EFFECT OF TEST SPEED ON
MECHANICAL PROPERTIES OF RX-03-BB

H. D. Johnson

DEVELOPMENT DIVISION

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Mason & Hanger-Silas Mason Co., Inc.
Parlax Plant
P. O. BOX 647
AMARILLO, TEXAS 79177
806-335-1581

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ABSTRACT

Compression and tensile properties of RX-03-BB, Blend 9 were measured at various test speeds. The results show that RX-03-BB mechanical properties are very insensitive to strain rate. Therefore, the tensile and compression test speeds will be increased to 0.008 mm/s and 0.021 mm/s, respectively, for RX-03-BB screening evaluation tests. This will significantly increase the testing rate for RX-03-BB.

DISCUSSION

The effect of test speeds on the mechanical properties of RX-03-BB, Blend 9 was investigated. Tensile (25.4 mm diameter by 127 mm long) and compression (20.3 mm diameter by 63.5 mm long) specimens were fabricated from one pressing (No. 83423Y4601). The finished pressing density was 1.899 Mg/m³. The tensile specimens were tested at 21 C at constant crosshead speeds of 0.002 mm/s and 0.008 mm/s. The average strain-at-rupture for both test speeds was 0.26% (see Table I and Fig. 1). The higher test speed (0.008 mm/s) increased the average rupture stress approximately 1 MPa and it also decreased the test time from 5 minutes to 1-1/2 minutes.

At present, compression tests are made at a constant crosshead speed of 0.001 mm/s. The number of compression tests performed in an eight-hour shift has been limited to 3 to 4 because of the long test time (see Table II). All compression specimens are tested to rupture.

The compression specimens were tested at 21 C at the following constant crosshead speeds:

Group 1	0.001 mm/s
Group 2	0.004 mm/s
Group 3	0.021 mm/s
Group 4	0.042 mm/s
Group 5	0.085 mm/s

The compression test results (see Table II and Fig. 2) show that the failure stress increases with an increase in the test speed. The increase in failure stress from Group 1 to Group 5 was 17.84 MPa to 22.25 MPa. The higher test speed did not have an appreciable effect on failure and rupture strain.

Fixturing for this set of experiments is different than the fixtures used in previous tests. Based on the recommendation of R. Bradey, W. F. Kirkwood and R. D. Breithaupt of LLL the standard compression cage was replaced with solid compression bars which are approximately 63.5 mm in diameter by 457.2 mm in length. Therefore, a direct comparison of these compression results with previous data is not possible.

RECOMMENDATIONS AND CONCLUSIONS

Tensile and compression test results show that RX-03-BB is very insensitive to strain rates. The compression test speed will, therefore, be increased from 0.001 mm/s to 0.021 mm/s and the tensile rate will be increased from 0.002 mm/s to 0.008 mm/s.

Table I. RX-03-BB, LLL B9 Tensile Test at 21 C
(Lot No. 5315-145-04, Pressing No. 83423Y4601, Density 1.899 Mg/m³)

Piece No.	Rupture ^a Mode	Rupture		
		Time (s)	Stress (MPa)	Strain (%)
Group No. 1 - Test Speed of 0.002 mm/s				
1	3	247	7.89	0.259
6	4	232	7.35	0.220
9	4	301	8.26	0.294
Mean		260	7.83	0.258
Std. Dev.		36	0.46	0.037

Group No. 2 - Test Speed of 0.008 mm/s				
2	4	73	8.83	0.250
5	4	75	8.39	0.222
7	6	79	9.28	0.311
Mean		76	8.83	0.261
Std. Dev.		3	0.45	0.046

^a1 and 7 are in the curved section, 2 and 6 are in the straight section outside the extensometers, 3 and 5 are at the knife edges and 4 is between the knife edges

Fig. 1. RX-03-BB, LLL B9 Tensile Tests at 21 C (Lot No. 5315-145-04, Pressing No. 83423Y4601, Density 1.899 Mg/m³)

Table II. RX-03-BB, LLL B9 Compression Tests at 21 C
(Lot No. 5315-145-04, Pressing No. 83423Y4601, Density 1.899 Mg/m³)

Piece No.	Failure			Rupture		Work To Rupture (MJ/m ³)
	Time (s)	Stress (MPa)	Strain (%)	Time (s)	Strain (%)	
Group No. 1 - Test Speed of 0.001 mm/s						
18	1449	17.93	1.88	3450	5.91	0.93
22	1380	17.93	1.77	3567	5.80	0.89
35	1413	17.68	1.51	4161	5.74	0.87
Mean	1414	17.85	1.72	3726	5.82	0.90
Std. Dev.	35	0.14	0.19	381	0.09	0.03
Group No. 2 - Test Speed of 0.004 mm/s						
15	294	19.86	1.65	793	5.82	1.01
25	277	19.80	1.29	713	4.98	0.84
28	294	20.05	1.99	749	6.41	1.14
30	281	19.14	1.76	781	5.21	0.97
Mean	287	19.71	1.67	759	5.61	0.99
Std. Dev.	9	0.40	0.29	36	0.64	0.12
Group No. 3 - Test Speed of 0.021 mm/s						
17	62	20.91	1.59	166	5.48	1.00
20	57	20.88	1.65	151	5.46	0.99
26	57	20.66	1.62	149	5.46	1.00
27	54	21.04	1.22	158	5.05	0.94
Mean	57	20.87	1.52	156	5.36	0.98
Std. Dev.	3	0.16	0.20	8	0.21	0.03
Group No. 4 - Test Speed of 0.042 mm/s						
19	30	21.65	1.60	77	5.53	1.05
21	30	21.43	1.87	82	6.45	1.20
23	28	21.62	1.77	80	6.00	1.13
Mean	29	21.57	1.75	80	5.99	1.12
Std. Dev.	1	0.12	0.14	2	0.46	0.07
Group No. 5- Test Speed of 0.085 mm/s						
12	14	22.06	1.66	45	5.51	1.06
29	14	22.31	1.37	43	5.31	1.03
33	15	22.42	1.22	45	5.20	1.03
34	15	22.20	1.78	42	6.21	1.20
Mean	14	22.25	1.51	44	5.56	1.08
Std. Dev.	1	0.15	0.26	2	0.45	0.08

Fig. 2. RX-03-BB, LLL B9 Compression Tests at Various Test Speeds at 21 C (Lot No. 5315-145-04, Pressing No. 83423Y4601, Density 1.899 Mg/m³)