

Application technology
Materials testing
Quality assurance

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Test report

Report no. 14-210-00756-PB

Material examination in accordance with ASTM F 1216

manufacturer: KOB Karl Otto Braun GmbH & Co. KG
sample designation: pipe section DN 150:
synthetic fiber hose with epoxy resin
sample no.: 1453004
resin ID: Brawo III

client: KOB Karl Otto Braun GmbH & Co. KG
Lauterstraße 50
67752 Wolfstein

This report includes 5 pages (incl. cover page).
It may only be handed over to third parties with the approval of SIEBERT+KNIPSCHILD GmbH and in unabbreviated form.

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1 Determination of material properties according to ASTM F1216-09

1.1 Determination of tensile properties in accordance with ASTM D638-10

Acc. to ASTM F1216-09, Table 1, the tensile strength of the material is only required for applications in pressurized pipes.

It is not intended to use the CIPP-system "Brawo-Liner" for the repair of pressure pipes.

1.2 Determination of bending stress and bending Young's modulus in accordance with ASTM D790-10

The specimens were taken from the cured CIPP in accordance with ASTM F1216-09, Section 8.1.1. The specimens were taken in the longitudinal direction.

Table: Summary of test results (mean values):

sample number	test date	wall thickness e_m [in (mm)]	flexural strength σ_b [psi (MPa)]	flexural modulus E_f [psi (MPa)]
1453004	19.05.2014	1.31 (3.32)	11051.9 (76.2)	461945 (3185)

The individual test log is enclosed as Annex.

1.3 Test of the resistance of the cured CIPP to chemical attack acc. to ASTM F1216, Table X2.1

For the test of the resistance of the cured CIPP to chemical attack acc. to ASTM F1216, Table X2.1 the test specimens were stored in the test media for one month at 23°C. The test media included:

- 100% tap water
- 5% nitric acid
- 10% phosphoric acid
- 10% sulfuric acid
- 100% gasoline
- 100% vegetable oil
- 0.1% detergent
- 0.1% soap

After the storage time the flexural properties were determined acc. to ASTM D790 – 10.

During the storage time the CIPP test specimens should lose no more than 20% of their initial flexural strength and flexural modulus.

1.3.1 Determination of the change of flexural properties

5 test specimens were used to determine the change of the flexural properties, i. e. flexural strength and flexural modulus, after one month of storage at 23°C in the test media listed in section 1.4.

The change of flexural strength and flexural modulus in per cent was determined after removal from the test media and conditioning (24 hours in standard climate conditions).

Table: Summary of test results (mean values):

test specimen designation	medium	flexural strength σ_{fb} [psi (MPa)]	flexural modulus E_f [psi (MPa)]
1453004	100% tap water	11254.9 (77.6)	462670 (3190)
	5% nitric acid	11254.9 (77.6)	448167 (3090)
	10% phosphoric acid	10486.2 (72.3)	379999 (2620)
	10% sulfuric acid	11095.4 (76.5)	436419 (3009)
	100% gasoline	10428.2 (71.9)	457594 (3155)
	100% vegetable oil	12473.2 (86.0)	487182 (3359)
	0.1% detergent	11400.0 (78.6)	450922 (3109)
	0.1% soap	11994.6 (82.7)	463396 (3195)

The measurement and test logs are enclosed as Annexes.

Table: Summary of test results (mean values):

test specimen designation	medium	change of flexural strength σ_{fb} [%]	change of flexural modulus E_f [%]
1453004	100% tap water	1.8	0.2
	5% nitric acid	1.8	-3.0
	10% phosphoric acid	-5.1	-17.7
	10% sulfuric acid	0.4	-5.5
	100% gasoline	-5.6	-0.9
	100% vegetable oil	12.9	5.5
	0.1% detergent	3.1	-2.4
	0.1% soap	8.5	0.3

The measurement and test logs are enclosed as Annexes.

2 Result

The CIPP-system "Brawoliner", consistent of the epoxy-based resin "Brawo III", shows no loss of 20 % or more of its initial flexural modulus and its flexural strength after the storage in media according to ASTM F1216, X2.1. The CIPP-System "Brawoliner" with the epoxy-resin "Brawo III" fulfils the requirements of ASTM F 1216, X2.1.

Oststeinbek, june 24, 2014


 Technical Director
 Dipl.-Ing. A. Haacker


 Prüflabor
 Inspektionsstelle
 D-PL-11222-01-00
 D-IS-11222-01-00


 Tester in charge
 B.Eng. Stefan Schwarzer

Annex:
 individual test logs

test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804
 date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 0,1% soap
 date of manufacturing: 14.04.2014

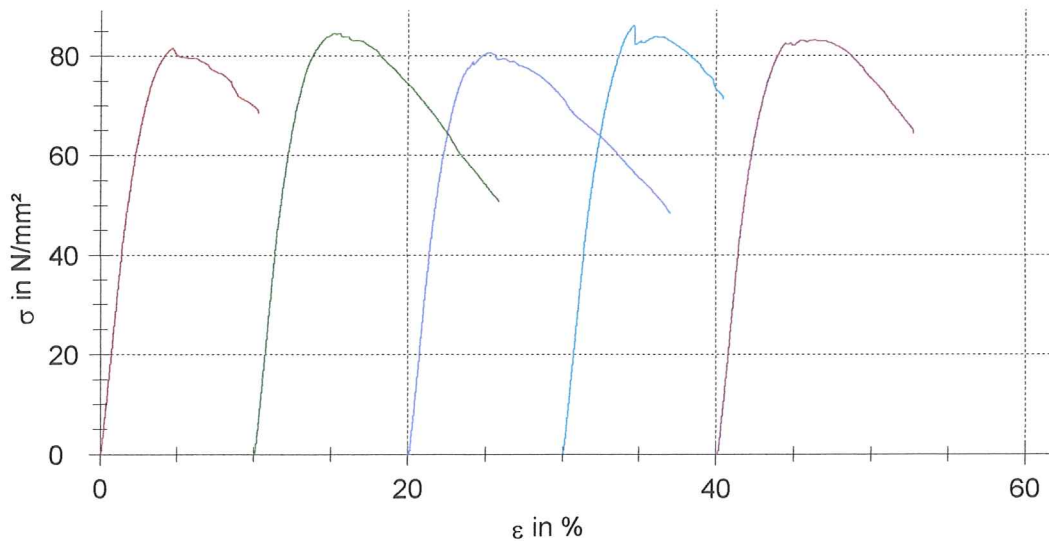
test parameters :

test date : 19.06.2014
 direction of testing : longitudinal direction
 machine data : 1445 WN:117562
 Traversenwegaufnehmer WN:117562
 Kraftsensor ID:0 WN:117563 10 kN
 rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,56	13,85	3206	81,4	4,64	81,4	4,52	15	20	54
2	3,21	13,77	3196	84,5	5,23	84,5	5,10	20	25	54
3	3,34	14,30	3178	79,0	4,19	80,6	5,12	20	25	54
4	3,45	14,09	3183	86,0	4,63	86,0	4,53	20	25	54
5	3,27	13,95	3209	82,5	4,47	83,2	6,21	20	25	54

diagram :



statistic :

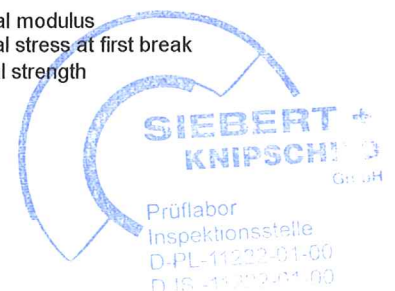
Serie	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
n = 5										
x̄	3,37	13,99	3195	82,7	4,63	83,2	5,09	19	24	54
min	3,21	13,77	3178	79,0	4,19	80,6	4,52	15	20	54
max	3,56	14,30	3209	86,0	5,23	86,0	6,21	20	25	54
R	0,35	0,53	31	7,1	1,05	5,4	1,69	5	5	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification

b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification

E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength



test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804
 date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 0,1% detergent
 date of manufacturing: 14.04.2014

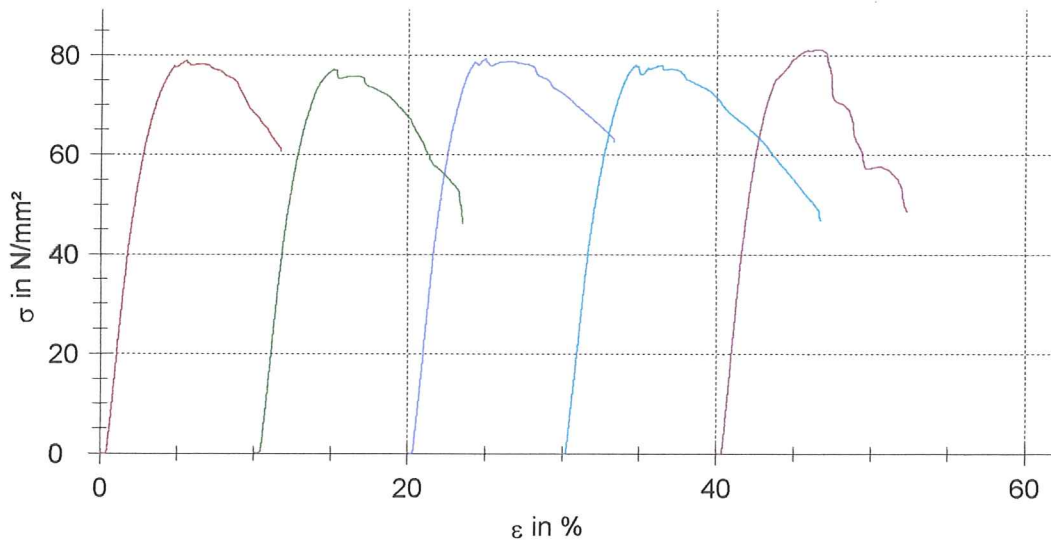
test parameters :

test date : 20.06.2014
 direction of testing : longitudinal direction
 machine data : 10TN2S WN:143453
 Traversenwegaufnehmer WN:143453
 Kraftsensor ID:0 WN:143454 10 kN
 rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,42	14,25	3155	77,8	4,76	78,9	5,08	15	25	56
2	3,47	14,01	3048	77,1	5,12	77,1	4,66	15	25	56
3	3,53	14,17	3168	78,7	4,27	79,3	4,59	15	25	56
4	3,58	13,86	2896	78,1	4,70	78,1	4,45	15	25	56
5	3,51	14,27	3278	81,1	5,87	81,1	6,13	15	25	56

diagram :



statistic :

Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
\bar{x}	3,50	14,11	3109	78,6	4,94	78,9	4,98	15	25	56
min	3,42	13,86	2896	77,1	4,27	77,1	4,45	15	25	56
max	3,58	14,27	3278	81,1	5,87	81,1	6,13	15	25	56
R	0,16	0,41	382	4,0	1,60	4,1	1,68	0	0	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification
 b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification
 E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength



test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804
 date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 100% vegetable oil
 date of manufacturing: 14.04.2014

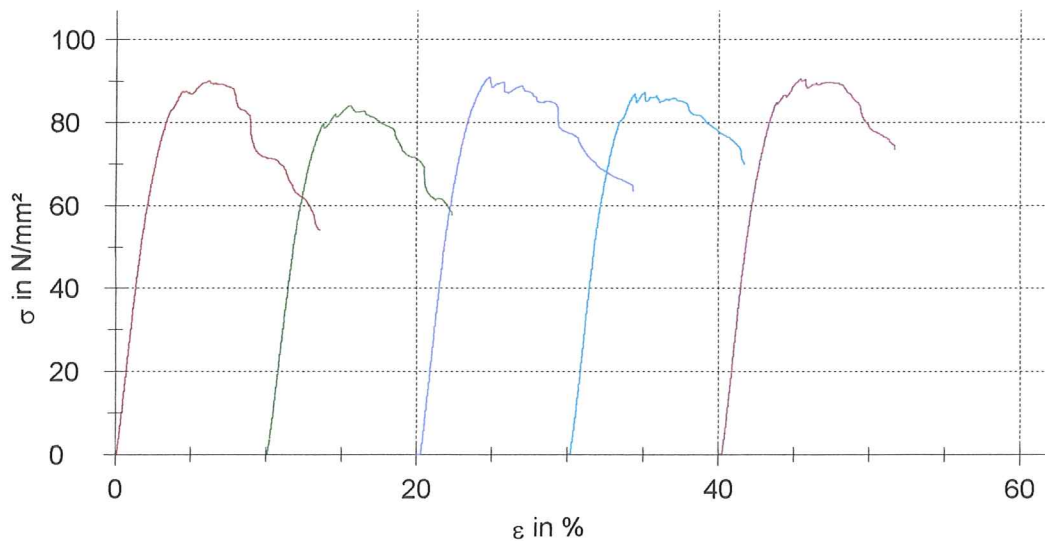
test parameters :

test date : 20.06.2014
 direction of testing : longitudinal direction
 machine data : 10TN2S WN:143493
 Traversenwegaufnahme WN:143493
 Kraftsensor ID:0 WN:143494 10 kN
 rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,12	14,22	3392	87,6	4,46	90,0	5,97	20	25	50
2	3,29	14,21	3147	79,8	3,77	83,9	5,39	15	20	50
3	3,12	14,04	3396	90,9	4,89	90,9	4,59	20	25	50
4	3,15	13,76	3411	87,0	4,43	87,2	4,80	20	25	50
5	3,14	13,91	3447	84,8	3,81	90,6	5,17	20	25	50

diagram :



statistic :

Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
x	3,16	14,03	3359	86,0	4,27	88,5	5,18	19	24	50
min	3,12	13,76	3147	79,8	3,77	83,9	4,59	15	20	50
max	3,29	14,22	3447	90,9	4,89	90,9	5,97	20	25	50
R	0,17	0,46	300	11,2	1,12	7,0	1,37	5	5	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification

b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification

E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength



test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804
 date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 100% gasoline
 date of manufacturing: 14.04.2014

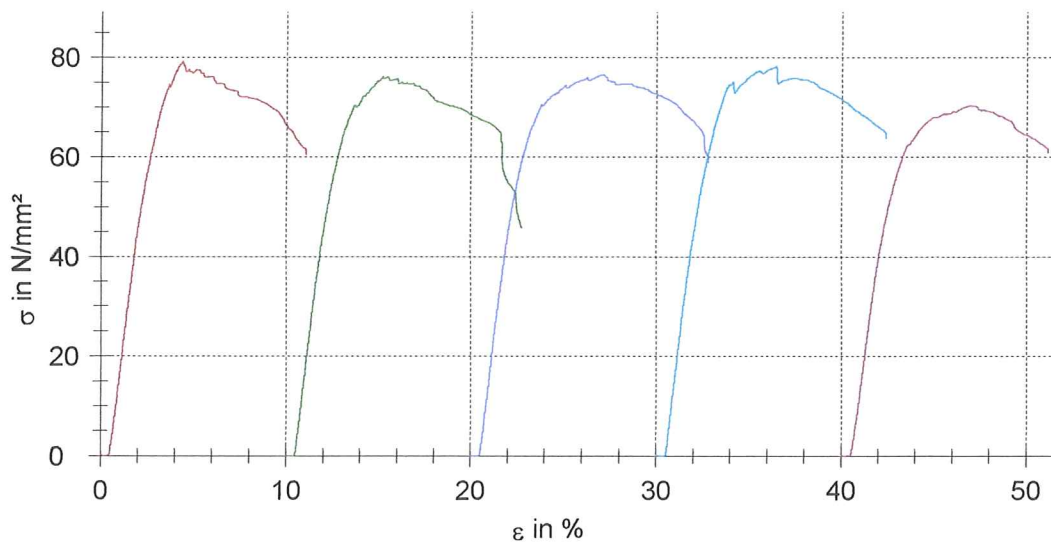
test parameters :

test date : 20.06.2014
 direction of testing : longitudinal direction
 machine data : 10TN2S WN:143453
 Traversenwegaufnehmer WN:143453
 Kraftsensor ID:0 WN:143454 10 kN
 rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,39	14,17	3142	74,8	3,70	79,2	3,87	10	20	54
2	3,43	14,24	3200	70,5	3,70	76,2	4,72	10	20	54
3	3,39	14,39	3249	70,5	3,80	76,6	6,67	10	20	54
4	3,36	14,15	3230	74,7	3,97	78,1	5,88	10	20	54
5	3,27	13,58	2952	69,3	6,07	70,4	6,37	10	20	54

diagram :



statistic :

Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
\bar{x}	3,37	14,11	3155	71,9	4,25	76,1	5,51	10	20	54
min	3,27	13,58	2952	69,3	3,70	70,4	3,87	10	20	54
max	3,43	14,39	3249	74,8	6,07	79,2	6,67	10	20	54
R	0,16	0,81	298	5,5	2,37	8,8	2,80	0	0	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification

b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification

E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength



test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804
 date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 10% sulfuric acid
 date of manufacturing: 14.04.2014

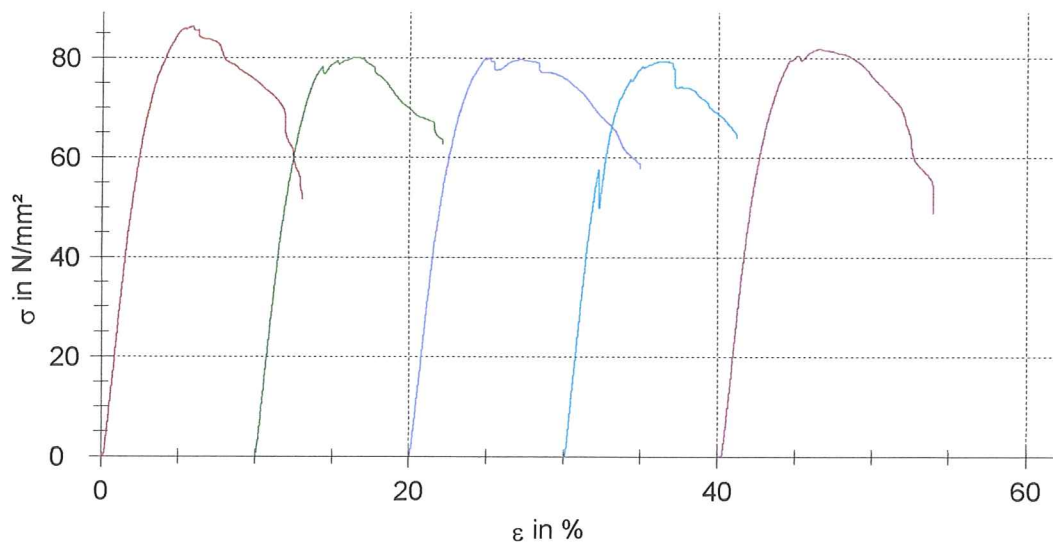
test parameters :

test date : 19.06.2014
 direction of testing : longitudinal direction
 machine data : 10TN2S WN:143493
 Traversenwegaufnehmer WN:143493
 Kraftsensor ID:0 WN:143494 10 kN
 rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,12	14,18	3076	86,3	5,88	86,3	5,66	10	20	52
2	3,35	14,17	2967	78,2	4,29	80,0	6,37	10	20	52
3	3,50	14,23	2835	79,9	4,87	80,0	5,05	10	20	52
4	3,39	14,05	3155	57,6	2,28	79,3	6,06	10	20	52
5	3,27	13,31	3011	80,5	5,16	81,9	6,22	10	20	52

diagram :



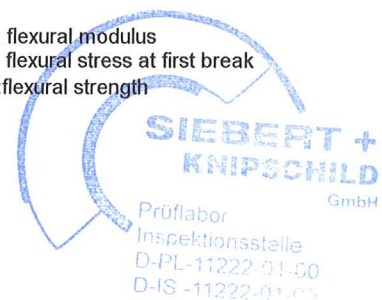
statistic :

Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
\bar{x}	3,33	13,99	3009	76,5	4,50	81,5	5,87	10	20	52
min	3,12	13,31	2835	57,6	2,28	79,3	5,05	10	20	52
max	3,50	14,23	3155	86,3	5,88	86,3	6,37	10	20	52
R	0,38	0,92	321	28,7	3,60	7,0	1,32	0	0	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification
 b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification

E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength



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test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804
 date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 10% phosphoric acid
 date of manufacturing: 14.04.2014

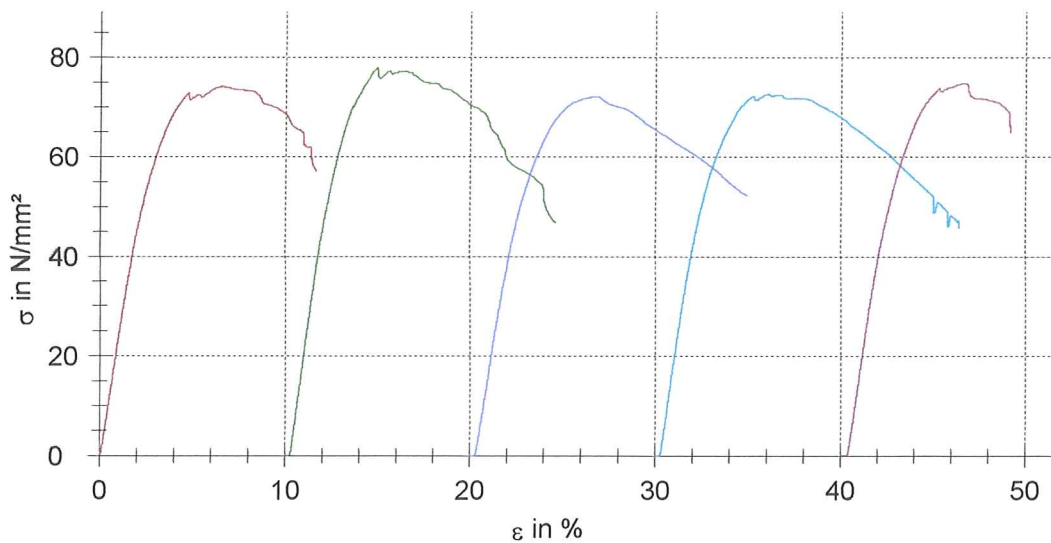
test parameters :

test date : 19.06.2014
 direction of testing : longitudinal direction
 machine data : 1445 WN:117562
 Traversenwegaufnehmer WN:117562
 Kraftsensor ID:0 WN:117563 10 kN
 rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,68	14,06	2531	72,9	4,79	74,1	6,51	10	20	54
2	3,49	13,81	2809	70,2	3,61	78,0	4,64	10	20	54
3	3,26	14,12	2451	72,1	6,77	72,1	6,44	15	20	54
4	3,32	14,19	2662	72,2	5,28	72,6	5,78	10	20	54
5	3,13	14,24	2646	73,9	5,33	74,9	6,20	10	20	54

diagram :



statistic :

Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
\bar{x}	3,38	14,08	2620	72,3	5,16	74,4	5,91	11	20	54
min	3,13	13,81	2451	70,2	3,61	72,1	4,64	10	20	54
max	3,68	14,24	2809	73,9	6,77	78,0	6,51	15	20	54
R	0,55	0,43	358	3,7	3,16	5,9	1,87	5	0	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification

b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification

E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength



test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804

date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 5% nitric acid
 date of manufacturing: 14.04.2014

test parameters :

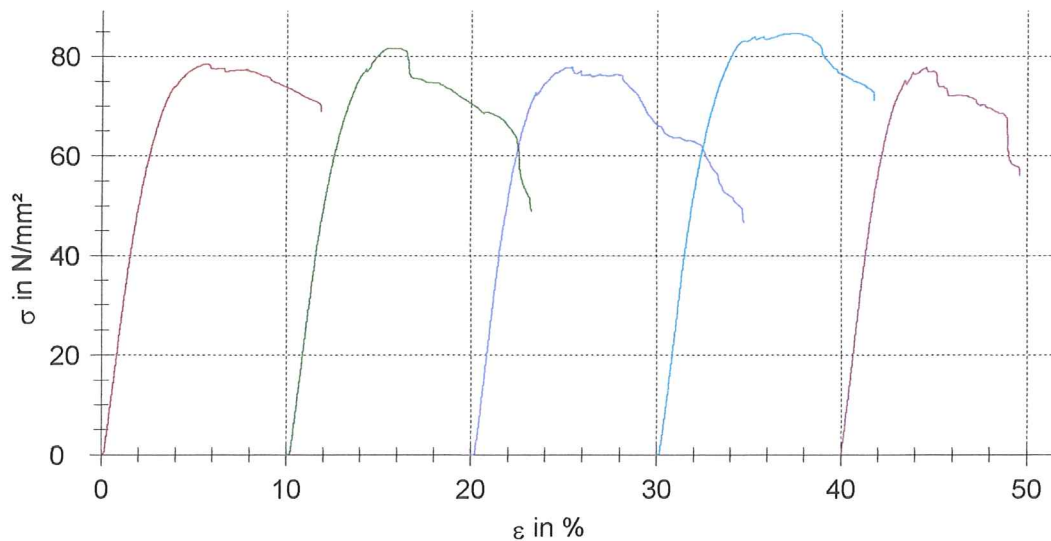
test date : 20.06.2014
 direction of testing : longitudinal direction
 machine data : 1445 WN:117562
 Traversenwegaufnehmer WN:117562
 Kraftsensor ID:0 WN:117563 10 kN

rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,33	14,10	2974	78,4	5,58	78,4	5,41	15	20	52
2	3,13	14,37	2978	77,5	4,32	81,6	5,69	15	20	52
3	3,28	13,78	3170	72,8	3,48	77,8	5,22	15	20	52
4	3,18	14,46	3115	84,0	5,31	84,6	7,20	15	20	52
5	3,44	14,40	3212	75,2	3,44	77,8	4,52	15	20	52

diagram :



statistic :

Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
x	3,27	14,22	3090	77,6	4,43	80,0	5,61	15	20	52
min	3,13	13,78	2974	72,8	3,44	77,8	4,52	15	20	52
max	3,44	14,46	3212	84,0	5,58	84,6	7,20	15	20	52
R	0,31	0,68	238	11,2	2,14	6,8	2,68	0	0	0

symbols pursuant to ASTM D790

- d : depth of beam
- L : support span
- σ_{f1} : initial stress of modulus identification
- b : sample width
- ε_{fb} : flexural strain at first break
- ε_{fM} : flexural strain
- σ_{f2} : end stress of modulus identification
- E_f : flexural modulus
- σ_{fb} : flexural stress at first break
- σ_{fM} : flexural strength



test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201400860804

date of order: 12.05.2014
 pipe geometry: DN 150
 line name: BRAWO III
 sample name: Test liner
 100% tap water
 date of manufacturing: 14.04.2014

test parameters :

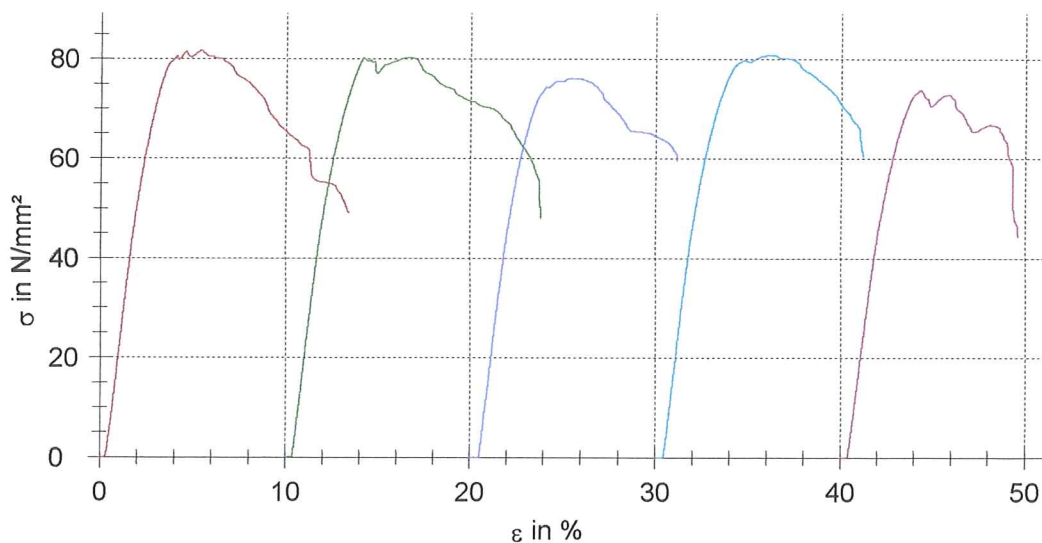
test date : 20.06.2014
 direction of testing : logitudinal direction
 machine data : 10TN2S WN:143453
 Traversenwegaufnehmer WN:143453
 Kraftsensor ID:0 WN:143454 10 kN

rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,53	13,75	3349	80,5	4,12	81,7	4,99	15	25	54
2	3,54	13,82	3222	80,2	4,16	80,3	6,30	10	20	54
3	3,26	14,14	3166	74,4	4,12	76,1	4,97	10	20	54
4	3,36	14,46	3260	79,8	4,72	80,8	5,64	10	20	54
5	3,74	13,92	2957	73,3	4,09	73,9	3,84	10	20	54

diagram :



statistic :

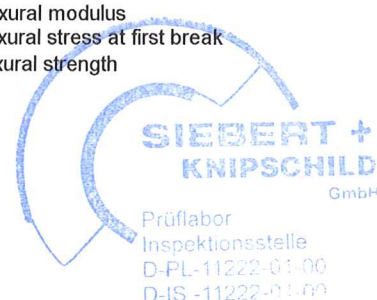
Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
\bar{x}	3,49	14,02	3190	77,6	4,24	78,6	5,15	11	21	54
min	3,26	13,75	2957	73,3	4,09	73,9	3,84	10	20	54
max	3,74	14,46	3349	80,5	4,72	81,7	6,30	15	25	54
R	0,48	0,71	392	7,3	0,63	7,8	2,46	5	5	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification

b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification

E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength



test data :

construction project: Material examination in acc. to ASTM- Standards
 client: Karl Otto Braun GmbH & Co. KG
 manufacturer: Karl Otto Braun GmbH & Co. KG
 material: EP - Syntesefaser
 Material-ID: 1201303824102

date of order: 31.01.2014
 pipe geometry: DN 150
 line name: BRAWO III
 date of manufacturing: 14.04.2014

test parameters :

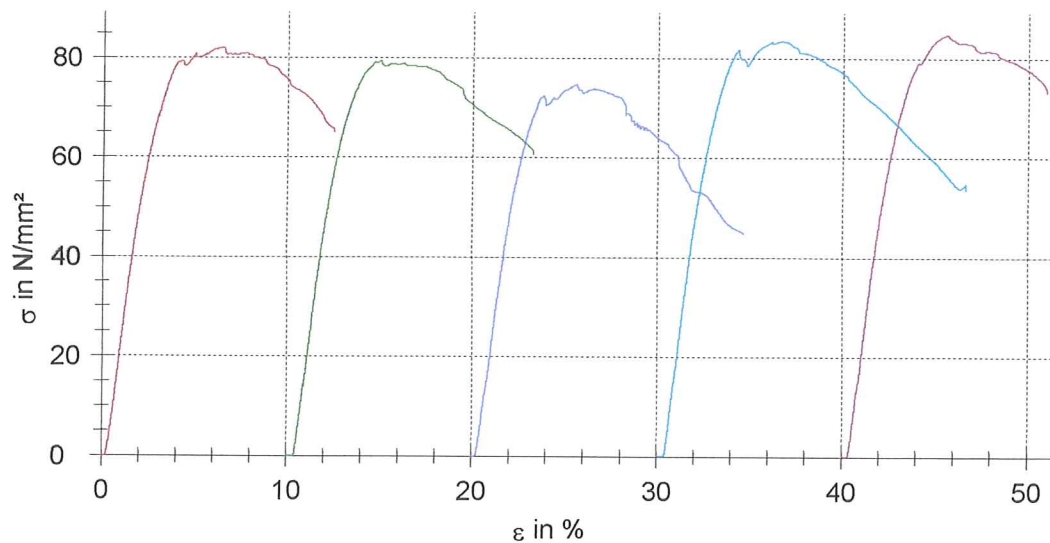
test date : 19.05.2014
 direction of testing : longitudinal direction
 machine data : 1445 WN:117562
 Traversenwegaufnehmer WN:117562
 Kraftsensor ID:0 WN:117563 10 kN

rate of crosshead motion : 1,3 mm/min
 tester : T. Benner

test results :

Nr	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
1	3,52	14,16	3174	68,4	3,00	82,0	6,18	20	25	52
2	3,16	14,07	3208	79,6	5,03	79,6	4,53	20	25	52
3	3,44	14,17	3049	72,2	3,68	74,7	5,30	20	25	52
4	3,13	14,22	3264	81,7	4,38	83,5	6,24	20	25	52
5	3,35	14,38	3229	79,2	4,10	84,7	5,12	20	25	52

diagram :



statistic :

Serie n = 5	d mm	b mm	E _f N/mm ²	σ _{fb} N/mm ²	ε _{fb} %	σ _{fM} N/mm ²	ε _{fM} %	σ _{f1} N/mm ²	σ _{f2} N/mm ²	L mm
\bar{x}	3,32	14,20	3185	76,2	4,04	80,9	5,47	20	25	52
min	3,13	14,07	3049	68,4	3,00	74,7	4,53	20	25	52
max	3,52	14,38	3264	81,7	5,03	84,7	6,24	20	25	52
R	0,39	0,31	215	13,3	2,03	10,0	1,71	0	0	0

symbols pursuant to ASTM D790

d : depth of beam
 L : support span
 σ_{f1} : initial stress of modulus identification

b : sample width
 ε_{fb} : flexural strain at first break
 ε_{fM} : flexural strain
 σ_{f2} : end stress of modulus identification

E_f : flexural modulus
 σ_{fb} : flexural stress at first break
 σ_{fM} : flexural strength

