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Empa Report No. 438'171/E

Testing assignment: Fatigue test on CLIC-plastic pipe clamps
Test object: CLIC- Plastic pipe clamps




Client reference: Mr Beat Aebi, Gotthardstrasse 6, CH-8022 Zürich
Order dated of: March 24, 2005
Receipt of test material May 1, 2005
Test performed: May 31 – July 3, 2005
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Duebendorf, 11. August 2005		
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Remark:	The test results are valid solely for the object tested. The use of the test reports for the purpose of publicity, the mere reference to them or publication of excerpts require the approval of the EMPA (see Information Note). Test reports and supporting documents are retained for 10 years.	

1 Assignment

Upon the request of the company Egli, Fischer & Cie. AG in Zurich, the Structural Engineering Research Laboratory of Empa Duebendorf, tested the fatigue behavior of the CLIC pipe clamp, made of polyamide, under dynamic alternating loads with a concluding test of the remaining load carrying capacity. According to the client's statement, the CLIC pipe clamps are used to mount telecommunication cables in tunnels.

2 Test procedure

2.1 Fatigue tests

The load regime for the fatigue tests of the pipe clamps was derived from the study of DB AG, FTZ München ‚Aerodynamik‘ which was performed upon request of the ‚ANDREW Kommunikationssysteme AG‘. In this study, the load on the suspension device of a communication cable, such as the CLIC pipe clamps, is due to the air current of trains passing by is calculated as follows:

P:	= 1.244 kg*/m ³	Air density with a pressure of 1470 Pa
A = L*D:	= 0.041 m ²	Cable area
L:	= 1 m	Distance between cable hangers
D:	= 0.041 m	Cable diameter
V:	= 49 m/s	Air speed
Cd	= 0.33	Aerodynamic coefficient

Provided with a dynamic safety factor of 6 [1], the outcome is a dynamic load of:

$$F_{dyn} = 0.5 * P * A * V^2 * Cd * 6 = 121.2N. [1] \quad (1)$$

This force was assumed as load amplitude. Friction effects, which reduce the dynamic load, remained unconsidered. One meter communication cable weighted 1033 g. This resulted in an extra static load of:

$$F_{stat} = 1.033 * 9.81 = 10.13N. \quad (2)$$

The load value was used as off-set value for the dynamic loading. The frequency of the sinus load was 4 Hz. The number of load cycles was 2 Mio. A sample (test 1) was tested in mounting direction (fig. 2), a second sample (test 2) was loaded vertically to it (fig: 3). The second test serves as evidence of the resistance of the catch of the pipe clamps.

The fatigue tests were performed in the testing machine Instron 1273 equipped with a 1000 N load cell, SOP-No. A-5070. The test of sample 1 started on June 15, 2005, and the test of sample 2 on June 25, 2005. Each test took approximately 8.5 days. The air temperature measured 23 °C and the relative air humidity was 50%.

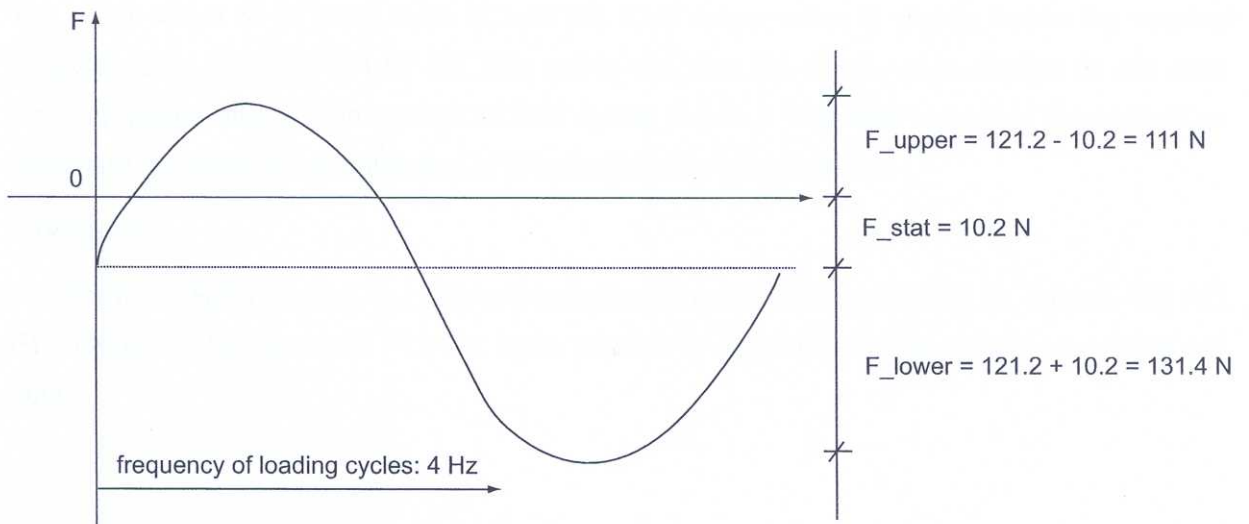


Abb. 1: Principle load during the fatigue tests.

2.2 Static rupture tests

On May 31, 2005, three not loaded tubing clamps, were tested regarding their load carrying behavior. The tests were performed in the testing machine Instron 1273 with a load cell (max. load 25kN), SOP-No. A-4031. (fig. 4). After the fatigue tests, the pipe clamps subjected to the fatigue tests were tested up to failure, to determine the residual strength. The tests were performed in the testing machine Zwick / Z010, ID 32782 and with the load cell (max. force 10 kN), SOP-No. A-5050. The deformation rate for all static tests was 5mm / min.

3 Test results

The first pipe clamp (fig. 2) was tested by 3 Mio. load changes. In the following static test (fig 5, 6) it showed a residual strength of 1.57 kN. The second pipe clamp, shifted in its loading direction by 90° (fig. 3), was tested by 2.9 Mio load changes. In the following static test (fig. 7) it showed a remaining breaking load of 1.84 kN. After the fatigue tests, no white discoloration was visible, which is common sign of fatigue of polyamide plastics.

The static strain test of the three pipe clamps, which were loaded in mounting direction and without previous fatigue, added up to maximal force:

Sample 3:	1.38 kN
Sample 4:	1.39 kN
Sample 5:	1.56 kN .

The mean value of all three tests is 1.44 kN. This mean value is slightly below the residual breaking force of test 1 of 1.57 kN. This points out, that the CLIC – pipe clamps do not show signs of fatigue after a high number of load cycles (3 Mio.). This was supported by a visual assessment, by which no discoloration of the plastic parts were detected.

Literature

[1] Wormstall-Reitschuster, H.J., Druckbeanspruchung auf Antennenkabel im Tunnel, DB AG, FTZ München Aerodynamik FTZ 82, upon request of ANDREW Kommunikationssysteme AG, 2000



Fig. 2: Fatigue test in the testing machine Instron, sample 1.

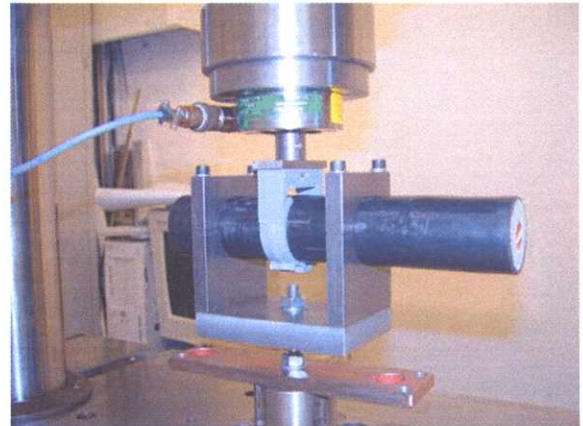


Fig. 3: Fatigue test, pipe clamp shifted by 90°, in the testing machine Instron, sample 2.

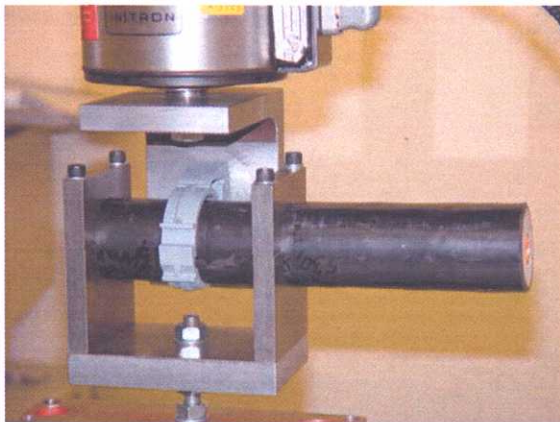


Fig. 4: Static rupture test, test machine Instron, without previous fatigue, sample 3.

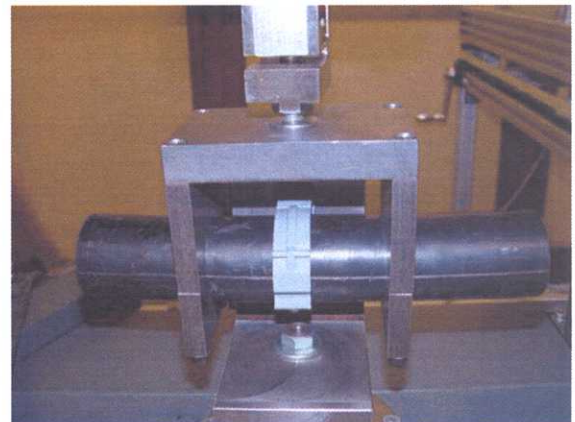


Fig. 5: Static rupture test, test machine Zwick, with previous fatigue, sample 1.

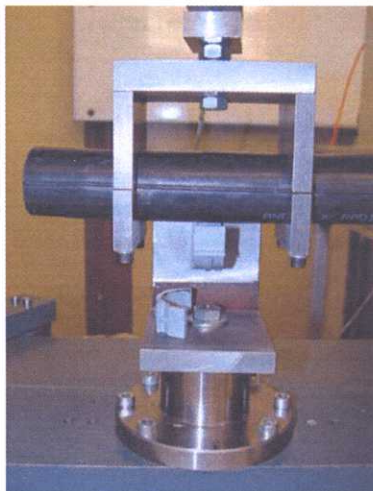


Fig. 6: sample 1 after static rupture test.



Fig. 7: Static rupture test, pipe clamp shifted by 90°, after previous fatigue, sample 2.