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**ALL-RUSSIAN SCIENTIFIC, RESEARCH, DESIGN AND TECHNOLOGICAL  
INSTITUTE  
VNIIZHELEZOBETON**

**Test Center NITSstrom of JSC VNIIZhelezobeton**

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**APPROVED:**

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\_\_\_\_\_ 2016

**Test Report**

Moscow

January 29, 2016

**1. Description of the product tested**

Polymer lining sheets (manufactured by JSC R&DE Hydropolymer) made of PE type polyethylene and PP type polypropylene, with anchor ribs (TU 224600-9-001-11146988-2015).

**2. Customer**

JSC R&DE Hydropolymer

**3. Company presenting the product for tests**

JSC R&DE Hydropolymer

**4. Grounds for testing**

Contract No. DP2-25\1.14DP2\1-33 dated November 09, 2015

**5. Test purpose**

Evaluation of performance characteristics of polymer lining sheets made of polyethylene and polypropylene, with anchor ribs by index of adhesive strength (anchorage) with concrete.

**6. Information on specimens**

Test specimens of lining sheets manufactured as rectangular plates with cross section 150x150 mm, in the amount of 12 pieces, six specimens made of polyethylene and polypropylene (Fig. 1), were transmitted for testing.

Geometrical size of the testing specimen of lining sheet

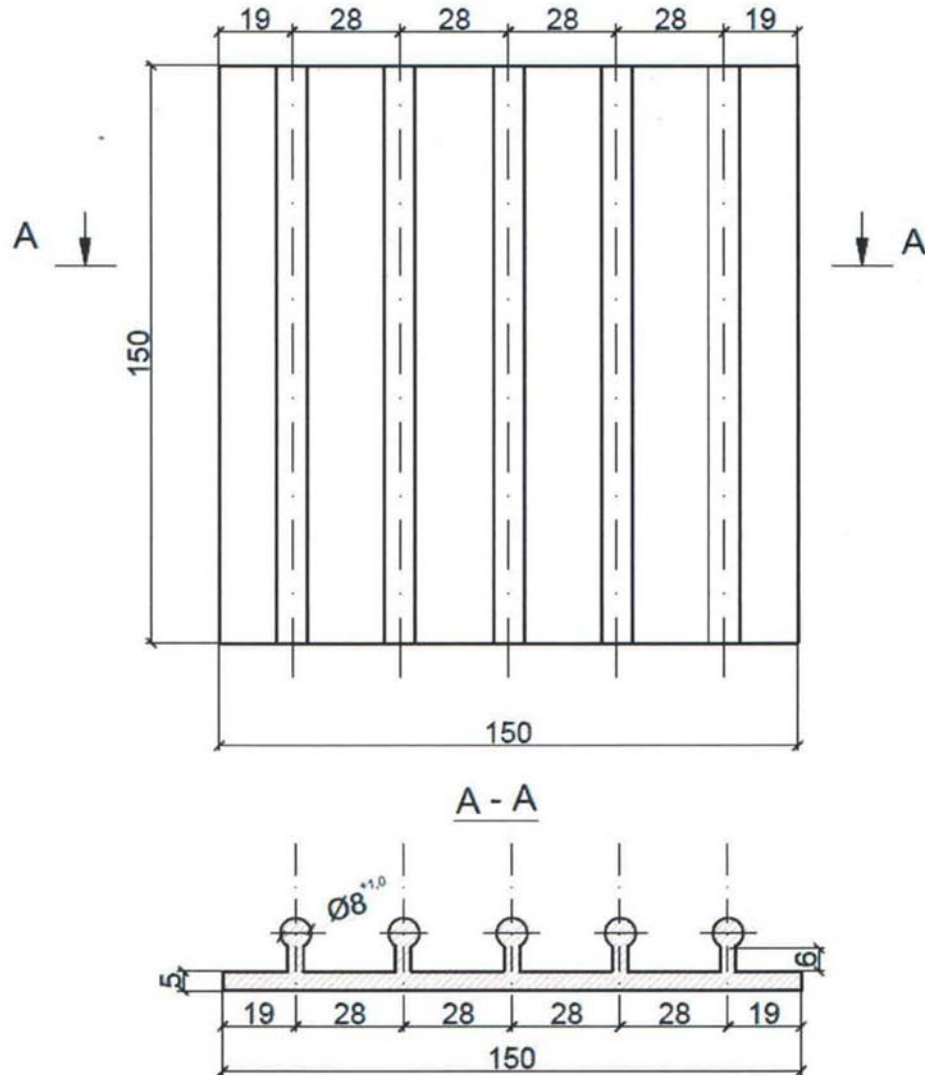


Fig. 1. Geometrical size of the testing specimen of lining sheet

## 7. Testing procedure

Check specimens of concrete with cross section 150x150 mm, 112 mm high, with concreted lining on two opposite edges, were manufactured for evaluation of performance characteristics of polymer lining sheets with anchor ribs by index of their adhesion with concrete.

Steel plates of size 150x150 mm, with ribs for ensuring swivel fixing in the test machine grips were used as stamps. As there are no adhesive compositions for polyethylene and polypropylene which could ensure the required adhesion strength of their connection to the metal, the decision was taken to perform a mechanical bolted connection of the test specimens with steel stamps (see Photo 1).



Photo 1. Bolted connection of the lining sheet to the stamp

Six concrete specimens with cross section 150x150 mm were manufactured, thereof: three specimens with lining sheet made of polyethylene and three ones made of polypropylene. Average compression strength of concrete for the moment of testing was 38.4 MPa, that corresponds to the concrete grade B27.5 (48 MPa).

Experimental evaluation of adhesion strength (anchorage) of polymer lining sheets with concrete was conducted on a multipurpose servo-hydraulic test bench MFL HUS 1060 manufactured in Germany, serial No. 8940, calibration certificate No. 336-1/30 dated 19.05.2015, issued by SUE NIIMosstroy. Diagram of test specimens loading is shown in Fig. 2 and Photo 2. Active grip displacement speed during tests was  $S = 0.01$  mm/s, that corresponded to the specimen loading speed  $P \approx 50\text{--}60$  N/s ( $\sigma \approx 0.0020\text{--}0.0025$  MPa/s). The Diagram of “P load – S displacement” deformation and the maximal break off force of the lining sheet from concrete were registered during tests of the test specimens.

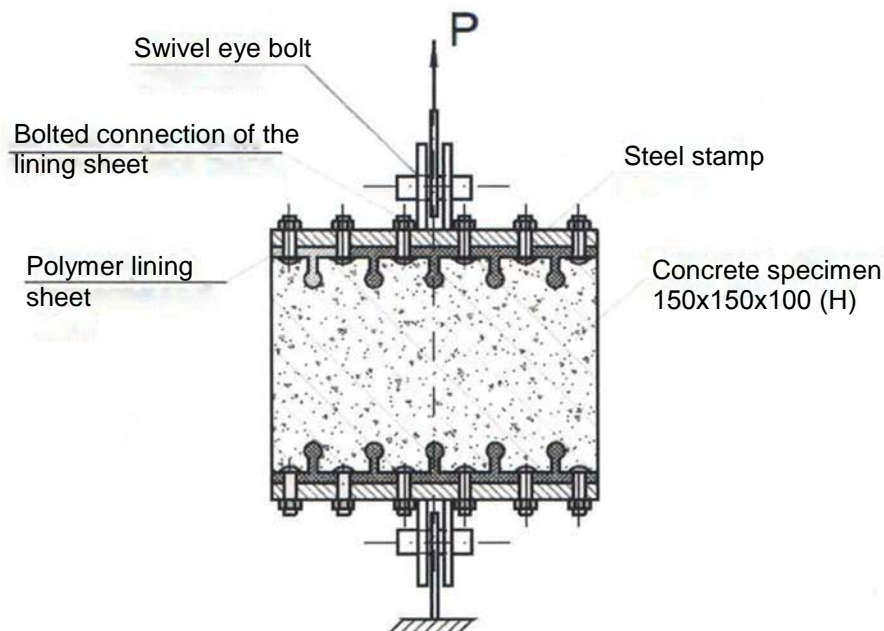


Fig. 2. Diagram of test specimen loading



Photo 2. Diagram of test specimen loading.

## 8. Test results

Destruction of test specimens during tests (axial tensile load  $P$ ) occurred on concrete. Destruction plane of concrete cross section occurred in parallel to one of the face edges of the specimen, at a distance 7–20 mm, for the upper, as well as for the lower grip.

Fracture behavior of test specimens is shown in Photo 4–9. Test results of test specimens and characteristic deformation diagrams are given in Table 1 and in Fig. 10–11, respectively.



Photo 3. Test specimen fracture behavior



Photo 4. Specimen No. 1.1 polyethylene



Photo 5. Specimen No. 1.2 polyethylene



Photo 6. Specimen No. 1.3 polyethylene

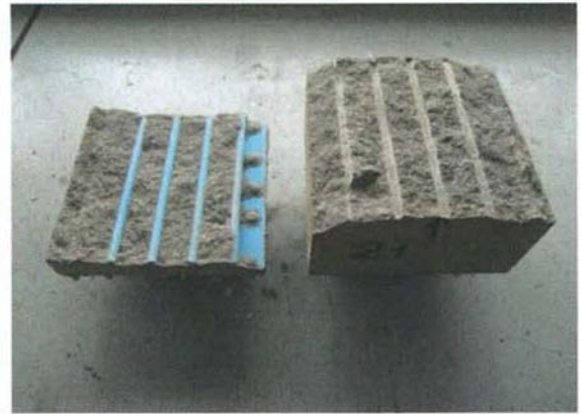


Photo 7. Specimen No. 2.1 polypropylene

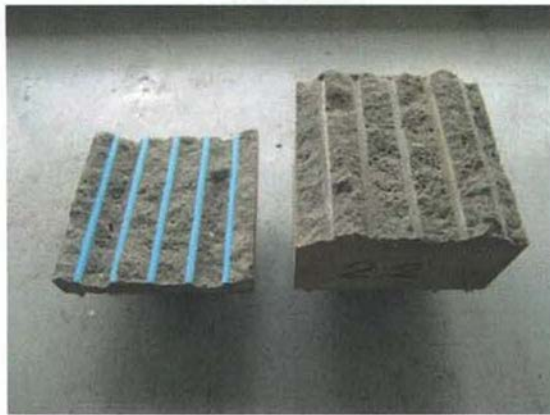


Photo 8. Specimen No. 2.2 polypropylene

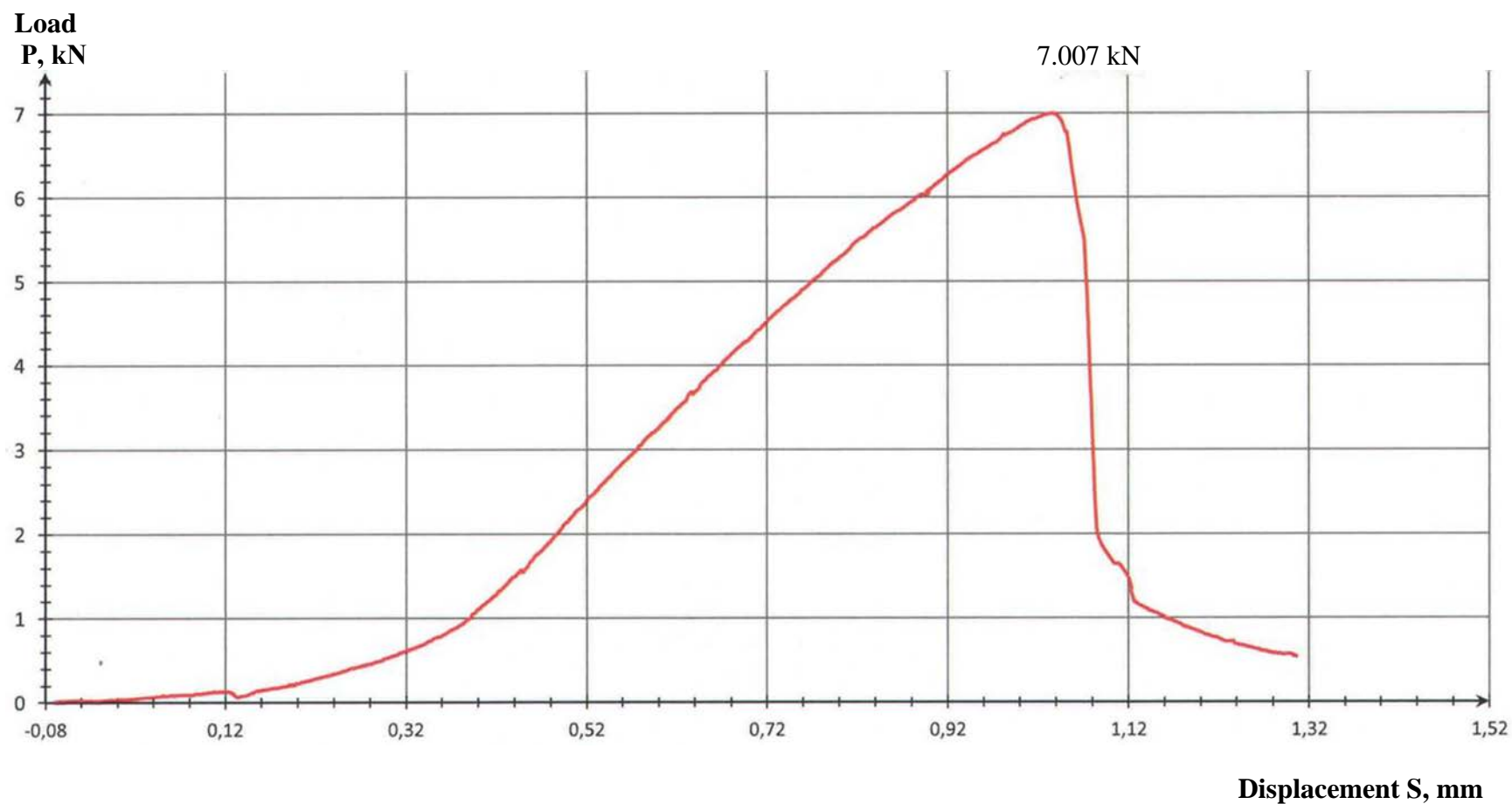


Photo 9. Specimen No. 2.3 polypropylene

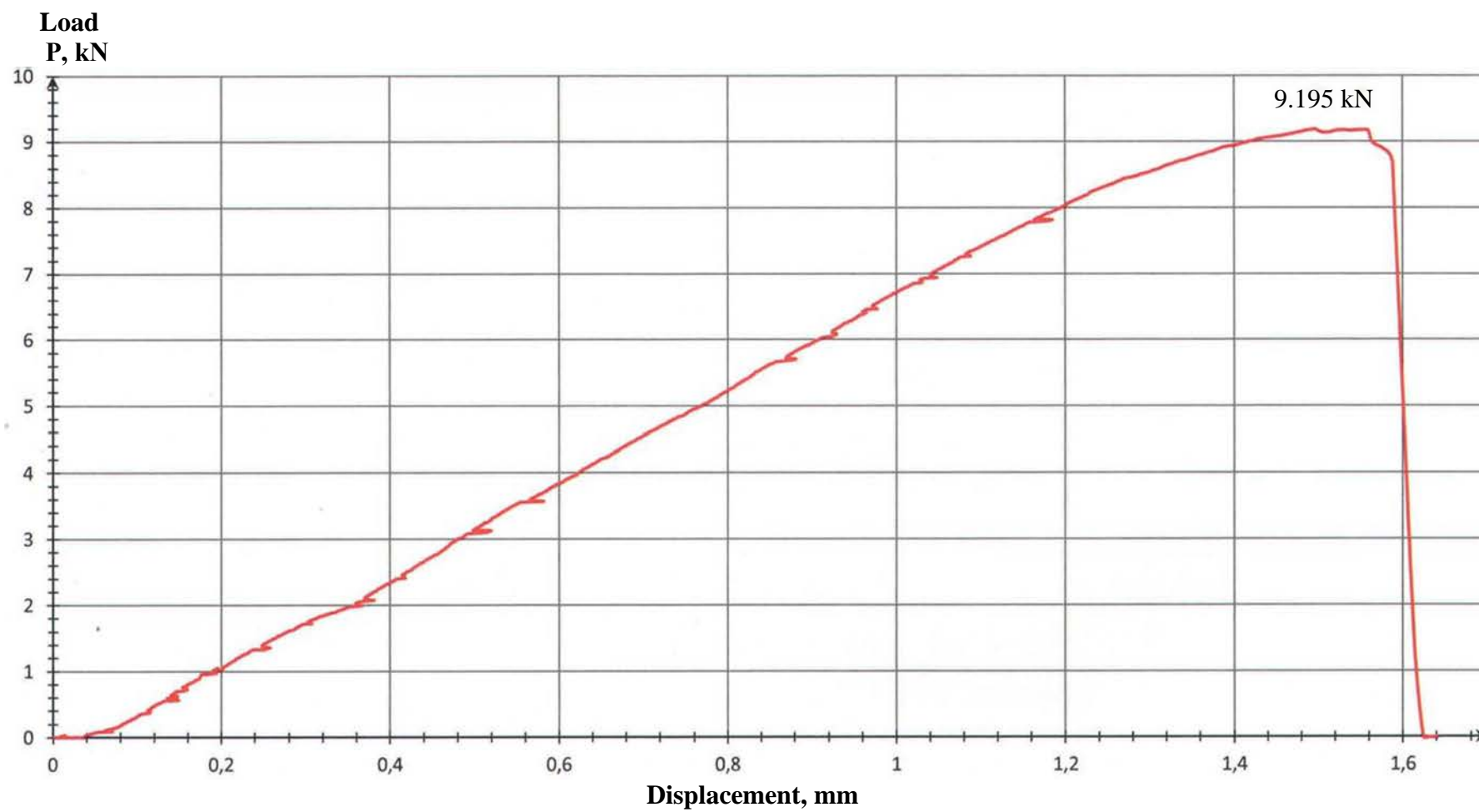
Table 1

## Adhesive strength (anchorage) of lining sheets with concrete of grade B27.5

Specimen No.	Material of lining sheet	Break off force (H)	Anchoring strength		Fracture behavior
			MPa (kN/m <sup>2</sup> )	kN/m	
1.1	polyethylene	6,740	> 0.30 (300)	> 9.0	on concrete
1.2		6,290	> 0.28(280)	> 8.4	on concrete
1.3		7,007	> 0.31(310)	> 9.3	on concrete
	<b>average</b>	6,679	<b>&gt; 0.30(300)</b>	<b>&gt; 9.0</b>	
2.1	polypropylene	7,746	> 0.34(340)	> 10.2	on concrete
2.2		9,308	> 0.41(410)	> 12.3	on concrete
2.3		9,195	> 0.41(410)	> 12.3	on concrete
	<b>average</b>	<b>8,750</b>	<b>&gt; 0.39 (390)</b>	<b>&gt; 11.6</b>	

Test results of specimen No. 1.3 (polyethylene)**Fig. 3. Diagram for “P – S” deformation of specimen No. 1.3 (polyethylene)**



Test results of specimen No. 2.3 (polypropylene)**Fig. 3. Diagram for “P – S” deformation of specimen No. 2.3 (polypropylene)**

## 9. Conclusion

Results of the tests conducted on evaluation of performance characteristics of polymer lining sheets with anchor ribs as to their adhesion strength (anchorage) with concrete of grade B27.5, showed as follows:

- adhesive strength (anchorage) of lining sheets made of polyethylene was the magnitude of 0.30 MPa as minimum (300 kN/m<sup>2</sup>), or 9 kN as minimum per 1 m of length of the anchor rib;

- adhesive strength (anchorage) of lining sheets made of polypropylene was the magnitude of 0.39 MPa as minimum (390 kN/m<sup>2</sup>), or 11.6 kN/m as minimum per 1 m of length of the anchor rib.

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