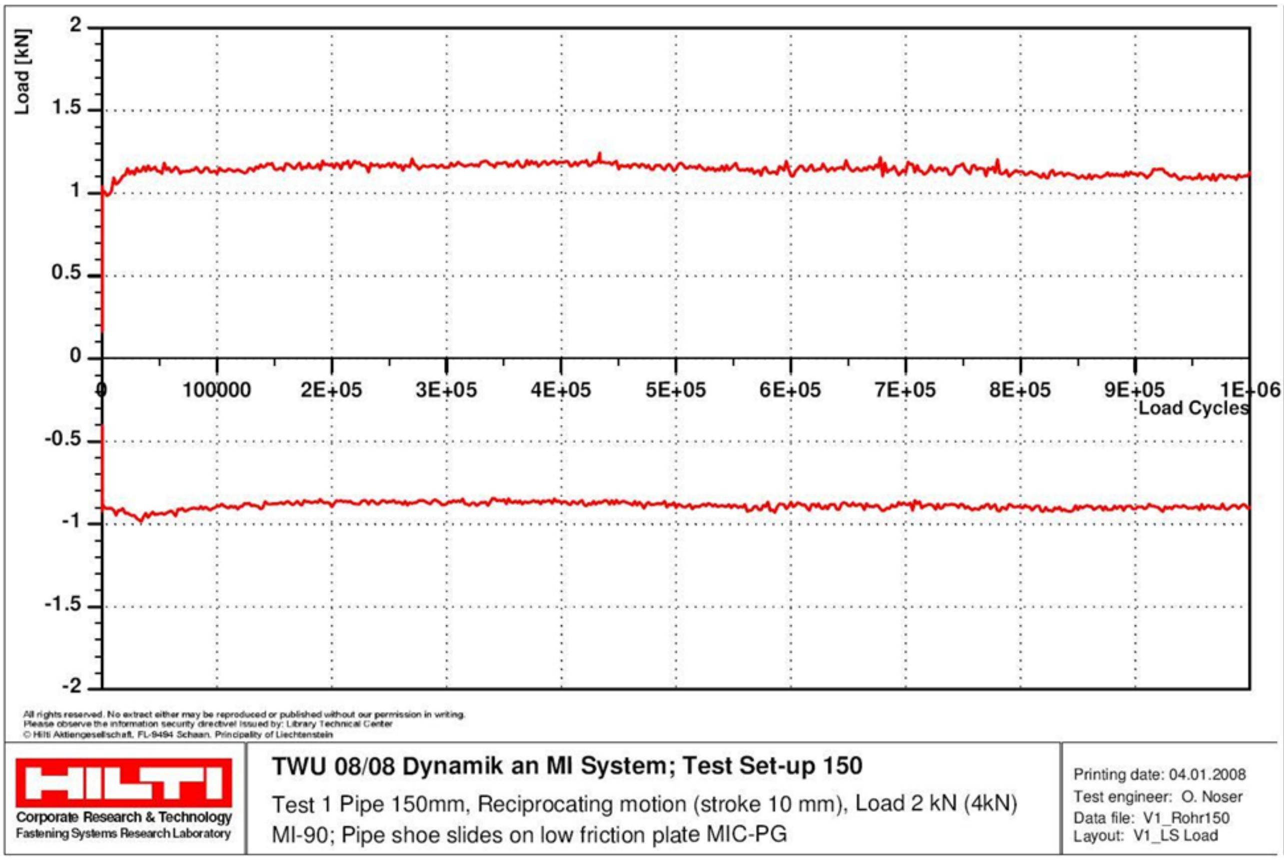


Fig. 7: Load graph of Test #1 over 1 million cycles.

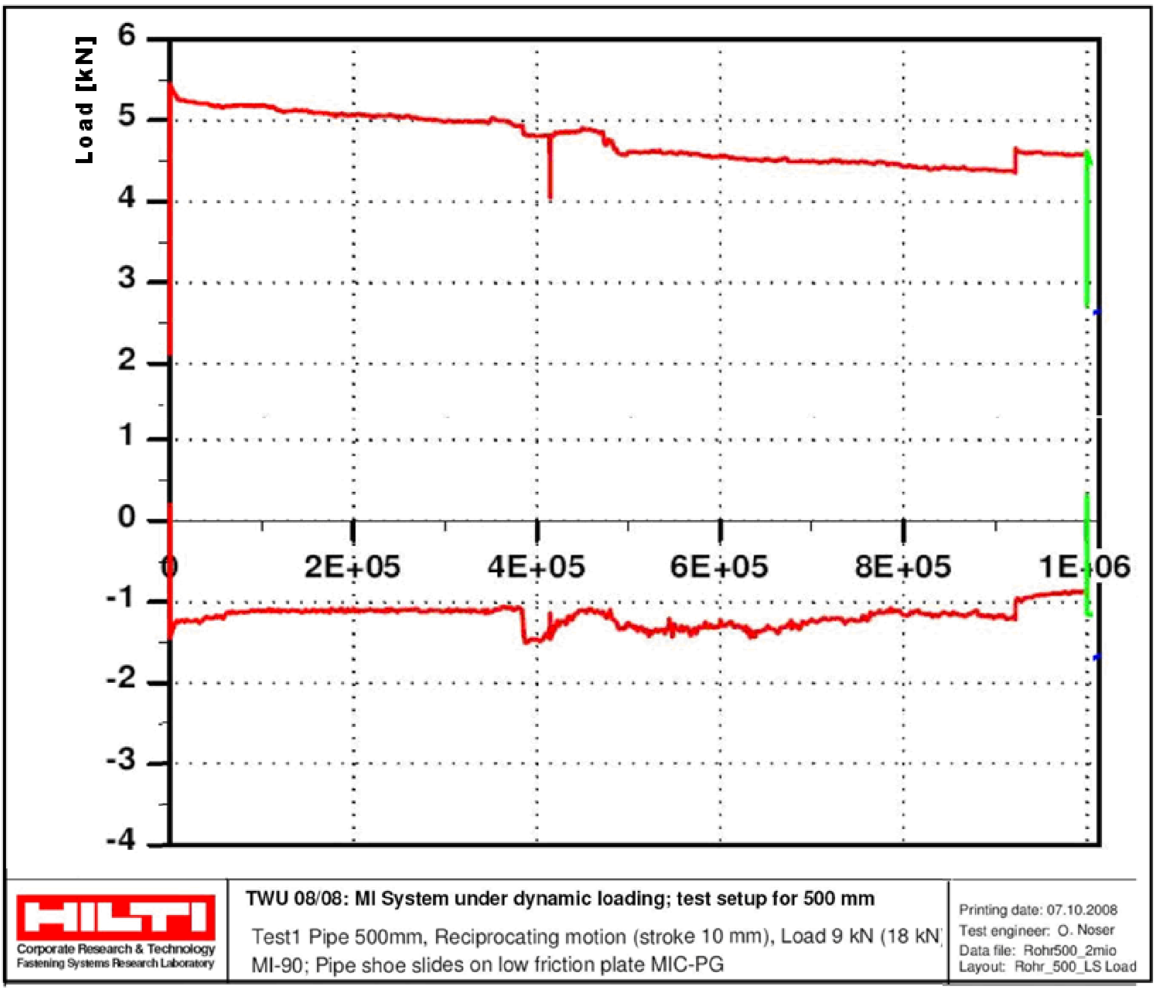


Fig. 8: Load graph of Test #2 over 1 million cycles.

Fig. 9: Wear in the sliding parts due to abrasion (Test #1).

Fig. 10: Wear in the sliding parts due to abrasion (Test #2).

Conclusion

Frames built with MI- systems were tested under dynamic loading conditions upto 1 million cycles. It was observed that all parts of MI-system including beam clamps, girders, connectors and pipe shoes held well under the reciprocating loads throughout the test length of 1 million cycles. No failure or defects were noticed.

IMPORTANT NOTICE: *The information and recommendations given are believed to be correct at the time of writing. The data has been obtained from tests under laboratory or other controlled conditions and it is the user's responsibility to use the data given in the light of conditions on site and taking account of the intended use of the products concerned. Whilst Hilti can give general guidance and advice, the nature of Hilti products means that the ultimate responsibility for selecting the right product for particular applications must lie with the customer.*