LGA
Landesgewerbeanstalt Bayern

Test Report
M 5991 081

Radiation Protection in a Shuttering Tie System Containing a Non-Recoverable Tie Rod

Name and address of client	PERI GmbH Shuttering and Scaffolding Systems Rudolf-Diesel-Str. 89264 Weissenhorn
Commission	Practical radiation protection requirements when using a non-recoverable tie rod in the construction of concrete walls
Expert	K. Kyser Certified Engineer

The test report comprises 4 pages and 2 enclosures.

L G A • Radiation Protection and * • Tillystraße 2 • 90431 Nürnberg
Tel.: +49 911 6 55-54 91 and 5492 • Fax: +49 911 6 55-58 84

1 Introduction

For the construction of radiation shelters, where operations will be carried out with ionized radiation (x-ray or γ-radiation) at a high energy level (higher than 100 keV) concrete walls are usually built in. Shuttering components are inserted when the concrete walls are erected. To guarantee stability, the wall components must be anchored and joined with each other. When the concrete has hardened and the shuttering is dismantled, tapered gaps remain in the concrete wall. Due to the gaps being situated at both ends, radiation protection of the concrete wall is reduced in a way which is not at all desirable. Following the calculations as described in Test Report M 4661 106, dated 1996-06-03, the solution was to compensate the reduced radiation protection of the shuttering tie site by the application of lead.

With the tie rod system examined here (viz. Fig. 1, Annexe) the prestressing steel is left in the concrete wall after dismantling the shuttering. Subsequently, the tapered gaps remaining on both sides of the wall are closed up by means of a concrete taper and a special adhesive agent at dead level with the wall surface. In order to check the radiation protection effectiveness the absorption behavior should be tested under radiation impact. This check should be carried out by means of such x-ray films as are used in non-destructive material testing.

The non-destructive test was carried out using technical x-ray device ISOVOLT 300 (manufacturer: Seifert). Following the pre-search, the x-ray-beamer was adjusted at U = 300 kV and tube voltage of I = 3 mA. The beamer's characteristic filtering is 2,5 mmAl.

2 Test Lay-Out

The two concrete samples were prepared by the client and had dimensions of 50 cm x 50 cm x 24 cm. The tension site was set centrally. The absorption behavior at the tension site was monitored using photographic film Fuji IX 100 + Pb. Focus-to-film distance was 70 cm.

Preliminary tests with the x-ray-beamer showed that the intensity of radiation which passed through the beamer's built-in filter caused such a high percentage of ray-scattering inside the concrete sample that even the prestressing steel could not be detected on the film. Additional filtering of 1,5 mm tin finally yielded the desired results. The higher intensity radiation caused less scattering of rays in the concrete, to the effect that absorption of the prestressing steel could also be made out on the x-ray film (viz. x-ray photograph A1). The preliminary test results showed that the exposure time for the x-ray should be set at t = 0,6 min for the additional tin-filtering.

The tests were carried out as shown in the lay-out shown in Fig. 2 (Annexe).

3 Test Procedure

For all control tests on samples A and B, and in all conditions under which they were carried out, (viz. Fig. 2) the x-ray-beamer was applied from left. The x-ray film was fixed in a central position to the tension site, on the right side of the sample, by means of adhesive tape.

3.1 X-Ray Evaluation

A1: Prestressing steel depicted as shadow. Around the prestressing steel, a circular color set-off (blackening) due to the "circular" gap in the concrete sample.

A2: Short-focus insertion of a 20 mm Pb-taper. As prescribed by the manufacturer the Pb-taper was fixed by means of a tool pipe to "encase" in lead even the thread of the prestressing steel, and to press the lead material against the inner concrete wall. On the x-ray film a narrow circular, lighter color set-off (corona) can be detected, caused by the "circular" gap in the concrete sample and by ray-scattering.

A3: A second Pb-taper was inserted long-focus. There was no significant difference to the photographic x-ray lay-out in A2.

A4: A concrete taper was glued in short-focus. The circular lighter color set-off in photos A2 and A3 is considerably reduced. The inserted concrete taper reduces ray-scattering in the concrete sample.

A5: A second concrete taper was glued in long-focus, with the desired results. Only marginal circular color heightening, relative to the outer dimensions of the taper, can be detected.

B1: The x-ray corresponds with photo A2, however, with a reduced circular color set-off due to radiation absorption by the concrete taper. An important effect was noted while making this x-ray: the lead material was not sufficiently pressed against the prestressing steel, with the result that a lighter color set-off in the shape of a crescent appeared in the x-ray.

B2: A second concrete tape was glued in long-focus. In the final analysis, the x-ray is comparable to the photograph under A5, with only one difference: the crescent-shaped lighter color set-off may be reduced in photo B1, but it is still visible.

4 Conclusions

Insertion of the Pb-taper in order to provide the necessary radiation protection to the shuttering tie site presents a decisive step in the radiation conditions opted for (viz. A2). Inserting the 2 concrete tapers reduces x-ray scattering in the concrete sample (viz. A5 and B2). Both measures taken are necessary to guarantee radiation protection at the tie site. A Pb-taper of the above mentioned strength is enough, however, it must always be fixed close to the beamer in the radiation protection wall which calls for a higher degree of attention to be given during actual construction. The second Pb-taper has another advantage as was found out in test lay-outs of sample B: a Pb-taper not accurately positioned can cause radiation penetration, which means that radiation protection at the tension site is reduced when compared to the surrounding area.

An important requisite for radiation protection of the formwork tie site is complete encasement by lead of the prestressing steel rod. The second Pb-taper serves as radiation protection and contributes largely to uniform operational processes at the radiation protection wall.

The investigations were carried out by means of prestressing steel DW 15. The results obtained here can also be applied to prestressing steels DW 20 and DW 26.

A disadvantage of Pb-tapers: There is no labyrinthian radiation prevention here, which is normal in radiation protection. Test lay-out A5 of the shuttering tie site provides equivalent radiation protection at the shuttering tie site of concrete walls for radiation shelters[1] under x-ray and γ-radiation impact.

Nürnberg, 1999-08-25
MBP MEDS Kys/

Klaus Kyser

by order of

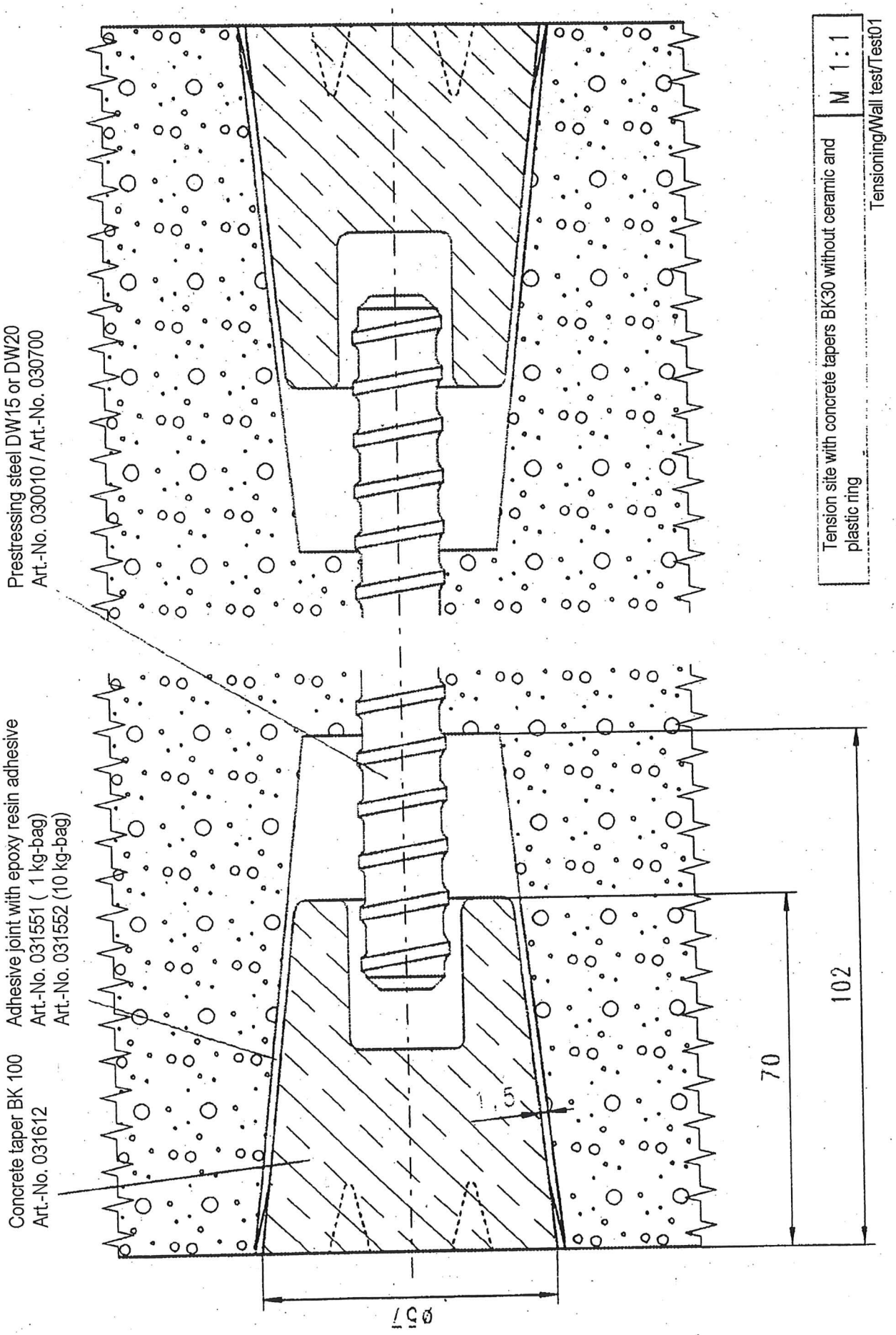
LGA - Product Division
Radiation Protection and Physics

Enclosures

[1] For radiation protection calculations viz. DIN 6812, DIN 6846, DIN 6847, DIN 54113-3, and DIN 54115-5.

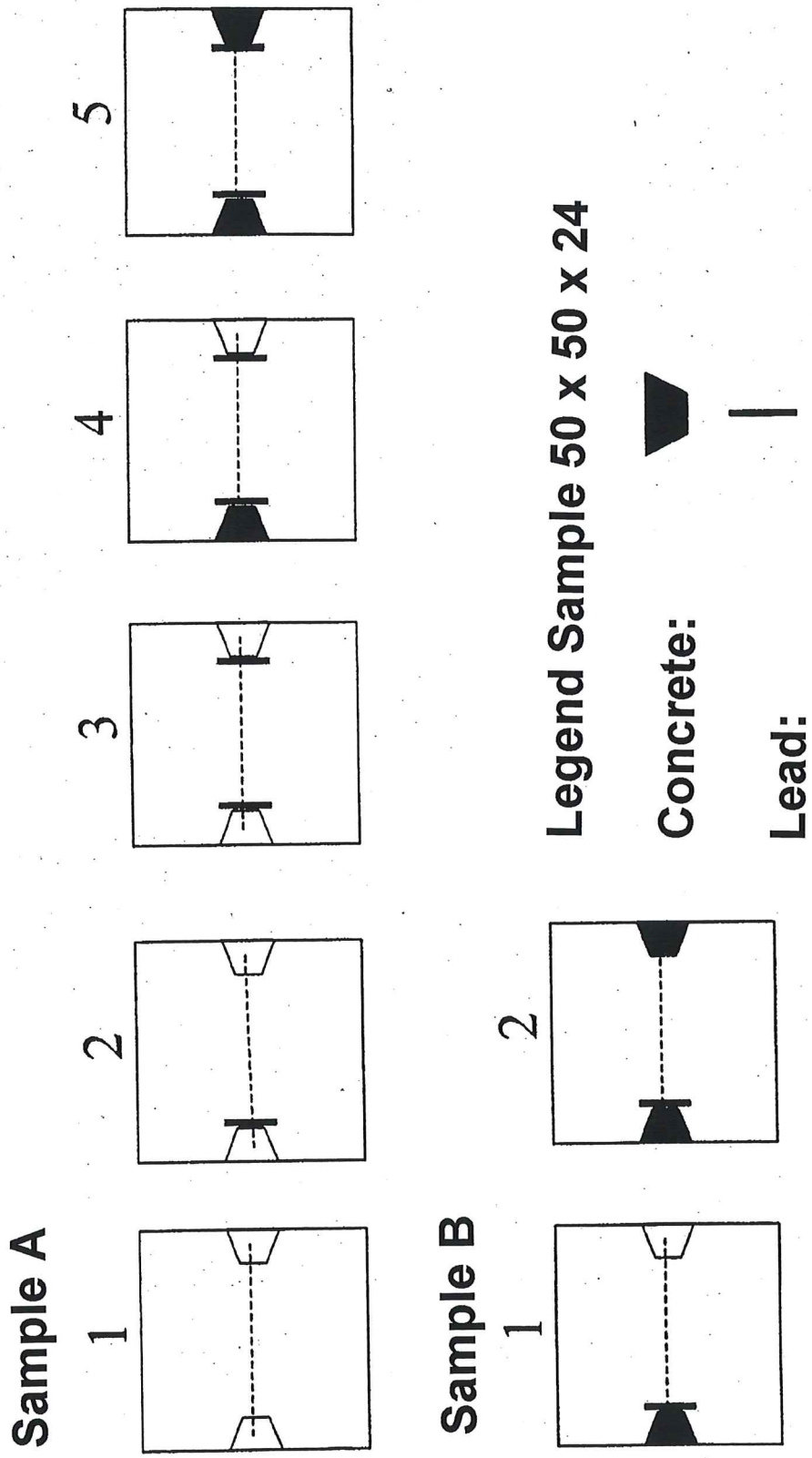
Annexe Test Report M 5991 081

Fig. 1



Test Procedure for Radiation Test

SK-System DW 15



LGA Bautechnik GmbH
Radiation Protection

Certified in accordance with DIN EN ISO 9001/14001

L G A Bautechnik GmbH • P.O. Box 3022 • 90014 Nuremberg, GERMANY

Peri GmbH
Rudolf-Diesel-Str.
89264 Weißenhorn
GERMANY

PERI
14. FEB. 2006
Weißenhorn

Your Letter	Your Reference:	Our Reference:	Handled By:	Tel.:	Nuremberg, GERMANY
Of 26.09.2005	lo-	BBGUS	Höhlein	(09 11) 6 55-54 92	09.12.2005

Testing of Radiation Protection Provided by Concrete Structures

Dear Mr. Lorenz:

In test report M 5991081 from 25.08.1999, the radiation protection when using of a sacrificial anchor rod during erection of concrete walls was evaluated.

In your letter of 26.09.2005, you informed us that the adhesive used to glue the concrete cones had been changed. The density of the adhesive was reduced from 1.55 g/cm³ to 1.48 g/cm³.

Through this change in density, the shielding effect of the adhesive changes only slightly (reduction of < 4% at 300 kV). For the overall shielding effect of the concrete/lead/adhesive combination, this reduction in the shielding effect is negligible.

Sincerely,

LGA Bautechnik GmbH
Radiation Protection

Karl-Heinz Höhlein
(Authorized Expert)

LGA Bautechnik GmbH • Tillystraße 2 • 90431 Nuremberg, GERMANY • http://www.lga.de
Tel.: (09 11) 6 55-54 92 • Fax: (09 11) 6 55-5618 • E-mail: karl-heinz.hoehlein@lga.de