Mechanical properties of DPX-6 before and after accelerated ageing at 71°C

Gunnar Ove Nevstad

FFI/RAPPORT-2006/03686

FORSVARETS FORSKNINGSINSTITUTT
Norwegian Defence Research Establishment
P O Box 25, NO-2027 Kjeller, Norway

FORSVARETS FORSKNINGSINSTITUTT (FFI)
Norwegian Defence Research Establishment

P O BOX 25
N0-2027 KJELLER, NORWAY

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (when data entered)

REPORT DOCUMENTATION PAGE

1) PUBL/REPORT NUMBER	2) SECURITY CLASSIFICATION	3) NUMBER OF PAGES
FFI/RAPPORT-2006/03686	UNCLASSIFIED	76
1a) PROJECT REFERENCE	**2a) DECLASSIFICATION/DOWNGRADING SCHEDULE**	
FFI-V/873/130	-	

4) TITLE

MECHANICAL PROPERTIES OF DPX-6 BEFORE AND AFTER ACCELERATED AGEING AT 71°C

5) NAMES OF AUTHOR(S) IN FULL (surname first)

NEVSTAD Gunnar Ove

6) DISTRIBUTION STATEMENT

Approved for public release. Distribution unlimited. (Offentlig tilgjengelig)

7) INDEXING TERMS

IN ENGLISH:	IN NORWEGIAN:
a) DPX-6	a) DPX-6
b) Accelerated Ageing	b) Akselerert aldring
c) Compressive Test	c) Kompresjonstest
d) Mechanical Properties	d) Mekaniske egenskaper
e)	e)

THESAURUS REFERENCE:

8) ABSTRACT

Uniaxial compression tests have been performed on cylindrical test items with L≈D of DPX-6 before and after ageing. Accelerated ageing was done at 71°C on test items wrapped in aluminium foil. Samples were taken out after 30, 60, 120 and 180 days of ageing and tested by uniaxial compression test at room temperature and – 50°C. For test items not aged and aged for 180 days, compression tests were also carry out at 60°C.

At room temperature the effect of ageing gives a moderate increase in max stress and strain at max stress, while the E-modulus is unchanged. At low temperature the max stress is unchanged or shows a slight reduction due to ageing. The strain at max stress shows an increase of 10% while the E-Modulus shows a similar reduction for the oldest test items.

Uniaxial compressive properties of DPX-6 at different test temperatures shown that max stress decrease from 44.0 MPa at -50°C to 8.8 MPa at 60°C, that strain at max stress goes from 5.72 % to 4.12 % and that E-modulus goes from 1405 MPa to 361.4 MPa when the test temperature goes from -50°C to 60°C.

The effect of accelerated ageing at 71°C for 180 days has moderate effect on the mechanical properties of DPX-6.

9) DATE	AUTHORIZED BY This page only	POSITION
2006-11-24	Jan Ivar Botnan	Director

P: ISBN
E: ISBN

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (when data entered)

CONTENTS

Mechanical properties of DPX-6 before and after accelerated ageing at 71°C

1 INTRODUCTION

M72 LAW (Light Antiarmour Weapon) has been redesigned with a new warhead for urban warfare. M72 ASM-RC (Anti-Structure Munition Reduced Caliber) has as the name indicates a new warhead for combat of light buildings. This requires a main charge explosive different from that used in shaped charge warheads. Selected explosive DPX-6 is an aluminized PBX which is press filled into the warhead. This composition has not been qualified, and to be used in weapons it has to be qualified according to STANAG 4170 (1) and accompanying AOP-7 (2). To qualify an explosive composition a large number of tests have to be carried out. Among these tests is accelerated ageing. For DPX-6 71°C was selected as ageing temperature and samples were decided to be taken out after 30, 60, 120 and finally 180 days of ageing. To characterize possible changes due to ageing it was decided to test aged pellets with regard to weight loss, density changes, shock sensitivity and mechanical properties. In this report we will report on uniaxial compressive properties for both aged and not aged pellets of DPX-6. The uniaxial compressive test has been performed according to STANAG 4443 (3).

2 EXPERIMENATALLY

2.1 Pressing

Dyno Nobel has produced all pellets tested in this report. The pellets have been pressed by a force of 2000 kp/cm^2 at room temperature by use of vacuum and with a dwell time of 60 seconds. In Appendix A the control report for the used composition is given.

2.2 Ageing Conditions

Aged pellets were wrapped up in aluminium foil before they were left for ageing at 71°C. In total 40 pellets were left for ageing. 7 pellets were taken out after 30, 60 and 120 days of ageing for characterization. 21 pellets were stored for 180 days.

2.3 Compression Mechanical Properties Testing

The compression testing was performed on a MTS, High Rate Test System on cylindrical charges with diameter 20.88±0.02 mm and height 21.3±0.1 mm. The compression rate was 50 mm/min.. Precondition time was 2 hours or more. The used test conditions were as described in STANAG 4443 (3). For the tests at room and higher temperatures a load cell of 5 kN was used. At low temperature a load cell of 25 kN was used. Appendix B gives test report sheets for every tested pellet with all necessary information about each pellet and conditions under which it was tested. In addition the test report sheet shows the stress-strain curve.

3 RESULTS

3.1 Not Aged pellets

Twelve pellets of DPX-6 were received for testing of the mechanical properties of virgin or not aged material. The measured dimensions and weights of these pellets are summarized in Table 3.1

Tested at (^{o}C)	Pellet No.	Height (mm)	Diameter (mm)	X-Sect. Area (cm^2)	Volume (cm^3)	Weight (g)	Density (g/cm^3)
	DPX-6-1	21.30	20.87	3.421	7.286	15.0105	2.060
	DPX-6-2	21.32	20.86	3.418	7.286	15.0059	2.059
	DPX-6-3	21.31	20.87	3.421	7.290	14.9797	2.055
14	DPX-6-4	21.30	20.88	3.424	7.293	15.0103	2.058
	DPX-6-5	21.30	20.86	3.418	7.279	15.0116	2.062
	DPX-6-6	21.28	20.87	3.421	7.280	14.9746	2.057
	DPX-6-7	21.37	20.86	3.418	7.303	15.0371	2.059
60	DPX-6-8	21.41	20.87	3.421	7.324	15.0450	2.054
	DPX-6-9	21.33	20.86	3.418	7.290	15.0130	2.059
	DPX-6-10	21.30	20.88	3.424	7.293	15.0052	2.057
-52	DPX-6-11	21.34	20.88	3.424	7.307	15.0200	2.056
	DPX-6-12	21.31	20.88	3.424	7.297	15.0076	2.057
		Average					**2.058**

Table 3.1 Properties of not aged pellets used for testing of compressive properties.

3.1.1 Room Temperature

Six pellets were tested at room temperature (14^{o}C), but only for 4 we got satisfactory results. The obtained results for these four pellets are given in Appendix B.1.1 in form of a report sheet for each pellet. In addition the results are summarized in Table 3.2, and Figure 3.1 shows the stress-strain curves for all tested pellets.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-2	10.373	4.18	431.43
DPX-6-4	10.096	4.01	440.98
DPX-6-5	10.337	3.72	442.77
DPX-6-6	9.977	4.15	446.58
Average	**10.20±0.20**	**4.02±0.21**	**440.4±6.4**

Table 3.2 Mechanical properties of DPX-6 obtained by compression testing of pellets at room temperature.

Figure 3.1 and Table 3.2 show that there are moderate variations in the obtained compressive properties. For pellet No 5 a slightly lower strain at max stress has been obtained. However for the max stress and E-modulus there are no significant difference for pellet No 5 compared with the properties obtained for the 3 other.

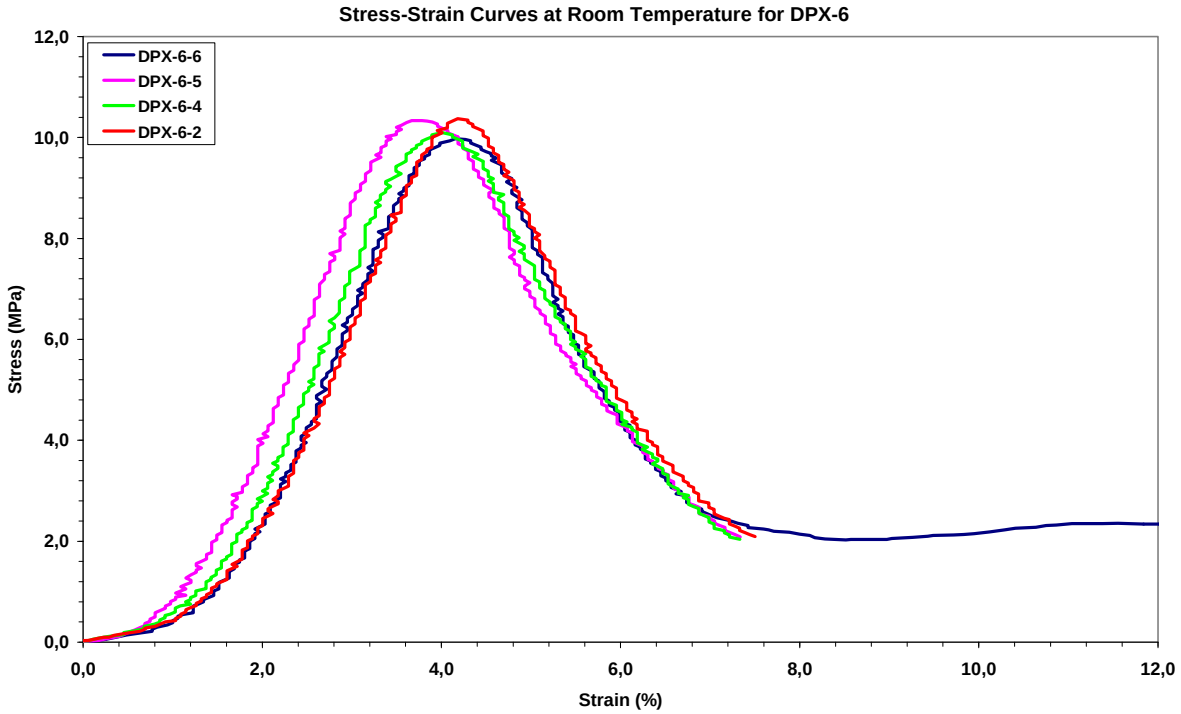


Figure 3.1 Stress-strain curves for DPX-6 at room temperature.

3.1.2 60°C

At 60°C we did select to test 3 pellets (7 to 9). The obtained results for each pellet is given in

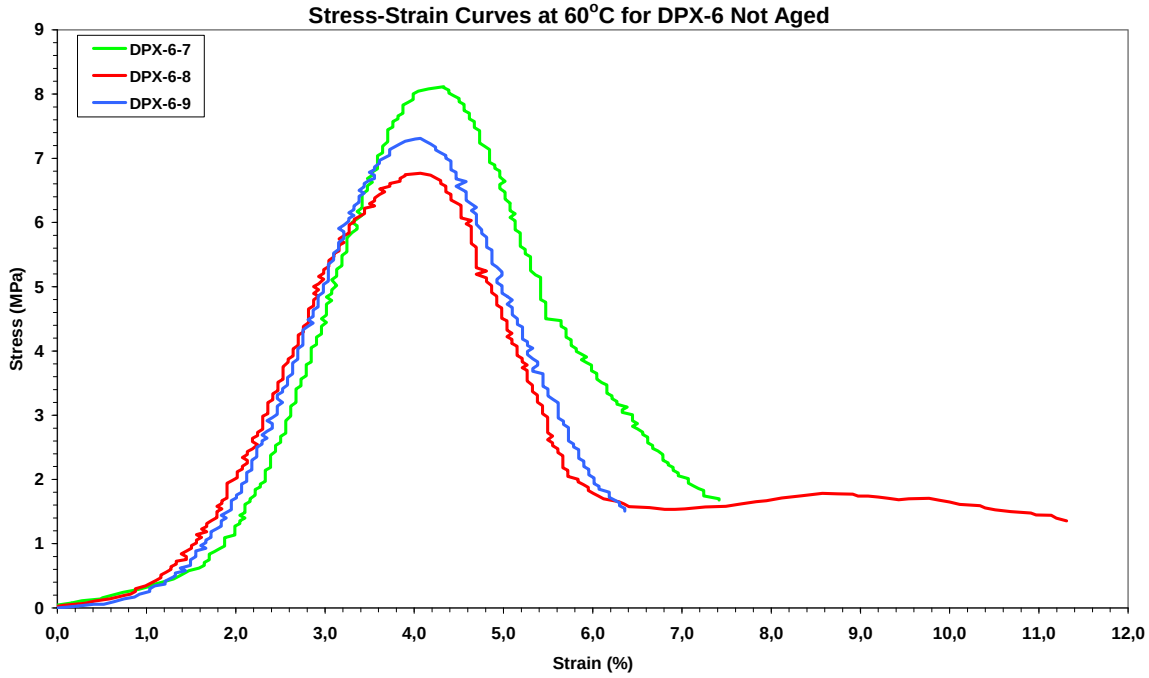


Figure 3.2 Stress-strain curves for DPX-6 at 60°C.

Appendix B.1.2. Figure 3.2 gives all stress-strain curves, and Table 3.3 gives the properties for each pellet in addition to the average results. From Figure 3.2 one can see that the curves have more or less the same form but the max stresses are different. Compared with the results at room temperature the max stress has decreased significantly from an average of 10.20 MPa at room temperature to 7.40 MPa at 60°C. Since the strain at max stress does not change

significantly the change in max stress gives a significant lower E-modulus at 60°C that at room temperature.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-7	8.115	4.33	395.99
DPX-6-8	6.766	4.07	344.42
DPX-6-9	7.308	4.07	337.14
Average	**7.40±0.68**	**4.16±0.15**	**359.2±32.1**

Table 3.3 Mechanical properties of DPX-6 at 60°C.

3.1.3 Low Temperature

Three pellets (No 10 to 12) were saved for testing at low temperature (-52°C). We had to change the load cell as the force was to low to break the pellet. Pellet No 10 was therefore pressed twice, first with 5 kN load cell then by use of the 25 kN load cell, and this explains the lower max stress. However, for the two other pellets we obtained very similar stress-strain curves as shown in Figure 3.3. Appendix B.1.3 gives the report sheet of each tested pellet. Compared with the results obtained at room temperature and 60°C the max stress increased

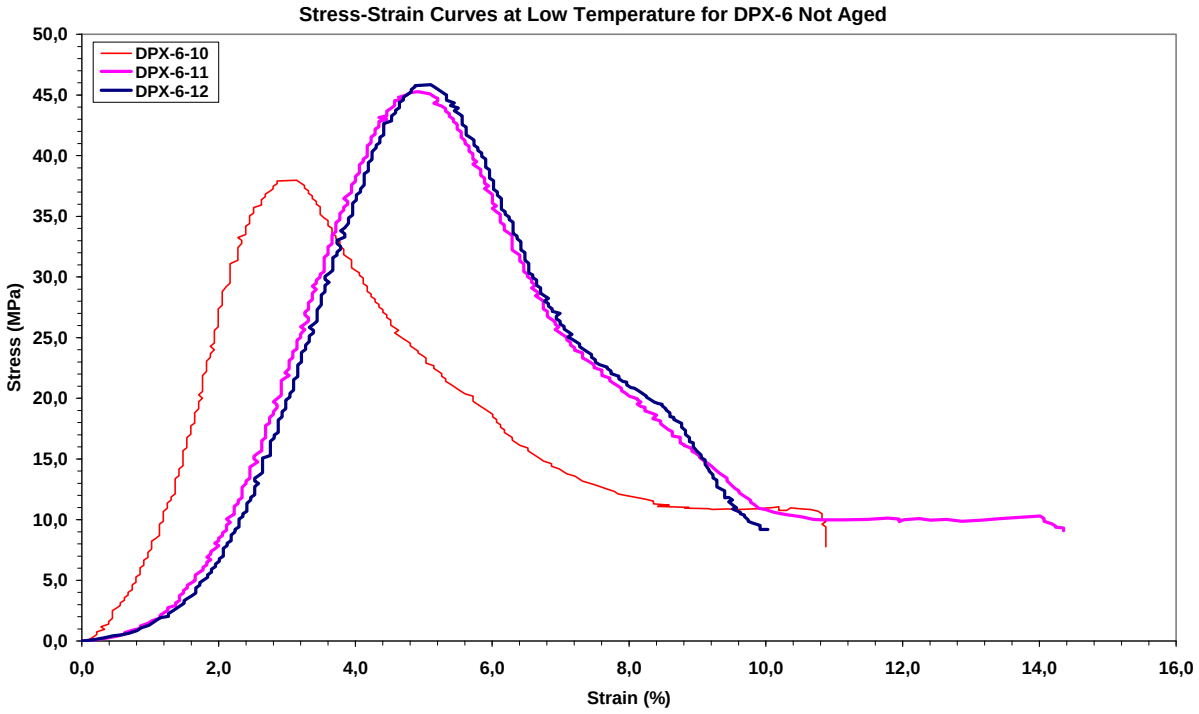


Figure 3.3 Stress-strain curves for DPX-6 at -52°C.

significantly at – 52°C. The same results are obtained for both compression at max stress and the E-modulus.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-10	38.00	3.14	2102.2
DPX-6-11	45.276	4.92	1622.8
DPX-6-12	45.846	5.10	1613.8
Average (11-12)	**45.56±0.40**	**5.01±0.13**	**1618.3±6.4**

Table 3.4 Mechanical properties at low temperature for not aged DPX-6 pellets.

3.2 Pellets Aged for 30 days

3.2.1 Room Temperature

Seven pellets that had been aged for 30 days at 71°C were received for compression testing. The measured dimensions and calculated densities of all pellets are given in Table 3.5.

Tested at (°C)	Pellet No.	Height (mm)	Diameter (mm)	X-Sect. Area (cm^2)	Volume (cm^3)	Weight (g)	Density (g/cm^3)
14	DPX-6-1	21.37	20.89	3.427	7.324	15.0311	2.052
	DPX-6-2	21.35	20.88	3.424	7.311	15.0353	2.057
	DPX-6-3	21.26	20.89	3.427	7.287	14.9866	2.057
	DPX-6-4	21.31	20.88	3.424	7.297	14.9914	2.055
-50	DPX-6-5	21.36	20.89	3.427	7.321	15.0260	2.052
	DPX-6-6	21.36	20.88	3.424	7.314	15.0349	2.056
	DPX-6-7	21.40	20.88	3.424	7.328	15.0655	2.056
	Average						**2.055**

Table 3.5 Properties of DPX-6 pellets aged for 30 days at 71°C.

Pellets No 1 to 4 were selected for testing at room temperature. Appendix B.2.1 gives the obtained results for each tested pellet. Figure 3.4 gives all stress-strain curves and Table 3.6 summarizes the numerical results in addition to the average results. For this test series the variation in properties are very small as indicated by the standard deviation given in Table 3.6.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-1	10.094	4.40	399.31
DPX-6-2	10.146	4.47	406.06
DPX-6-3	10.193	4.26	406.35
DPX-6-4	10.210	4.30	406.37
Average	**10.16±0.05**	**4.36±0.10**	**404.5±3.5**

Table 3.6 Mechanical properties of DPX-6 pellets tested at room temperature.

Compared with the results obtained for not aged pellets of DPX-6 the differences are moderate. A slight increase in average compressibility that gives a lower E-modulus is observed. For the max stress there is no change due to ageing.

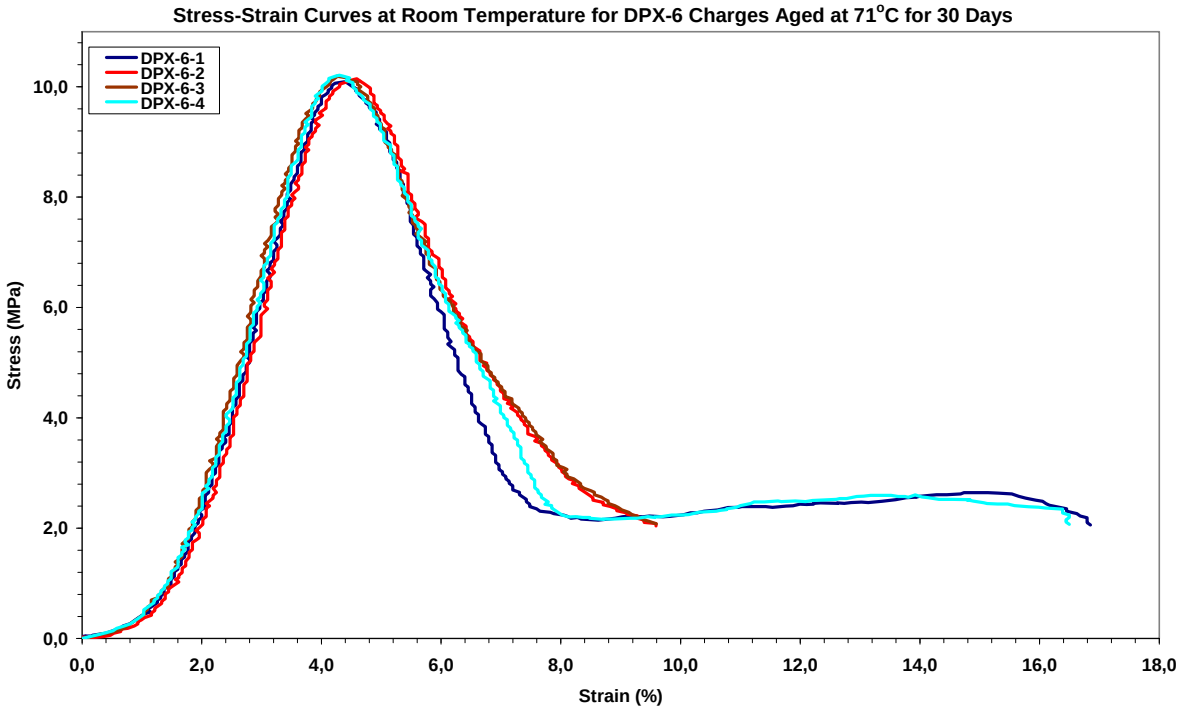


Figure 3.4 Stress-strain curves at room temperature for DPX-6 pellets aged for 30 days.

3.2.2 Low Temperature

The last three pellets that had been aged for 30 days were tested at low temperature (-50°C). Appendix B.2.2 gives the obtained results for each tested pellet. Figure 3.5 gives all stress-strain curves and Table 3.7 summarizes the numerical results in addition to the average results. For this test series the variation in properties are larger for max stress and E-modulus than at room temperature. Compared with the results of not aged samples 30 days of ageing have resulted in a moderate increase in strain at max stress. The change in compression has effect on the E-modulus that is reduced.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-5	44.449	5.14	1400.1
DPX-6-6	42.459	5.29	1299.6
DPX-6-7	45.097	5.08	1484.6
Average	**44.00±1.37**	**5.17±0.11**	**1394.8±92.6**

Table 3.7 Mechanical properties of tested of DPX-6 pellets tested at low temperature.

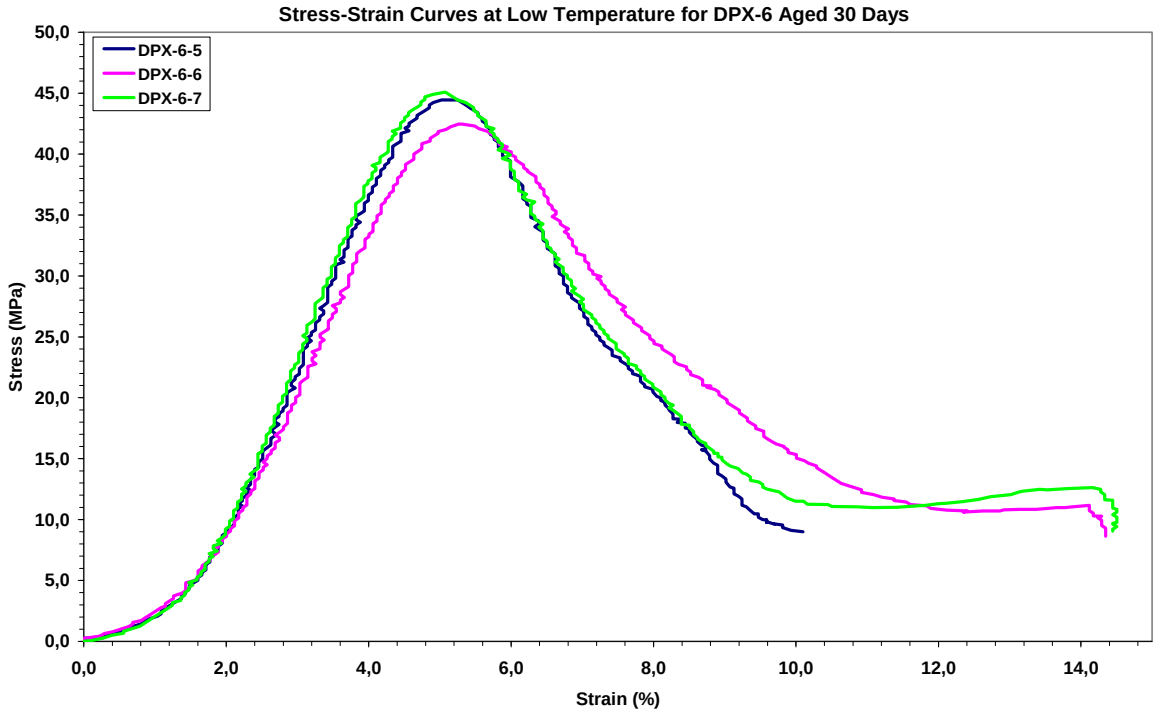


Figure 3.5 Stress-strain curves at low temperature of DPX-6 pellets aged for 30 days.

3.3 Pellets Aged for 60 Days

3.3.1 Room Temperature

Seven pellets aged for 60 days at 71°C were received for testing in uniaxial compression test. The dimensions of all pellets are given in Table 3.8.

Tested at (°C)	Pellet No.	Height (mm)	Diameter (mm)	X-Sect. Area (cm^2)	Volume (cm^3)	Weight (g)	Density (g/cm^3)
14	DPX-6-8	21.32	20.88	3.424	7.300	15.0106	2.056
	DPX-6-9	21.33	20.88	3.424	7.304	15.0180	2.056
	DPX-6-10	21.36	20.88	3.424	7.314	15.0336	2.055
	DPX-6-11	21.40	20.87	3.421	7.321	15.0632	2.058
-50	DPX-6-12	21.29	20.88	3.424	7.290	14.9926	2.057
	DPX-6-13	21.27	20.88	3.424	7.283	14.9994	2.059
	DPX-6-14	21.30	20.87	3.421	7.286	15.0107	2.060
		Average					**2.057**

Table 3.8 Properties of pellets aged for 60 days.

Pellet No 8 to 11 were selected for testing at room temperature. Appendix B.3.1 gives the obtained results for each tested pellet. Figure 3.6 gives all stress-strain curves and Table 3.9 summarizes the numerical results in addition to the average results. For this test series the variation in properties are larger than for 30 days of ageing as indicated by the standard deviations. Pairs of pellets have approximately the same max stress and E-modulus. For both max stress and compression a slight increase is observed, while for the E-modulus a slight

decrease is observed. However the differences in properties between pellets aged for 30 and 60 days are within the standard deviations.

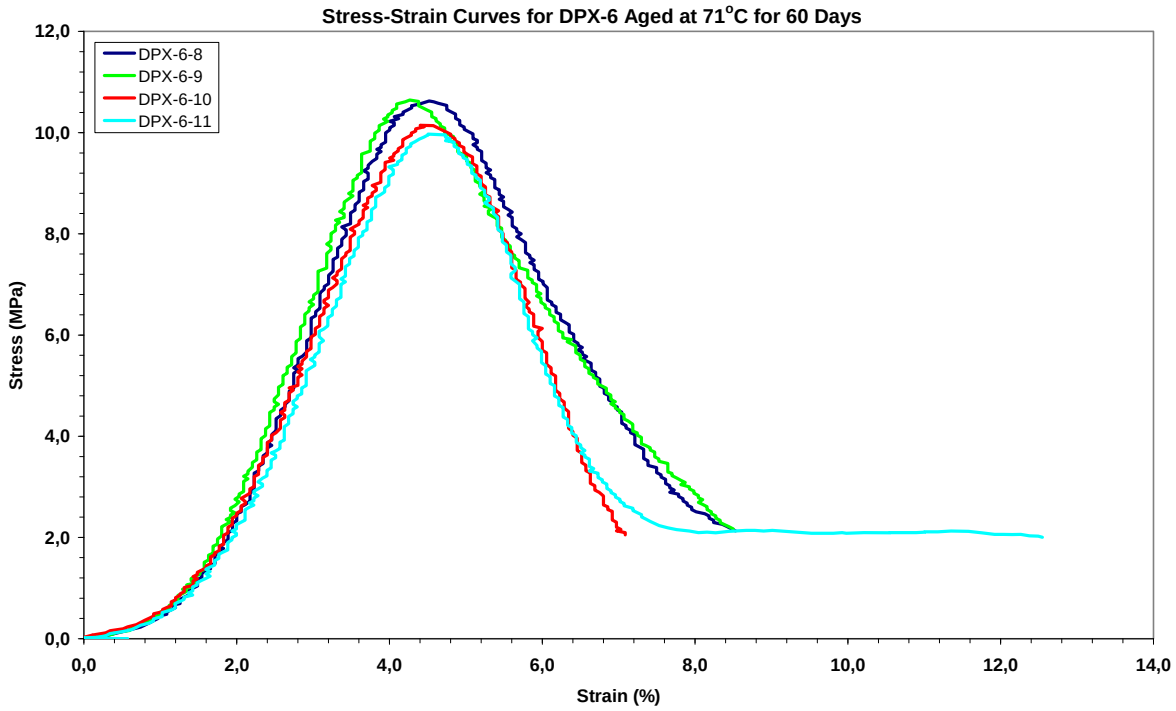


Figure 3.6 Stress-strain curves at room temperature for DPX-6 after ageing at 71°C for 60 days.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-8	10.624	4.52	410.59
DPX-6-9	10.645	4.27	414.61
DPX-6-10	10.146	4.40	367.67
DPX-6-11	9.984	4.50	372.39
Average	**10.35±0.34**	**4.42±0.11**	**391.4±24.7**

Table 3.9 Mechanical properties at room temperature for DPX-6 pellets after being aged for 60 days.

3.3.2 Low Temperature

The last three pellets (12-14) aged for 60 days were tested at low temperature (-50°C). Appendix B.3.2 gives the report sheets for each pellet. Figure 3.7 gives all the stress-strain curves, while Table 3.10 summarizes the obtained results. From Figure 3.7 it can be seen that all three pellets have very similar stress-strain curves with respect to both form and size. Compared with the results for pellets aged 30 days we observe a reduction in max stress and E-modulus and a slight increase in compressibility.

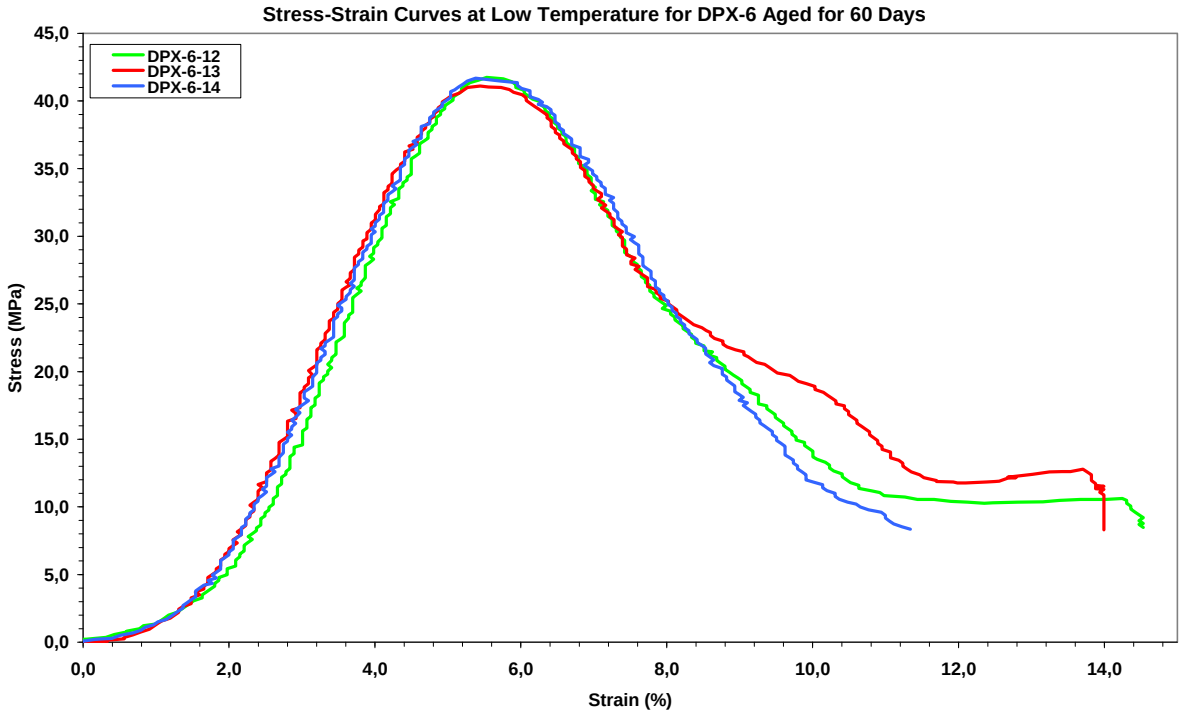


Figure 3.7 Stress-strain curves at low temperature for DPX-6 pellets being aged for 60 days.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-12	41.746	5.53	1305.6
DPX-6-13	41.104	5.44	1276.4
DPX-6-14	41.679	5.38	1270.3
Average	**41.51±0.35**	**5.45±0.08**	**1284.1±18.9**

Table 3.10 Mechanical properties at low temperature for DPX-6 pellets after being aged for 60 days.

3.4 Pellets Aged for 120 Days

3.4.1 Room Temperature

As for pellets aged for 30 and 60 days we did receive 7 pellets that had been aged for 120 days. The dimensions and weight for all pellets are given in Table 3.11. In addition the table gives calculated X-section area, pellet volume and density. The variation in density for the pellets is very small and is not different from virgin pellets or pellets aged for 30 and 60 days. The observed difference is within the measurement accuracy.

Tested at (°C)	Pellet No.	Height (mm)	Diameter (mm)	X-Sect. Area (cm^2)	Volume (cm^3)	Weight (g)	Density (g/cm^3)
14	DPX-6-15	21.31	20.88	3.424	7.297	15.0336	2.060
	DPX-6-16	21.26	20.88	3.424	7.280	14.9934	2.060
	DPX-6-17	21.27	20.87	3.421	7.276	14.9855	2.060
	DPX-6-18	21.34	20.88	3.424	7.307	15.0343	2.057
-50	DPX-6-19	21.31	20.88	3.424	7.297	15.0110	2.057
	DPX-6-20	21.28	20.88	3.424	7.287	14.9857	2.057
	DPX-6-21	21.29	20.87	3.421	7.283	15.0058	2.060
		Average					**2.059**

Table 3.11 Properties of pellets aged for 120 days.

Four pellets were selected for testing at room temperature, pellets No 15 to 18. In Appendix B.4.1 is given all test report sheets for each tested pellet. Figure 3.8 shows all stress-strain curves and Table 3.12 summarizing the obtained results in addition to the average values.

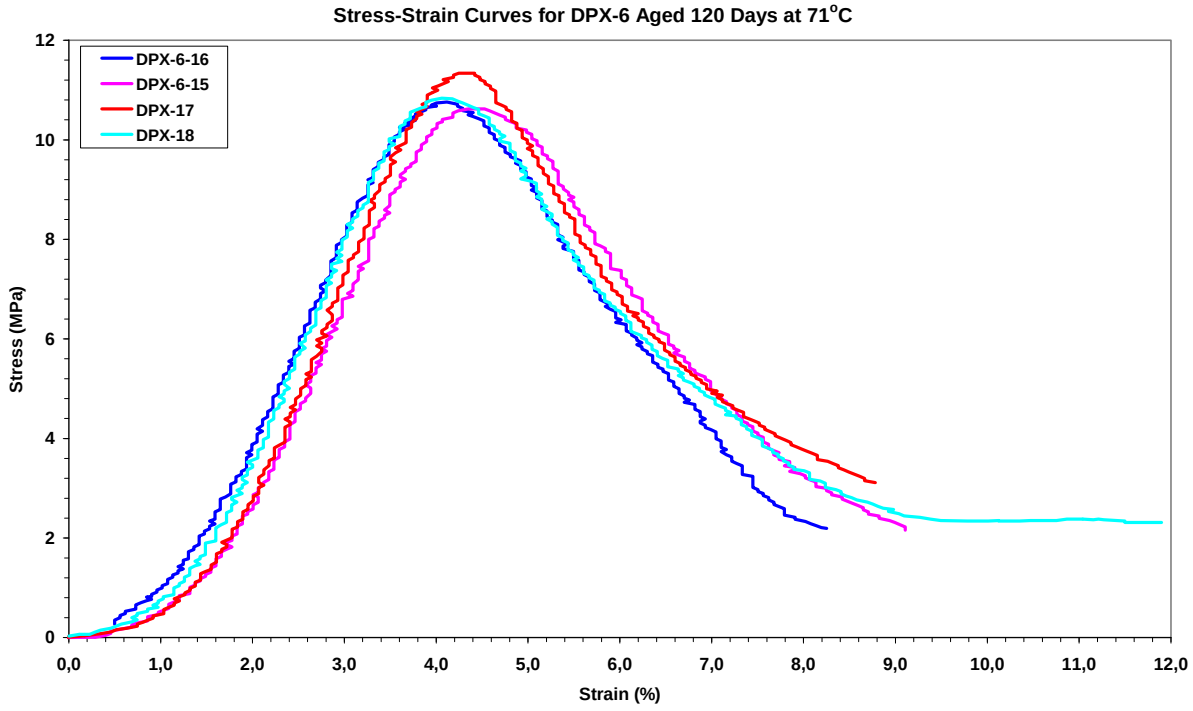


Figure 3.8 Stress-strain curves at room temperature for DPX-6 pellets being aged for 120 days.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-15	10.640	4.44	417.42
DPX-6-16	10.759	4.12	418.83
DPX-6-17	11.340	4.33	445.83
DPX-6-18	10.838	4.08	428.67
Average	**10.89±0.31**	**4.24±0.17**	**427.7±13.1**

Table 3.12 Compressive mechanical properties of DPX-6 pellets aged for 120 days at 71°C and tested at room temperature.

From the results in Table 3.12 it can be seen that although there are some variation the standard deviations are moderate both for max stress and E-modulus. For the compressibility

the standard deviation is slightly higher than the results obtained for pellets aged for 30 and 60 days, while the absolute value of 4.24% is between the obtained results for 30 and 60 days. Both the average max stress and E-modulus are slightly higher than after both 60 and 30 days ageing. Compared with not aged pellets pellets aged for 120 days have a higher E-modulus and a lower max stress.

3.4.2 Low Temperature

The last three pellets (19-21) aged for 120 days were used for testing at low temperature (-50°C). Appendix B.4.2 gives test report sheets for each pellets, while Figure 3.9 gives all stress-strain curves. Table 3.13 summaries obtained results in addition to give the averages properties.

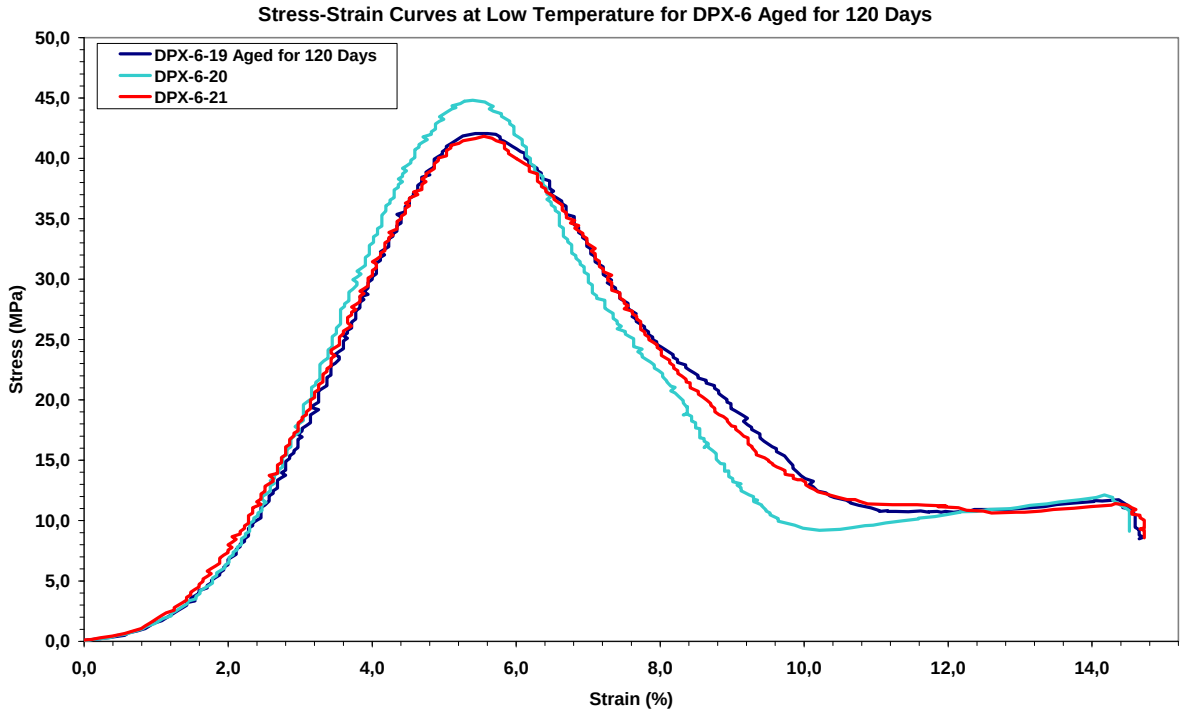


Figure 3.9 Stress-strain curves at low temperature for DPX-6 being aged for 120 days at 71°C.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-19	42.067	5.52	1308.4
DPX-6-20	44.812	5.40	1439.9
DPX-6-21	41.822	5.55	1207.0
Average	**42.90±1.66**	**5.49±0.08**	**1318.4±116.8**

Table 3.13 Compressive mechanical properties of DPX-6 pellets aged for 120 days at 71°C and tested at low temperature.

From both Figure 3.9 and Table 3.13 it can be seen that the strain at max stress do not vary very much between the pellets. For the max stress we observe that one pellet has a higher strength than the other two. For the E-modulus we have obtained three different values with an average result not significantly different from what we got for pellets aged for 60 days.

3.5 Pellets Aged for 180 Days

19 pellets that had been aged at 71°C for 180 days were received for testing of mechanical properties by compression test. Before testing all pellets were weighted and measured dimensions of. Table 3.14 gives all measured properties in addition to calculated density for each pellet. We decided to test the mechanical properties at four different temperatures, and did test four pellets at each temperature.

Tested at (°C)	Pellet No.	Height (mm)	Diameter (mm)	X-Sect. Area (cm^2)	Volume (cm^3)	Weight (g)	Density (g/cm^3)
14	DPX-6-22	21.32	20.88	3.424	7.300	15.0128	2.056
	DPX-6-23	21.32	20.87	3.421	7.293	15.0124	2.058
	DPX-6-24	21.31	20.88	3.424	7.297	15.0160	2.058
	DPX-6-25	21.32	20.88	3.424	7.300	15.0057	2.056
40	DPX-6-26	21.29	20.88	3.424	7.290	14.9838	2.055
	DPX-6-27	21.32	20.88	3.424	7.300	15.0098	2.056
	DPX-6-28	21.30	20.88	3.424	7.293	14.9887	2.055
	DPX-6-29	21.26	20.88	3.424	7.280	14.9847	2.058
60	DPX-6-30	21.33	20.88	3.424	7.304	15.0196	2.056
	DPX-6-31	21.30	20.87	3.421	7.286	14.9887	2.057
	DPX-6-32	21.27	20.88	3.424	7.283	14.9841	2.057
	DPX-6-33	21.36	20.88	3.424	7.314	15.0372	2.056
-50	DPX-6-34	21.36	20.88	3.424	7.314	15.0394	2.056
	DPX-6-35	21.33	20.87	3.421	7.297	15.0108	2.057
	DPX-6-36	21.35	20.89	3.427	7.318	15.0333	2.054
	DPX-6-37	21.34	20.88	3.424	7.307	15.0306	2.057
	DPX-6-38	21.33	20.89	3.427	7.311	15.0084	2.053
	DPX-6-39	21.35	20.88	3.424	7.311	15.0196	2.055
	DPX-6-40	21.32	20.88	3.424	7.300	15.0148	2.057
	Average						**2.057**

Table 3.14 Properties of pellets aged at 71°C for 180 days.

3.5.1 Room Temperature

Four pellets were selected for testing at room temperature, pellet No 22 to 25. In Appendix B.5.1 all test report sheets are given for each tested pellet. Figure 3.10 shows all stress-strain curves, and Table 3.15 summarizing obtained results in addition to the average results. As shown by Figure 3.10 and the standard deviation for the obtained results in Table 3.15 there are only small variations in the results for all four tested pellets at room temperature. All properties have increased values compared to the results for not aged or shorter aged pellets. The largest increase is obtained for max stress which has increased by 10% or more.

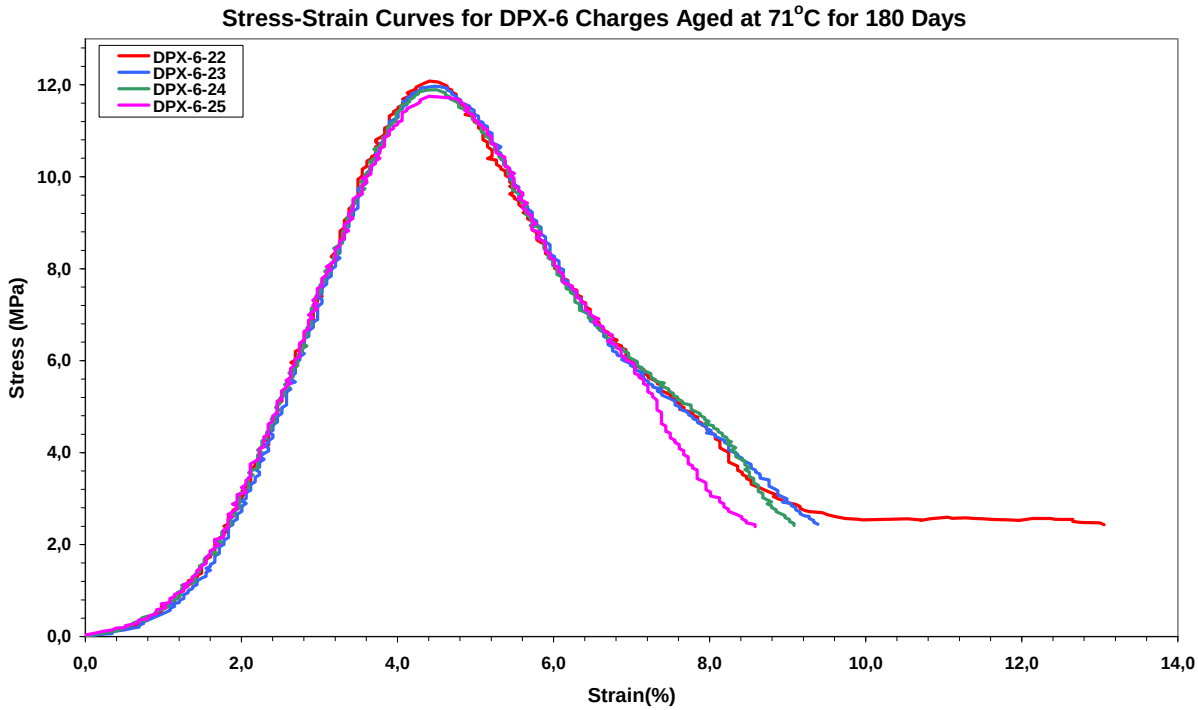


Figure 3.10 Stress-strain curves at room temperature for DPX-6 pellets being aged for 180 days.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-22	12.078	4.41	455.13
DPX-6-23	11.968	4.47	445.87
DPX-6-24	11.893	4.50	446.37
DPX-6-25	11.750	4.75	436.66
Average	**11.92±0.14**	**4.53±0.15**	**443.0±7.5**

Table 3.15 Compressive mechanical properties of tested pellets of DPX-6.

3.5.2 40°C

Four pellets were selected for testing at 40°C, pellets No 26 to 29. Appendix B.5.2 gives test report sheets for each tested pellet. Figure 3.11 shows all stress-strain curves and Table 3.16 summarizes obtained results in addition to the average results. As shown by Figure 3.11 and the standard deviations in Table 3.16 there are larger variations in the results for the four tested pellets at 40°C than at room temperature. For pellet 28 there was some trouble with the registration of the stress-strain curve. However, since results for the max stress and strain at max stress seem to be ok we have decided to include the results for this pellet in the average results. All average properties have decreased values compared to the properties obtained at room temperature. Largest decreases are observed for the max stress and E-modulus which have decreased by more than 10%.

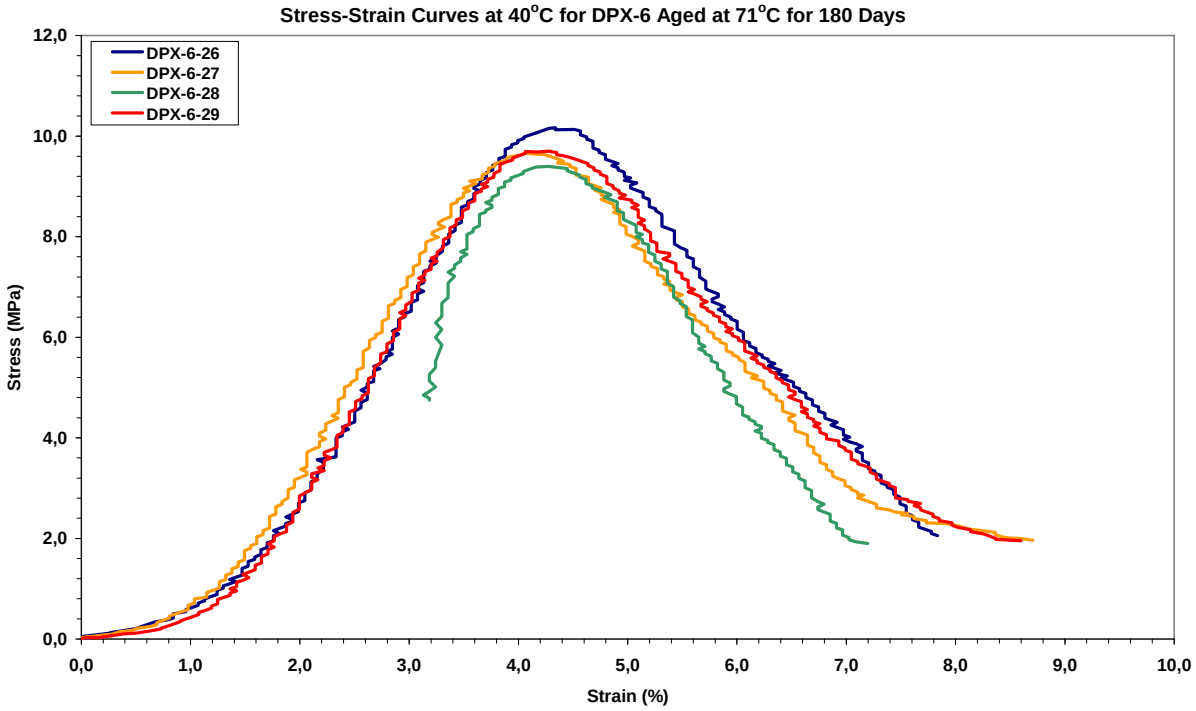


Figure 3.11 Stress-strain curves at 40°C of DPX-6 pellets being aged for 180 days at 71°C.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-26	10.167	4.34	396.43
DPX-6-27	9.661	4.07	374.92
DPX-6-28	9.397	4.27	
DPX-6-29	9.704	4.29	385.65
Average	**9.73±0.32**	**4.24±0.12**	**385.7±10.8**

Table 3.16 Compressive mechanical properties of tested pellets of DPX-6 at 40°C.

3.5.3 60°C

Four pellets were selected for testing at 60°C, pellets No 30 to 33. Appendix B.5.3 gives report sheets for each tested pellet. Figure 3.12 shows all stress-strain curves and Table 3.17 summarizes obtained results in addition to the average results. As shown by Figure 3.12 and the standard deviations in Table 3.17, there are moderate variations in the results for the four tested pellets at 60°C. For all properties decreased values have been obtained compared to what was obtained at both room temperature and 40°C. Largest decrease is observed for the max stress which has decreased by approximately 10%.

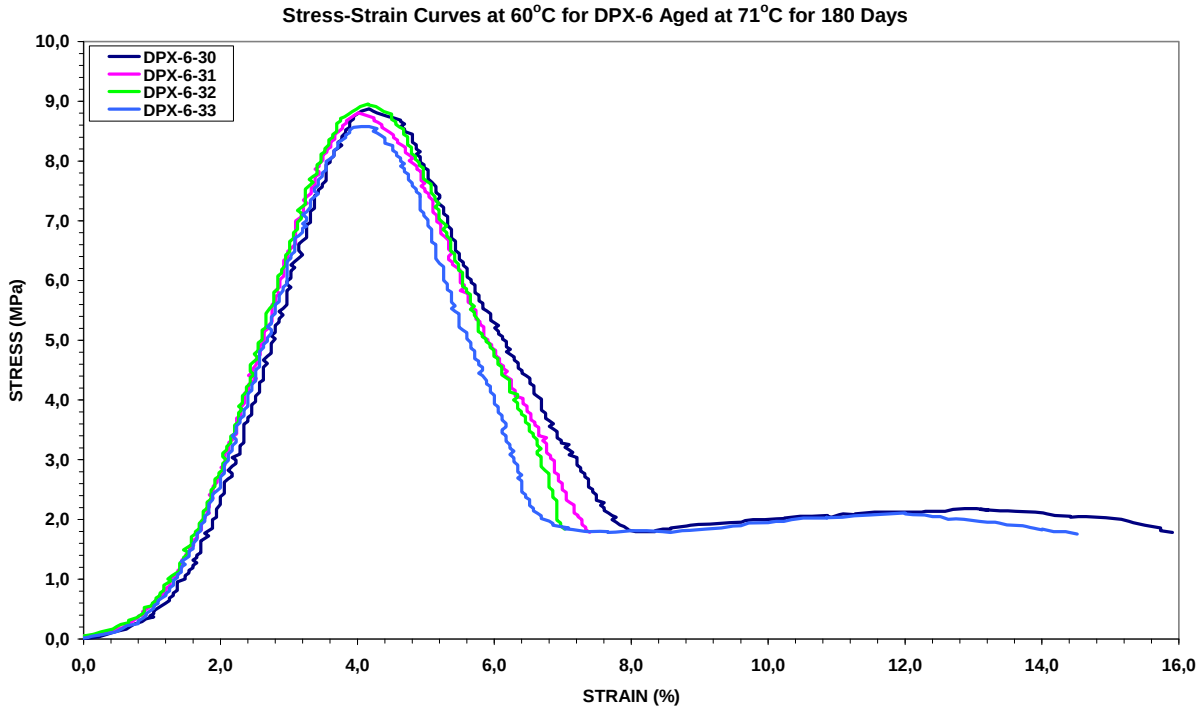


Figure 3.12 Stress-strain curves at 60°C for DPX-6 pellets being aged for 180 days at 71°C.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-30	8.877	4.17	370.19
DPX-6-31	8.807	4.01	371.46
DPX-6-32	8.955	4.16	359.43
DPX-6-33	8.577	4.12	344.66
Average	**8.80±0.16**	**4.12±0.07**	**361.4±12.4**

Table 3.17 Compressive mechanical properties of tested pellets of DPX-6.

3.5.4 Low Temperature

Of the remaining seven pellets four were selected for testing at low temperature, pellets No 34 to 37. Appendix B.5.4 gives test report sheets for each tested pellet. Figure 3.13 shows all stress-strain curves and Table 3.18 summarizes obtained results in addition to the average results. As shown by Figure 3.13 and Table 3.18 the variation in the properties for the four tested pellets are small except at max stress for pellet No 36, which is significantly higher than for the three other pellets. However, the stress-strain curve is similar in form and size to the three other curves. Therefore max stress and E-modulus for pellet No 36 are not significantly different compared with the properties of the other pellets. All average properties of DPX-6 at – 50°C have significantly higher values compared to the properties of DPX-6 at room or higher temperatures.

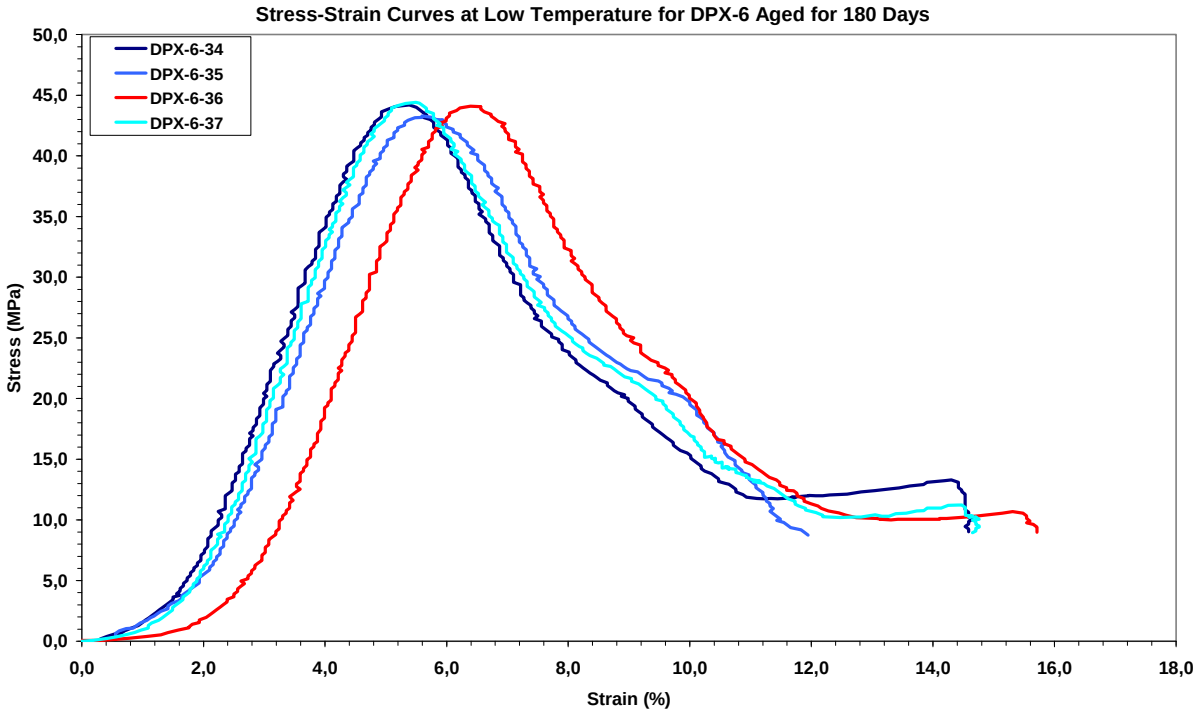


Figure 3.13 Stress-strain curves at -50°C of DPX-6 pellets being aged for 180 days at 71°C.

Pellet No	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
DPX-6-34	44.206	5.39	1435
DPX-6-35	43.356	5.59	1392.1
DPX-6-36	44.092	6.39	1352.2
DPX-6-37	44.420	5.50	1440.8
Average	**44.02±0.46**	**5.72±0.46**	**1405.0±41.4**
Average (All-36)		**5.49±0.10**	

Table 3.18 Compressive mechanical properties of tested pellets of DPX-6 at low temperature

3.6 Comparison of compression properties

3.6.1 Low Temperature

At low temperature pellets of all ages have been tested. The results are summarized in Table 3.19, and a plot of the same results is given in Figure 3.14. From the results it seems to be a trend that the compressibility increases slightly with age, from 5 to 5.5% after 180 days. For both max stress and E-modulus there are variations in the properties with a minimum after 60 days.

Age	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
Not Aged	45.56±0.40	5.01±0.13	1618.3±6.4
30 Days	44.00±1.37	5.17±0.11	1394.8±92.6
60 Days	41.51±0.35	5.45±0.08	1284.1±18.9
120 Days	42.90±1.66	5.49±0.08	1318.4±116.8
180 Days	44.02±0.46	5.72±0.46	1405.0±41.4
Average (All-36)		5.49±0.10	

Table 3.19 Average compressive properties at low temperature of DPX-6 after different time of ageing.

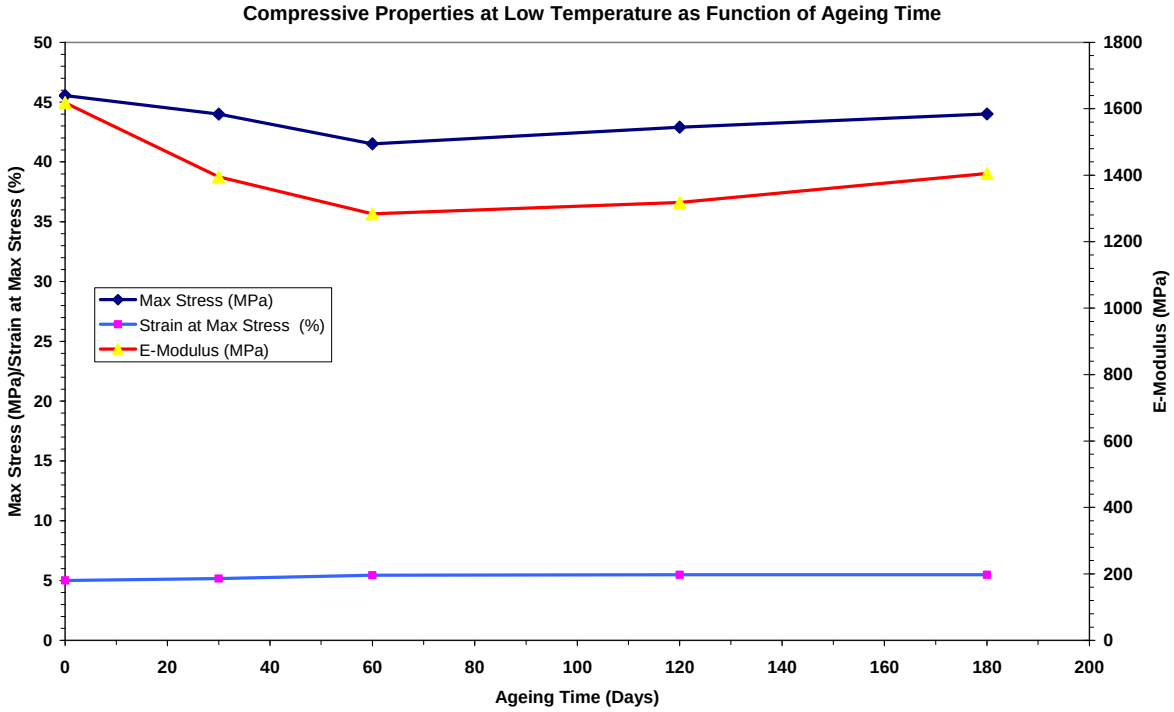


Figure 3.14 Plot of compressive properties of DPX-6 at low temperature as function of ageing time.

3.6.2 Room Temperature

Table 3.20 gives average measured compressive mechanical properties at room temperature (14°C) for pellets aged from 0 to180 days. Figure 3.15 shows a plot of the same properties as function of ageing time. For the max stress an increase is obtained for pellets aged 120 and 180 days. For pellets aged for 30 and 60 days the change is within the standard deviation of the results. For the strain at max stress the change has also the same trend. Strain at max stress is higher for aged pellets than for not aged and highest for the pellets being aged for 180 days. For the E-modulus the picture is more complex.

Age	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
Not Aged	10.20±0.20	4.02±0.21	440.4±6.4
30 Days	10.16±0.05	4.36±0.10	404.5±3.5
60 Days	10.35±0.34	4.42±0.11	391.4±24.7
120 Days	10.89±0.31	4.24±0.17	427.7±13.1
180 Days	11.92±0.14	4.53±0.15	443.0±7.5

Table 3.20 Average compressive properties for DPX-6 pellets at room temperature at different time of ageing.

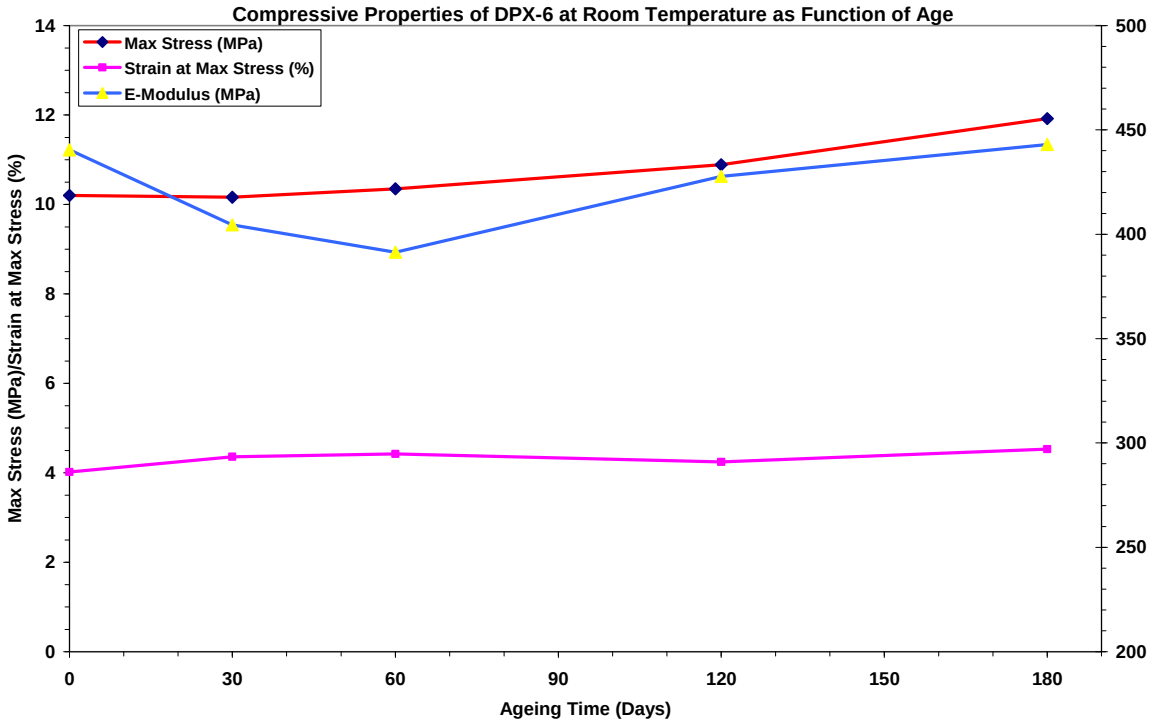


Figure 3.15 Compressive properties at room temperature for DPX-6 as function of age.

3.6.3 40°C

Compressive properties at 40°C are given in Table 3.21.

Age	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
180 Days	9.73±0.32	4.24±0.12	385.7±10.8

Table 3.21 Average compressive mechanical properties of DPX-6 at 40°C for pellets aged for 180 days at 71°C.

3.6.4 60°C

Compressive mechanical properties at 60°C are given in Table 3.22. Comparing compressive mechanical properties of aged pellets with not aged pellets of DPX-6 at 60°C shows that significant differences are found only for max stress. Strain at max stress and the E-modulus after ageing are unchanged.

Age	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
Not Aged	7.40±0.68	4.16±0.15	359.2±32.1
180 Days	8.80±0.16	4.12±0.07	361.4±12.4

Table 3.22 Average compressive mechanical properties of DPX-6 at 60°C for not aged pellets and pellets aged for 180 days at 71°C.

3.6.5 Different Temperatures

In Table 3.23 average properties at different temperatures for DPX-6 pellets aged for 180 days at 71°C have been summarized. These properties have also been plotted in Figure 3.16. Both from the data in Table 3.23 and Figure 3.16 it can be seen that all properties (max Stress, strain at max stress and E-modulus) decrease as the test temperature increase.

Test Temperature (°C)	Max Stress (MPa)	Strain at Max Stress (%)	E-Modulus (MPa)
-50	44.02±0.46	5.72±0.46 5.49±0.10	1405.0±41.4
14	11.92±0.14	4.53±0.15	443.0±7.5
40	9.73±0.32	4.24±0.12	385.7±10.8
60	8.80±0.16	4.12±0.07	361.4±12.4

Table 3.23 Average compressive properties of DPX-6 at different temperatures after been aged for 180 days at 71°C.

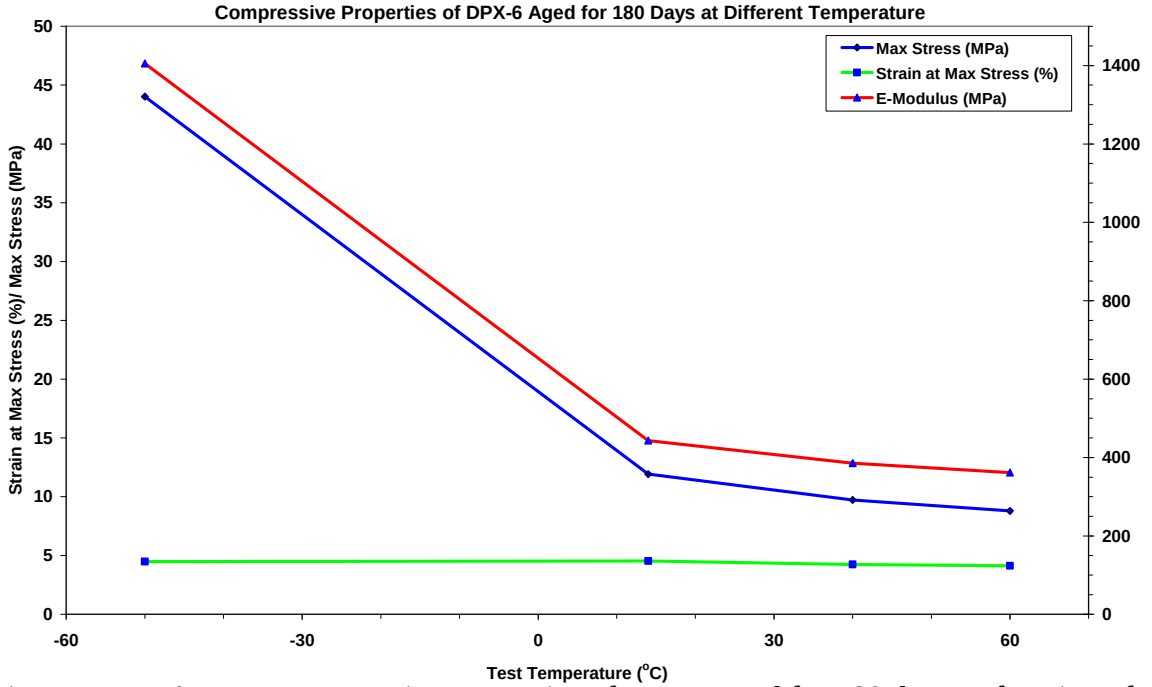


Figure 3.16 Average compressive properties of DPX-6 aged for 180 days as function of test temperature.

4 SUMMARY

At room temperature the effect of ageing gives a moderate increase in max stress and strain at max stress, while the E-modulus is unchanged. Max stress increase from 10.2 MPa for not

aged pellets to 11.92 MPa for pellets aged for 180 days. The strain at max stress increases from 4.02 to 4.53% for the 180 days aged pellets.

At low temperature the max stress is unchanged or has a slight reduction due to ageing. The strain at max stress shows an increase of 10%, while the E-Modulus shows a similar reduction for the oldest test items.

Uniaxial compressive properties of DPX-6 at different test temperature show that max stress decreases from 44.0 MPa at -50^{o}C to 8.8 MPa at 60^{o}C, that strain at max stress goes from 5.72 % to 4.12 % and that E-modulus goes from 1405 MPa to 361.4 MPa when the test temperature goes from -50^{o}C to 60^{o}C.

The effect of accelerated ageing at 71^{o}C for 180 days has moderate effect on the mechanical properties of DPX-6.

APPENDIX

A CONTROL REPORT

DYNO
High Energy Materials

Kontrollrapport
etter EN 10204 – 2.3

Kjøper / Mottaker FFI v/ Gunnar Nevstad	Bestillingsnummer Telf. G.Nevstad	Rapportnummer RD-25/05
	Bestillingsdato 14.03.06	Kontroll dato 25.11.05
Produsent Dyno Nobel ASA N-3476 Sætre NORGE	Produksjonsdato 24.11.05	Offentlig oppdragsnummer
Lot nummer DDP05K0014E	Mengde 725 gram	
Sprengstofftype DPX-6 (PBXW-11 med 45 % Aluminium (kl 6))	Leveringsbetingelser/Teknisk underlag Kun informative verdier, 45 % aluminium	

Analyseresultater

	Sammensetning				Fuktighet	Volumvekt
	HMX	Aluminium	HyTemp	DOA		
KRAV	Informativ	Informativ	Informativ	Informativ	≤ 0,10 %	Informativ
RESULTAT Ch 06/05	50,0	45,9	1,1	3,0	0,02	0,90

	Granulatfordeling, % gjennom USSS Nr.					
	6 (3350 µ)	8 (2360 µ)	12 (1700 µ)	18 (1000 µ)	25 (710 µ)	40 (425 µ)
KRAV	Informativ	Informativ	Informativ	Informativ	Informativ	Informativ
RESULTAT Ch 06/05	100	100	99	55	28	5

Øyvind H. Johansen
FoU Sjef

Kjell-Tore Smith
Forsker

B REPORT SHEETS MECHANICAL TESTING

B.1 Not Aged Pellets

B.1.1 Room Temperature

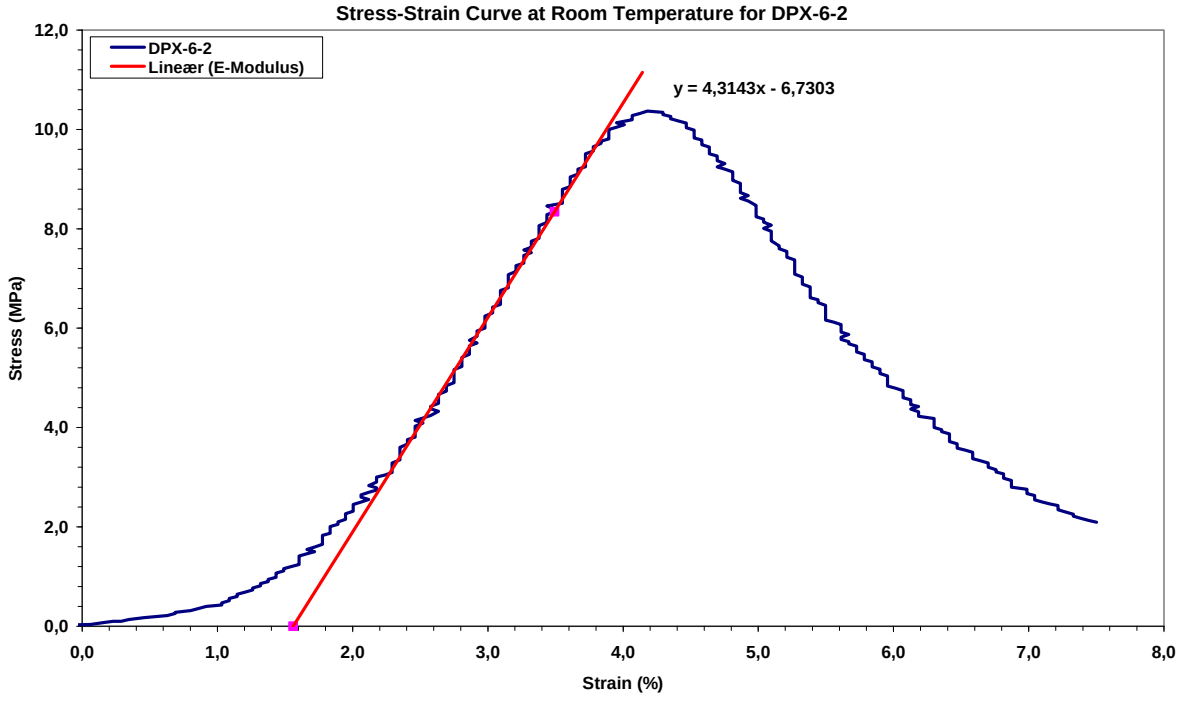
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 12 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 14 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.86 mm
X-Sectional Area (cm^2): 3.418
Form: Cylindrical
Preparation Method: As received L/D=1.0221
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-2
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.373 MPa STRAIN at Max Stress: 4.18 % E-Modulus: 431.43 MPa

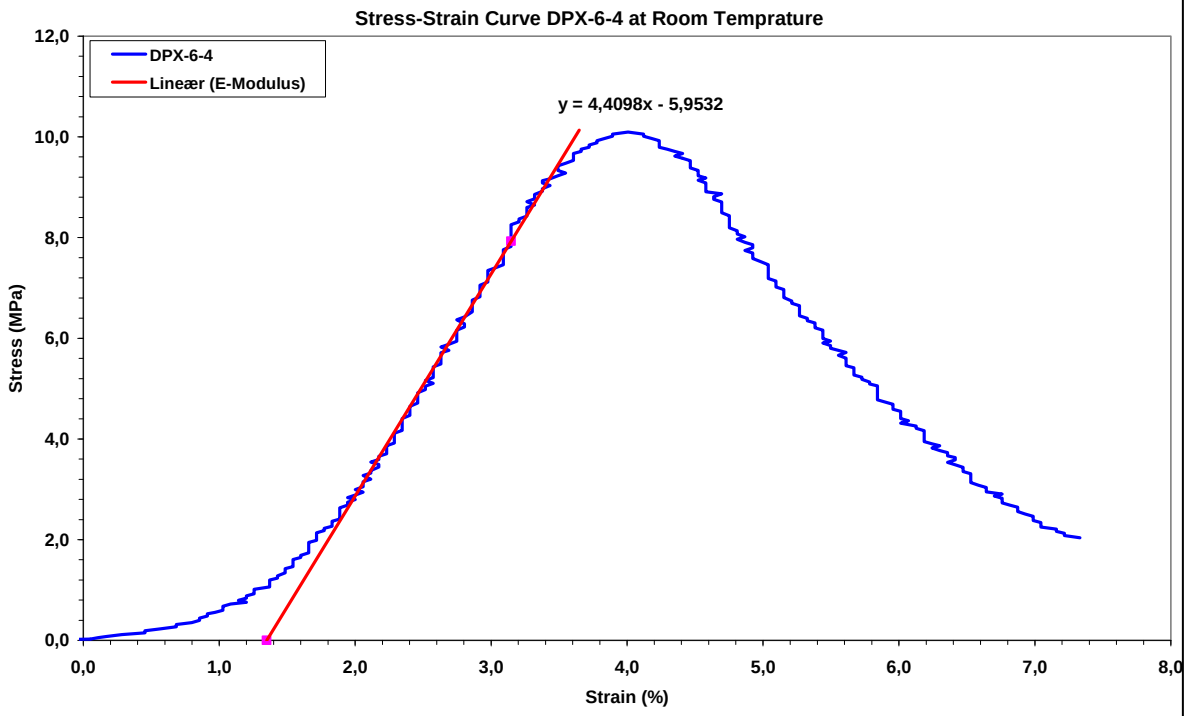
TEST REPORT SHEET
Uniaxial Compressive Test Page 2 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 12 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 14 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.31mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-4
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.096 MPa STRAIN at Max Stress: 4.01 % E-Modulus: 440.98 MPa

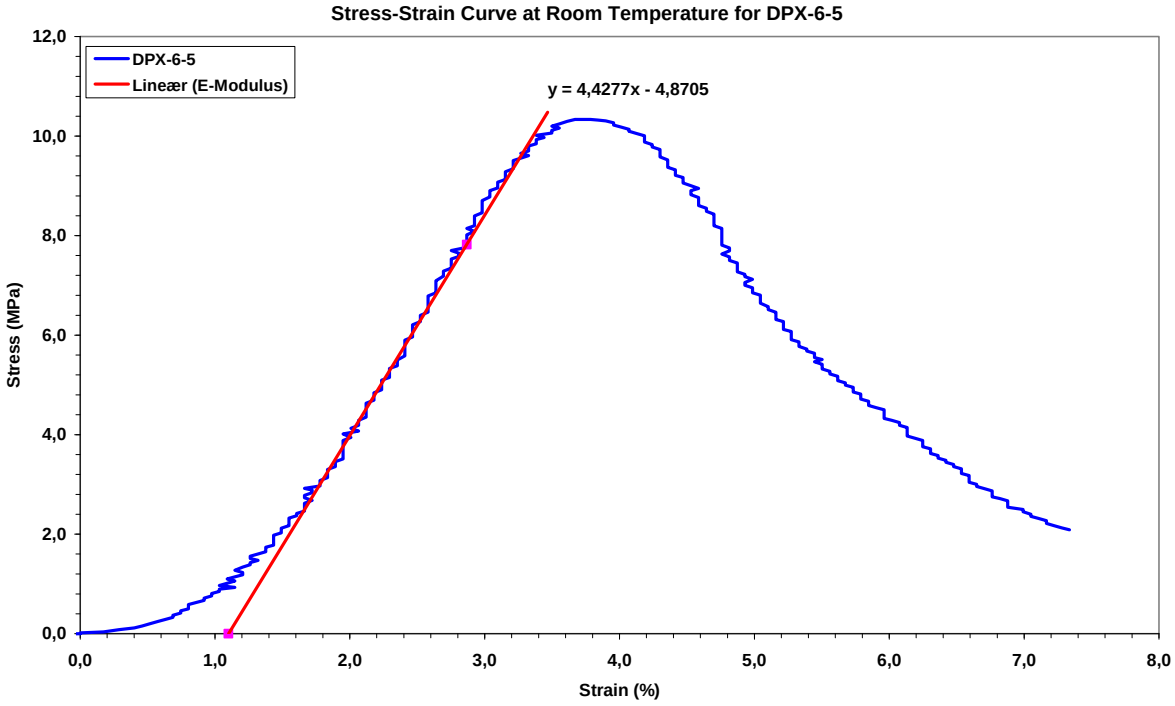
TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION
Laboratory: FFI
Date: 12 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 15 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.30 mm
Width:
Thickness (Diameter): 20.86 mm
X-Sectional Area (cm^2): 3.418
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-5
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.337 MPa STRAIN at Max Stress: 3.72 % E-Modulus: 442.77 MPa

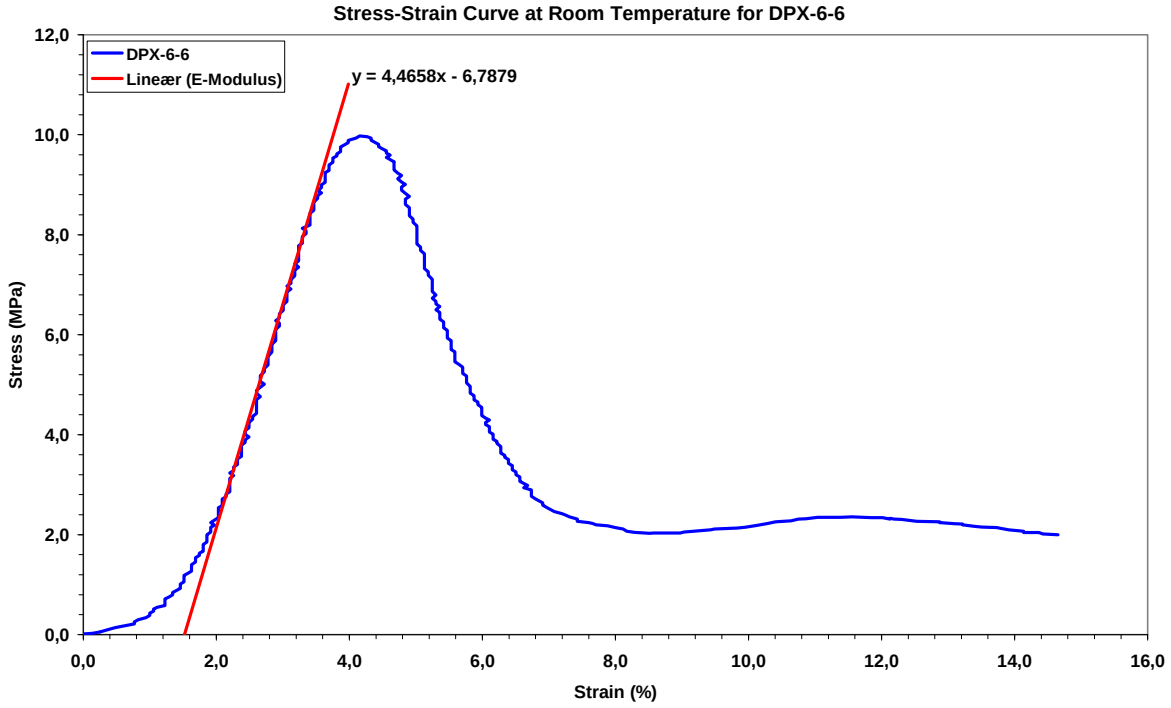
TEST REPORT SHEET
Uniaxial Compressive Test
Page 4 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 12 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 15 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (^{o}C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.28 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.421
Form: Cylindrical
Preparation Method: As received L/D=1.0196
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-6.
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 9.977 MPa STRAIN at Max Stress: 4.15 % E-Modulus: 446.58 MPa

B.1.2 60°C

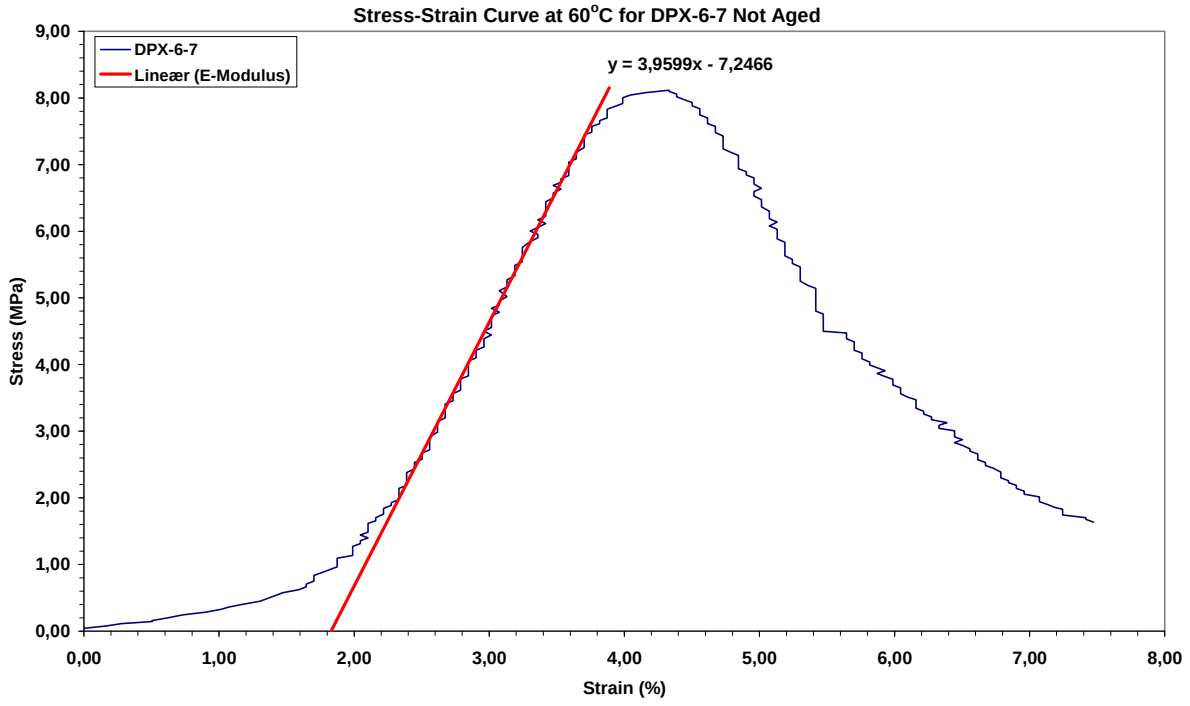
TEST REPORT SHEET
Uniaxial Compressive Test
Page 1 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 60
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.37 mm
Width:
Thickness (Diameter): 20.86 mm
X-Sectional Area (cm^2): 3.418
Form: Cylindrical
Preparation Method: As received L/D=1.0244
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-7
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 8.115 MPa STRAIN at Max Stress: 4.33 % E-Modulus: 395.99 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

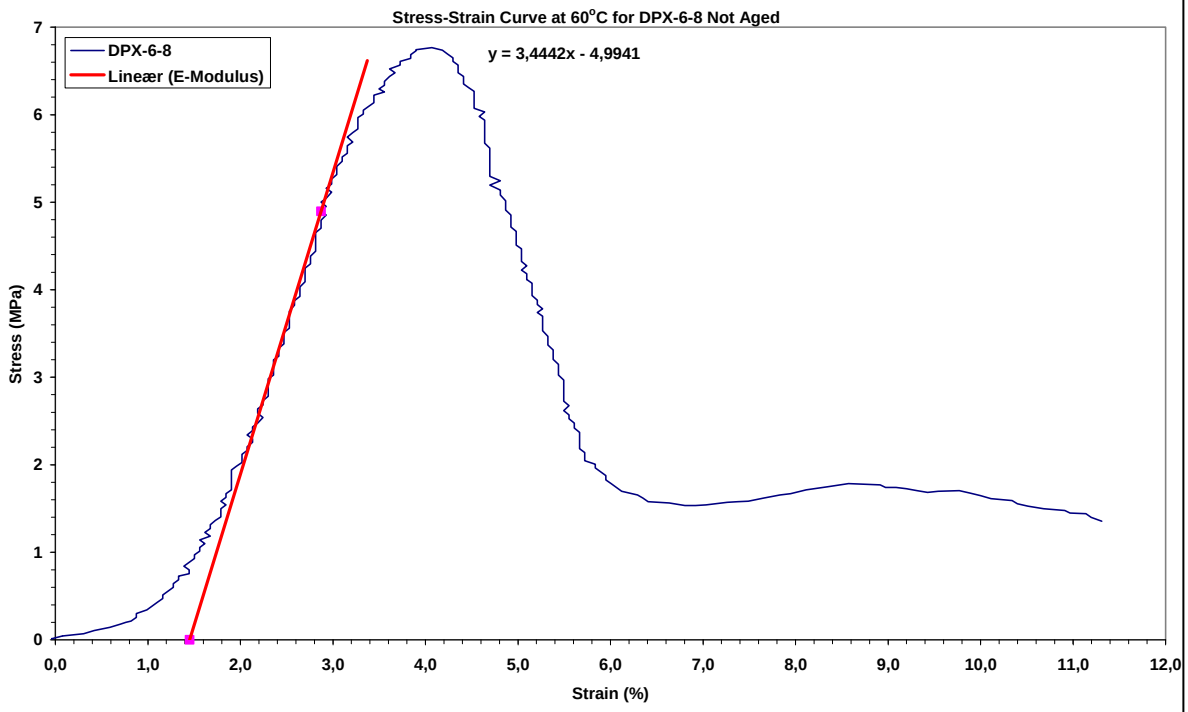
TEST CONDITIONS

Temperature (^{o}C): 60
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.41 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.421
Form: Cylindrical
Preparation Method: As received L/D=1.0259
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-8
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 6.766 MPa STRAIN at Max Stress: 4.07 % E-Modulus: 344.42 MPa

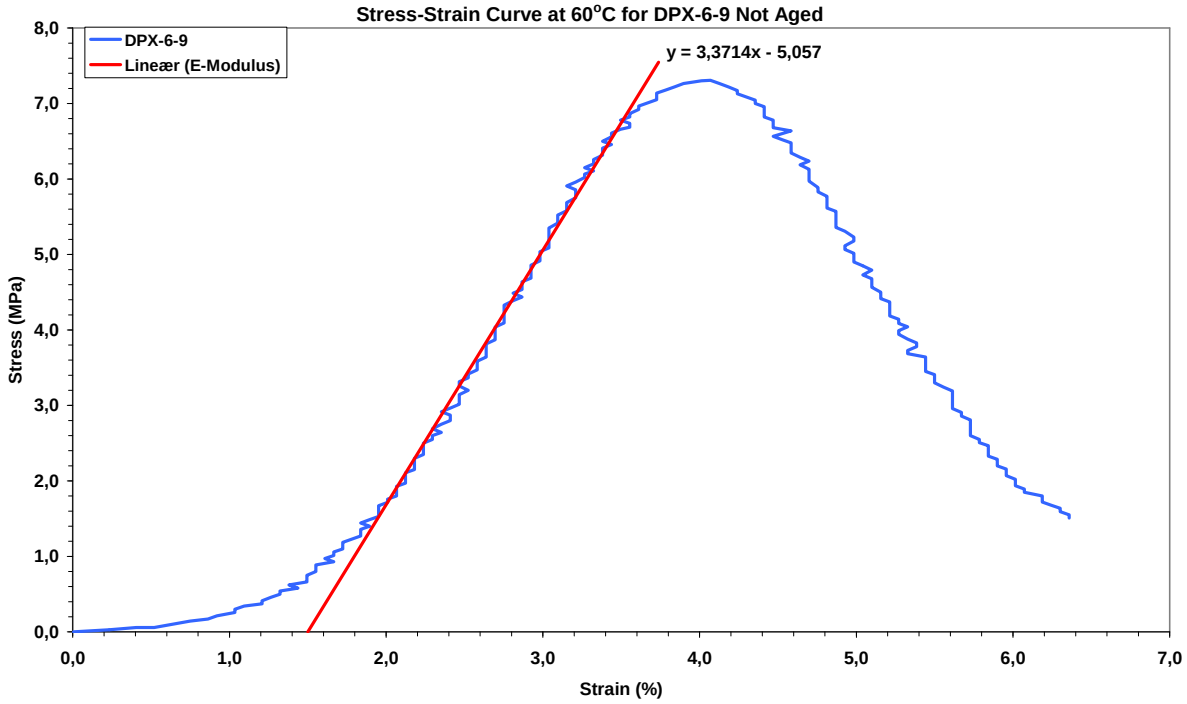
TEST REPORT SHEET
Uniaxial Compressive Test Page 3 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 60
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.33 mm
Width:
Thickness (Diameter): 20.86 mm
X-Sectional Area (cm^2): 3.418
Form: Cylindrical
Preparation Method: As received L/D=1.0225
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-9
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 7.308 MPa STRAIN at Max Stress: 4.07 % E-Modulus: 337.14 MPa

B.1.3 Low Temperature

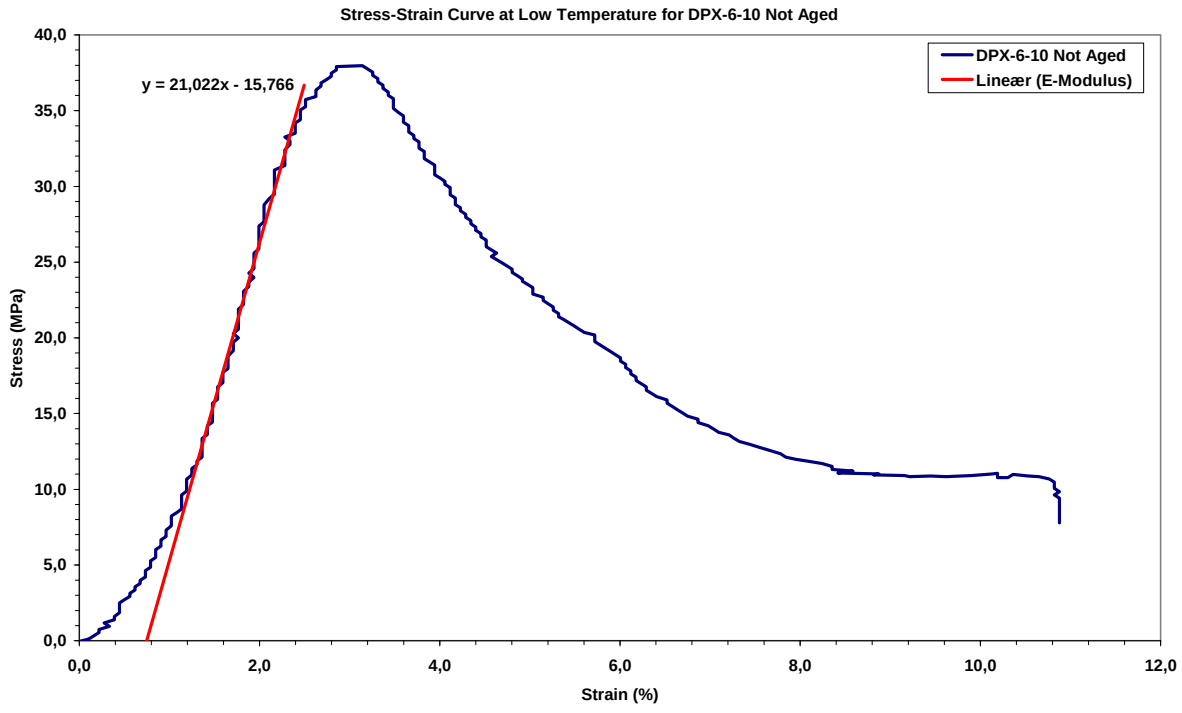
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -52
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.30 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0201
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-10
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 38.0029 MPa STRAIN at Max Stress: 3.14 % E-Modulus: 2102.2 MPa

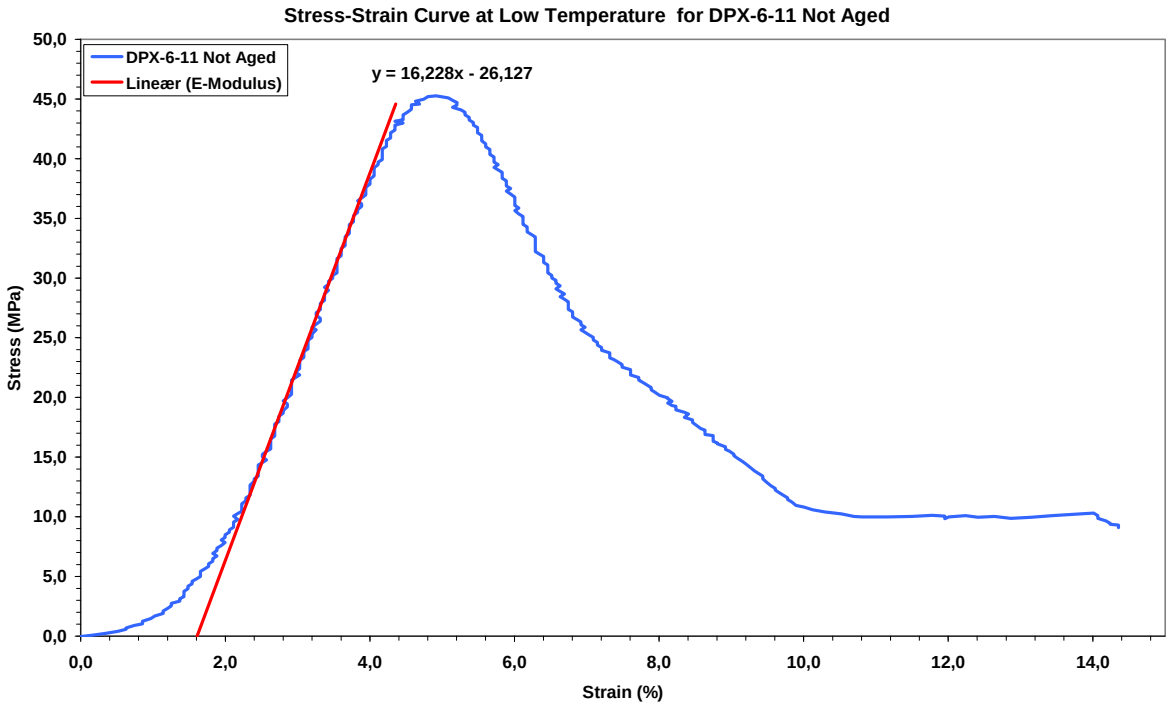
TEST REPORT SHEET
Uniaxial Compressive Test
Page 2 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -52
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.34 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0220
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-11
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 45.276 MPa STRAIN at Max Stress: 4.92 % E-Modulus: 1622.8 MPa

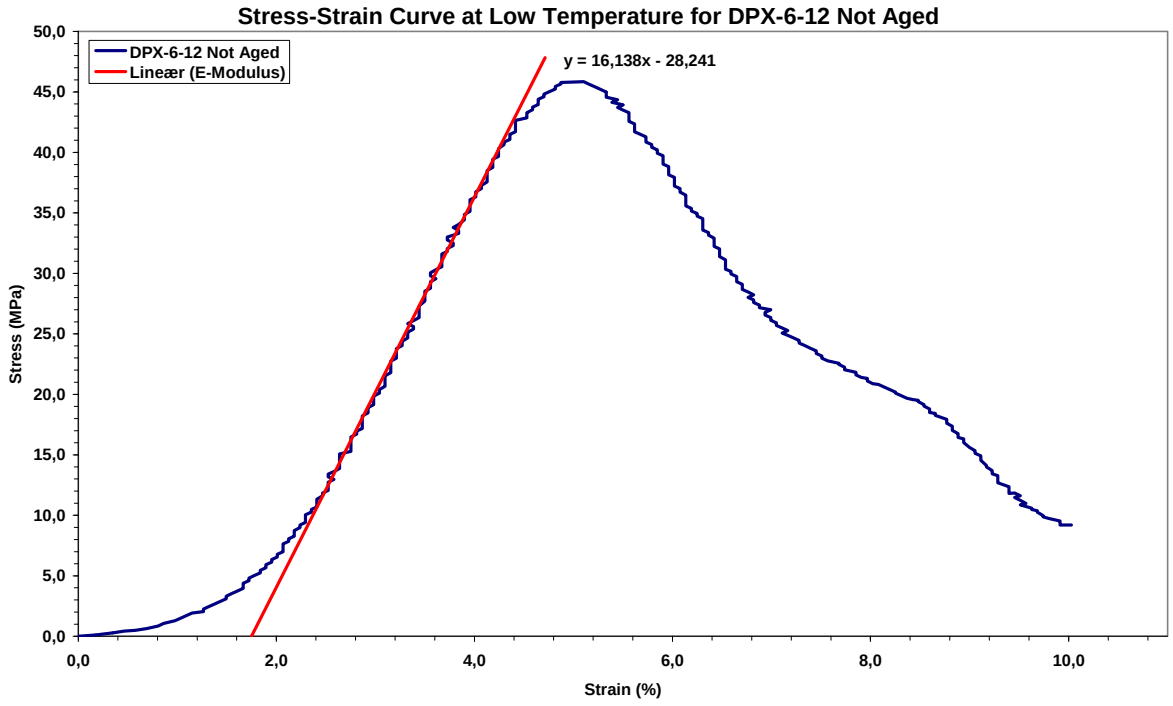
TEST REPORT SHEET
Uniaxial Compressive Test Page 3 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (^{o}C): -52
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.31 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-12
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 45.846 MPa STRAIN at Max Stress: 5.10 % E-Modulus: 1613.8 MPa

B.2 Pellets Aged for 30 Days

B.2.1 Room Temperature

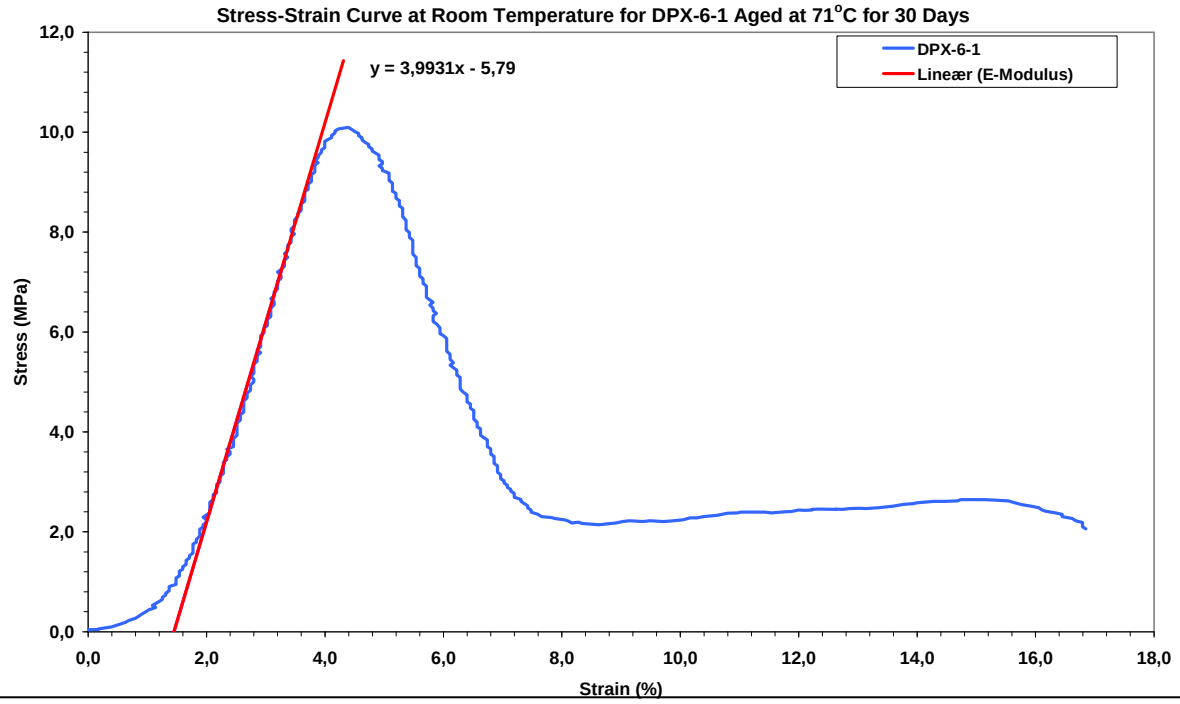
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 15October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.37 mm
Width:
Thickness (Diameter): 20.89 mm
X-Sectional Area (cm^2): 3.427
Form: Cylindrical
Preparation Method: As received L/D=1.0230
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-1 Aged 30 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.094 MPa STRAIN at Max Stress: 4.40 % E-Modulus: 399.31 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 15 October 2006
POC: Gunnar Ove Nevstad

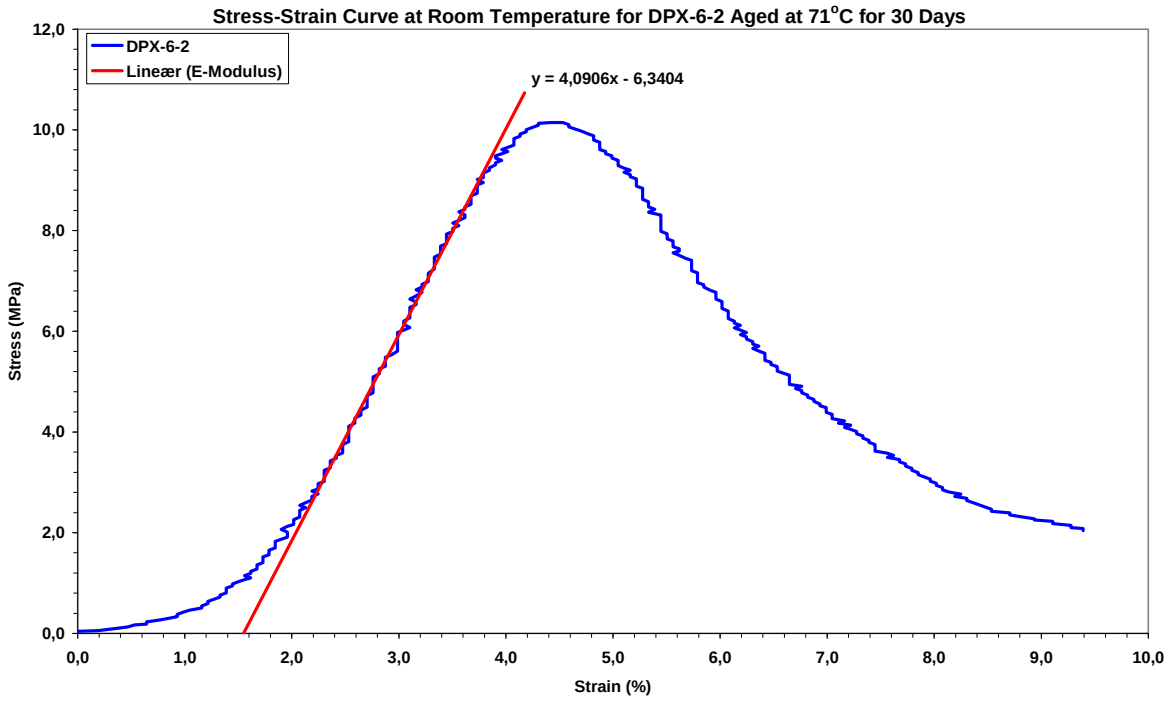
TEST CONDITIONS

Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.35 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0225
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-2 Aged for 30 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.146 MPa STRAIN at Max Stress: 4.47 % E-Modulus: 409.06 MPa

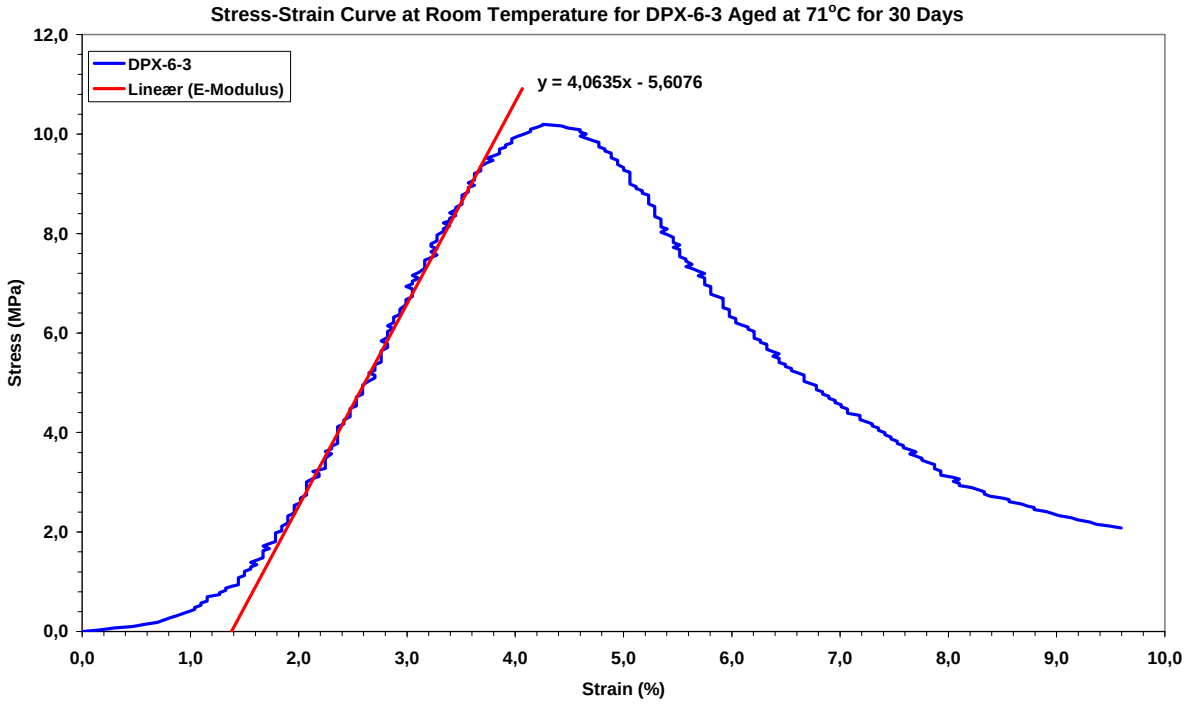
TEST REPORT SHEET
Uniaxial Compressive Test
Page 3 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 15 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.26 mm
Width:
Thickness (Diameter): 20.89 mm
X-Sectional Area (cm^2): 3.427
Form: Cylindrical
Preparation Method: As received L/D=1.0177
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-3 Aged for 30 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.193 MPa STRAIN at Max Stress: 4.26 % E-Modulus: 406.35 MPa

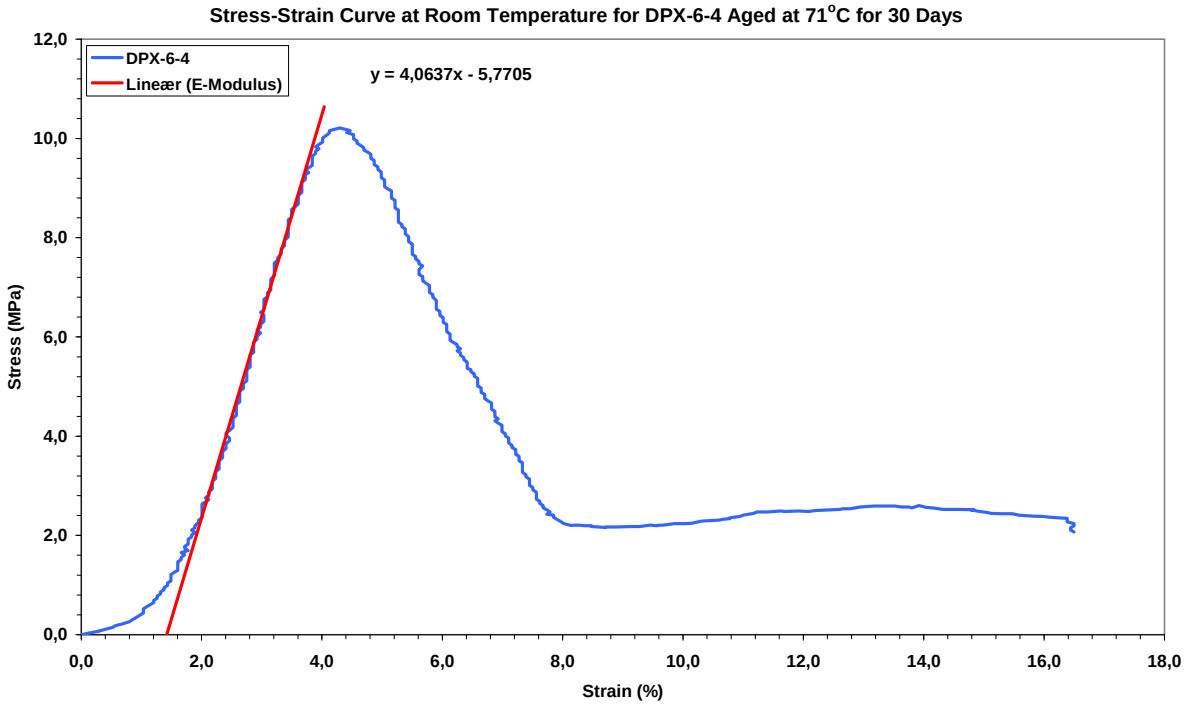
TEST REPORT SHEET
Uniaxial Compressive Test
Page 4 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 15 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (^{o}C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.31 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area ((cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-4 Aged for 30 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.210 MPa STRAIN at Max Stress: 4.30 % E-Modulus: 406.37 MPa

B.2.2 Low Temperature

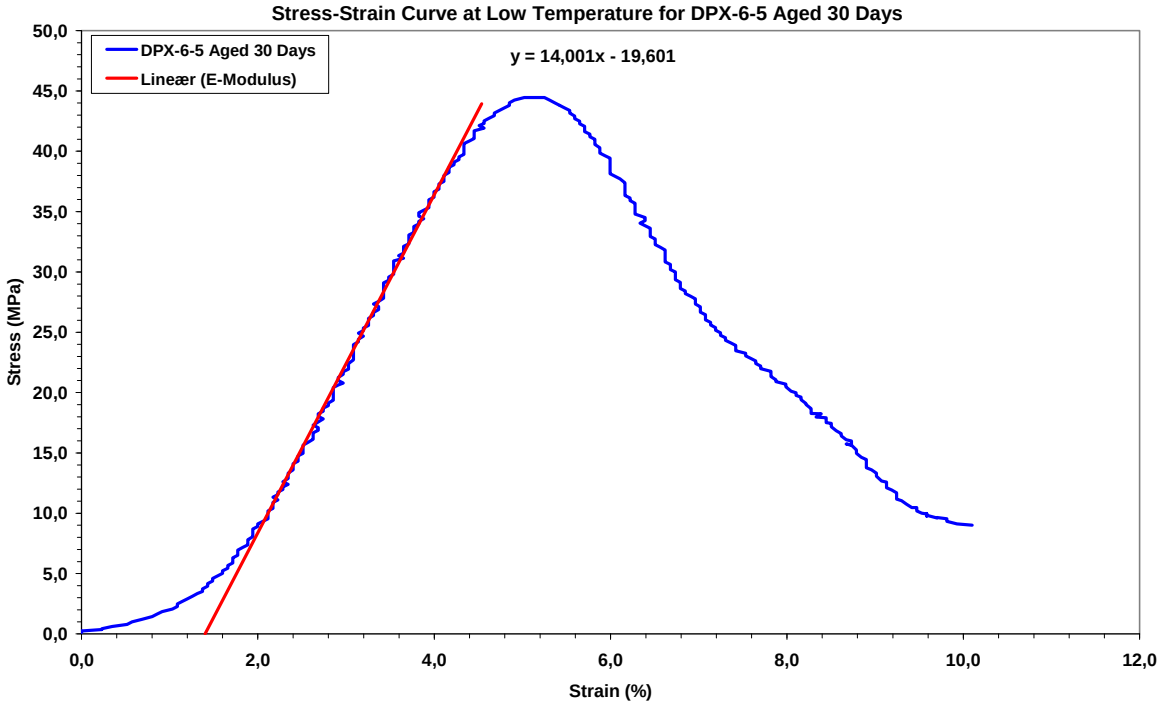
TEST REPORT SHEET
Uniaxial Compressive Test
Page 1 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.36 mm
Width:
Thickness (Diameter): 20.89 mm
X-Sectional Area (cm^2): 4.427
Form: Cylindrical
Preparation Method: As received L/D=1.0225
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-5 Aged 30 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 44.449 MPa STRAIN at Max Stress: 5.14 % E-Modulus: 1400.1 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

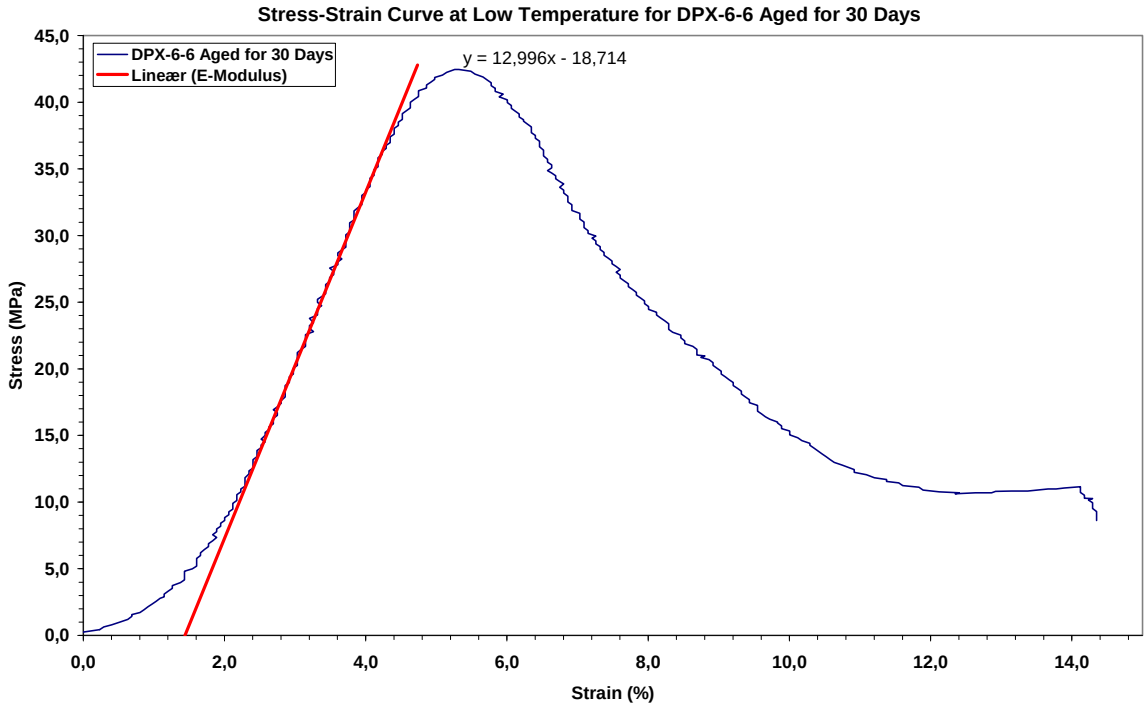
TEST CONDITIONS

Temperature (^{o}C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.36 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0230
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-6 Aged for 30 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 42.459 MPa STRAIN at Max Stress: 5.29 % E-Modulus: 1299.6MPa

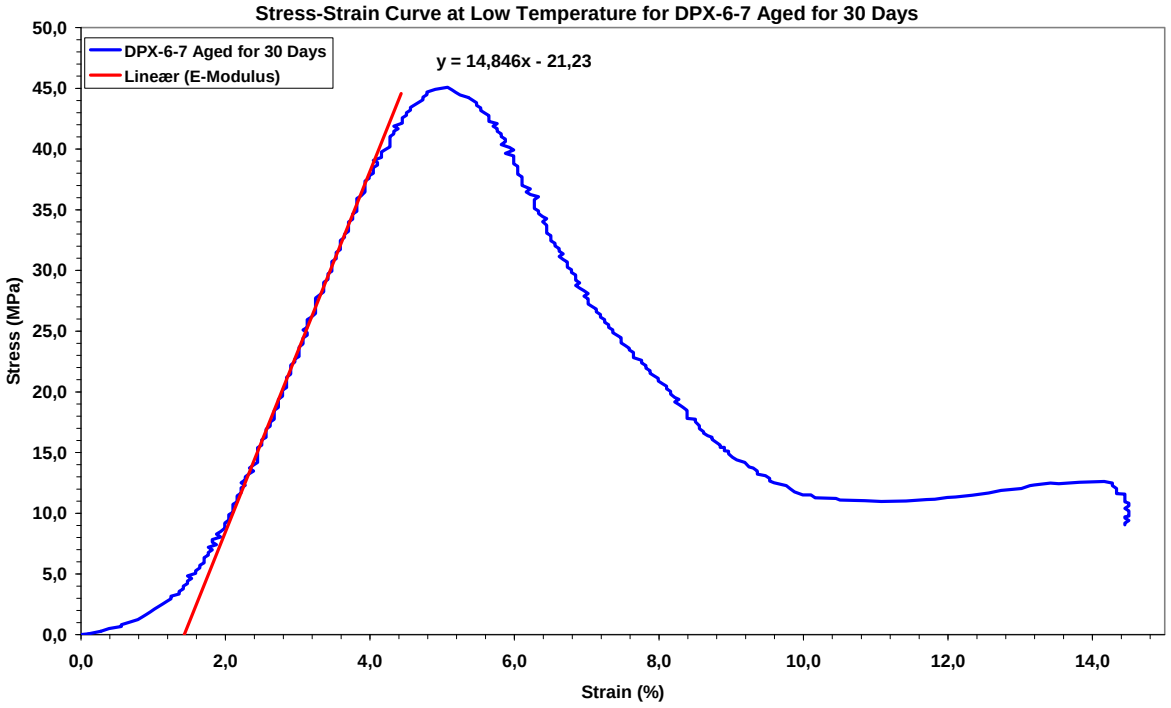
TEST REPORT SHEET
Uniaxial Compressive Test
Page 3 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.40 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0249
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-7 Aged for 30 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 45.097MPa STRAIN at Max Stress: 5.08 % E-Modulus: 1484.6 MPa

B.3 Pellets Aged for 60 Days

B.3.1 Room Temperature

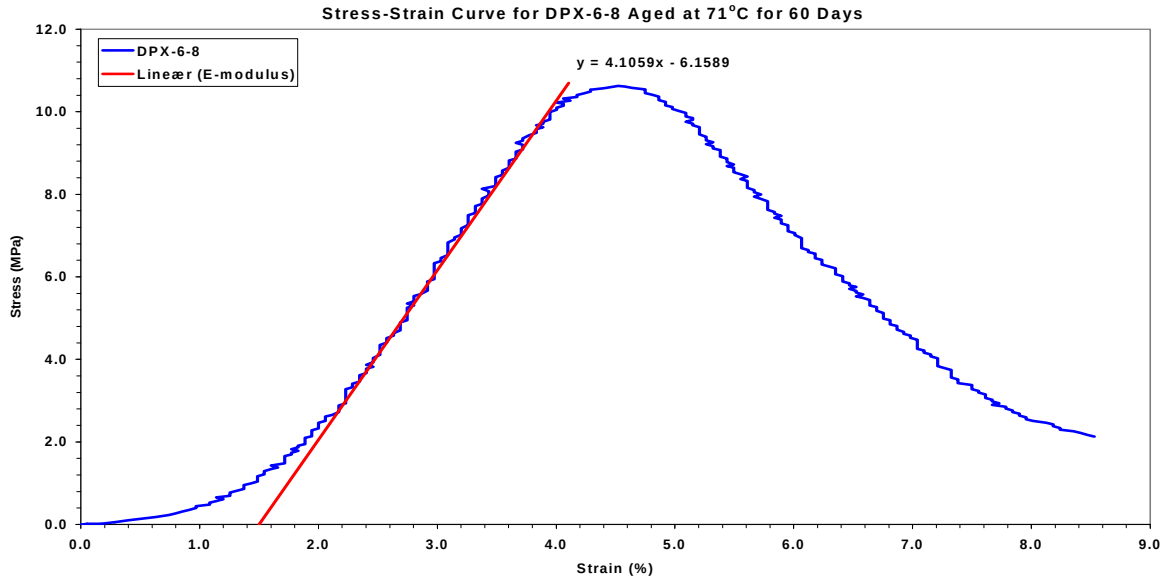
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0211
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-8 Aged for 60 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.624 MPa STRAIN at Max Stress: 4.521 % E-Modulus: 410.59 MPa

TEST REPORT SHEET
Uniaxial Compressive Test
Page 2 of 4 Pages

TEST SITE INFORMATION

Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

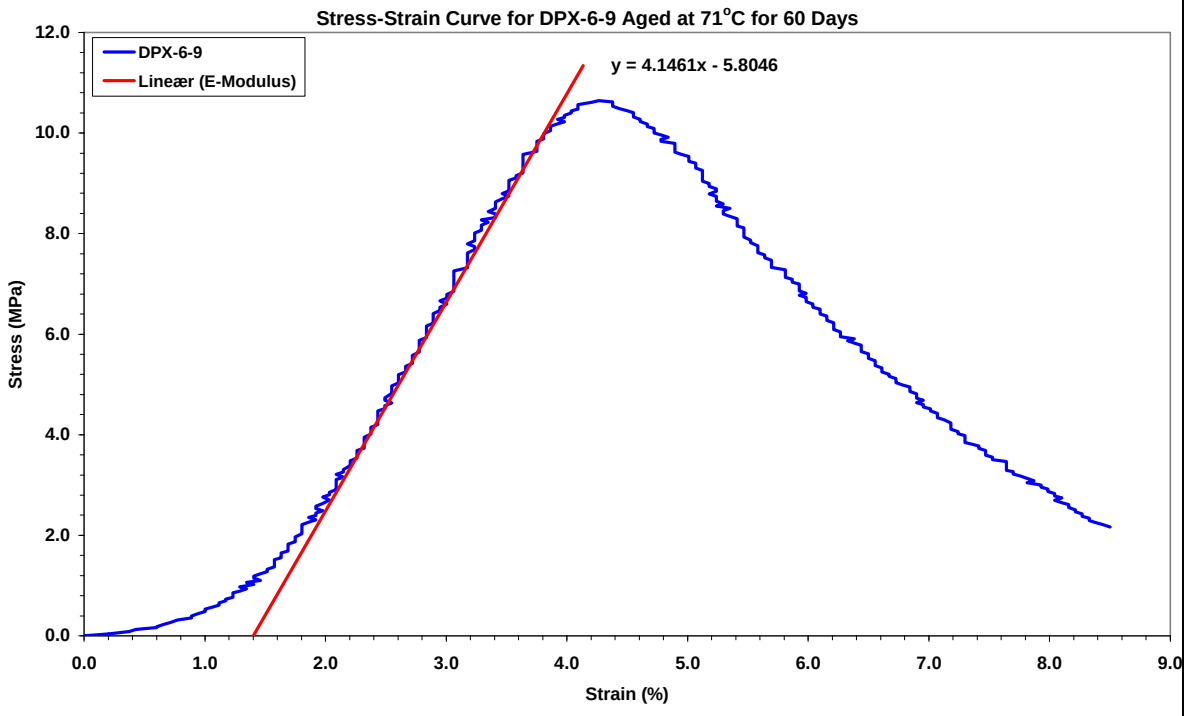
TEST CONDITIONS

Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.33 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2). 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0216
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-9 Aged for 60 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.645 MPa STRAIN at Max Stress: 4.27 % E-Modulus: 414.61 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

Page 3 of 4 Pages

TEST SITE INFORMATION

Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS

Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

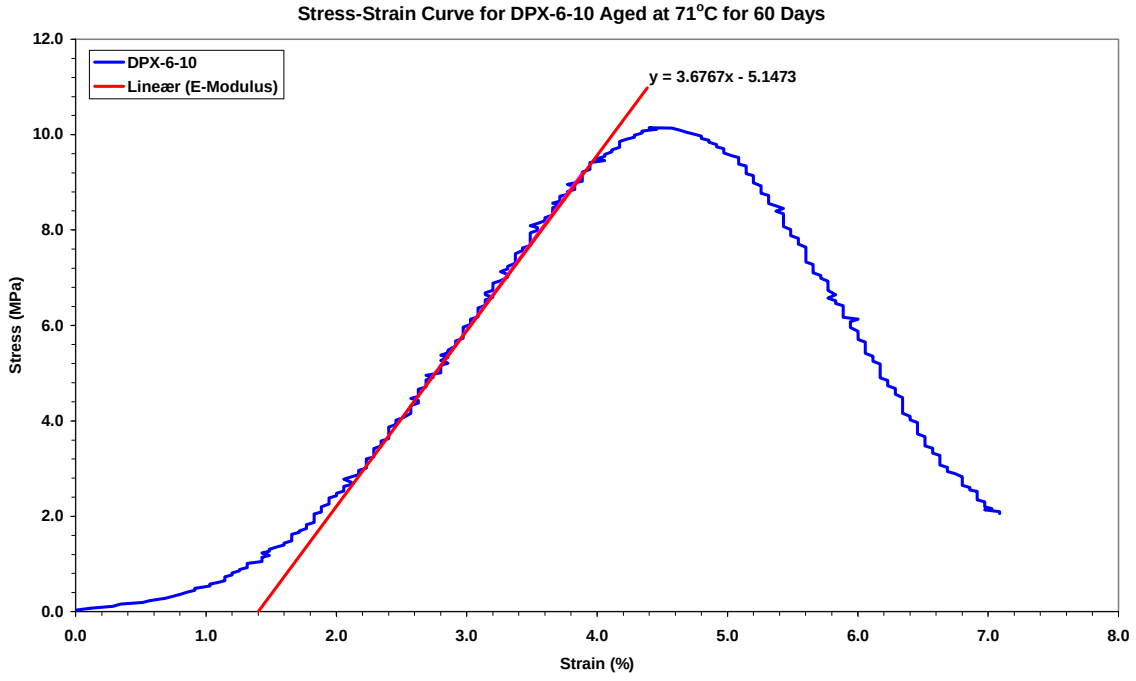
SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.36 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424

Form: Cylindrical
Preparation Method: As received L/D=1.0230
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-10 Aged for 60 Days
Preconditioning:
Condition Period:

Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.146 MPa STRAIN at Max Stress: 4.40 % E-Modulus: 367.67 MPa

TEST REPORT SHEET
Uniaxial Compressive Test
Page 4 of 4 Pages

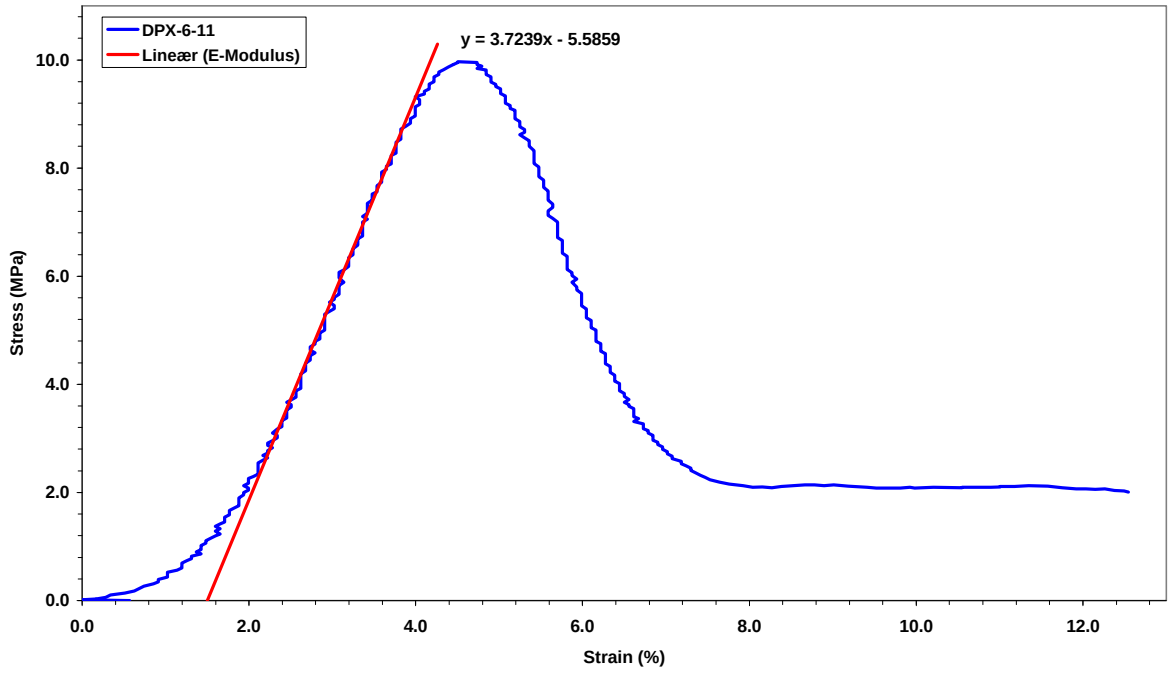
TEST SITE INFORMATION
Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.40 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.421
Form: Cylindrical
Preparation Method: As received L/D=1.0254
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-11 Aged for 60 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1

Stress-Strain Curve for DPX-6-11 Aged at 71°C for 60 Days



Max STRESS: 9.984 MPa STRAIN at Max Stress: 4.50 % E-Modulus: 372.39 MPa

B.3.2 Low Temperature

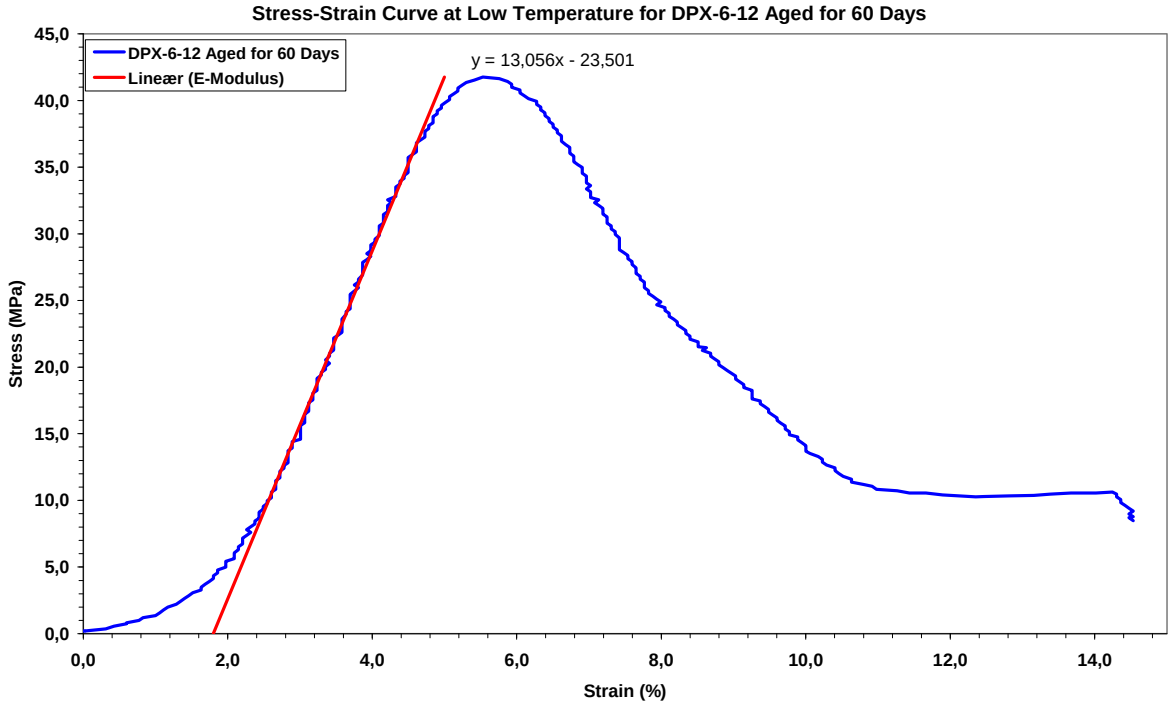
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (^{o}C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.29 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0196
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-12 Aged 60 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 41.746 MPa STRAIN at Max Stress: 5.53 % E-Modulus: 1305.6 MPa

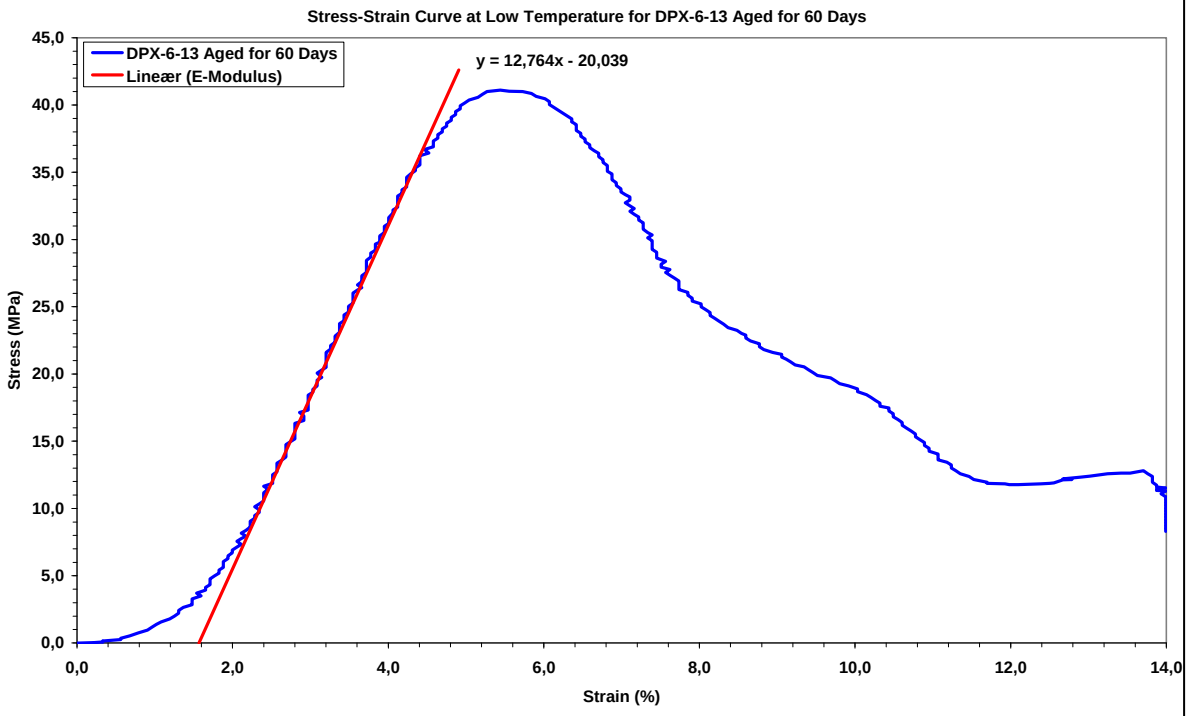
TEST REPORT SHEET
Uniaxial Compressive Test
Page 2 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.27 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0187
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-13 Aged for 60 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 41.104 MPa STRAIN at Max Stress: 5.44 % E-Modulus: 1276.4MPa

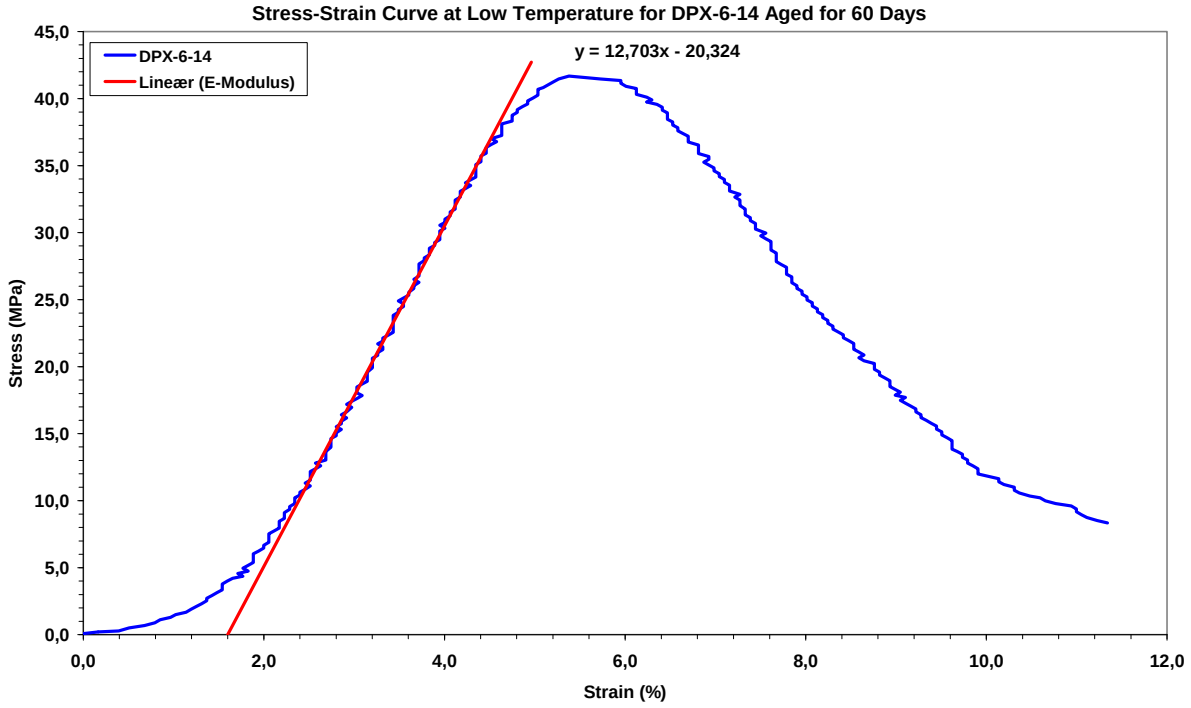
TEST REPORT SHEET
Uniaxial Compressive Test
Page 3 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.30 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.421
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-14 Aged for 60 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 41.679 MPa STRAIN at Max Stress: 5.38 % E-Modulus: 1270.3 MPa

B.4 Pellets Aged for 120 Days

B.4.1 Room Temperature

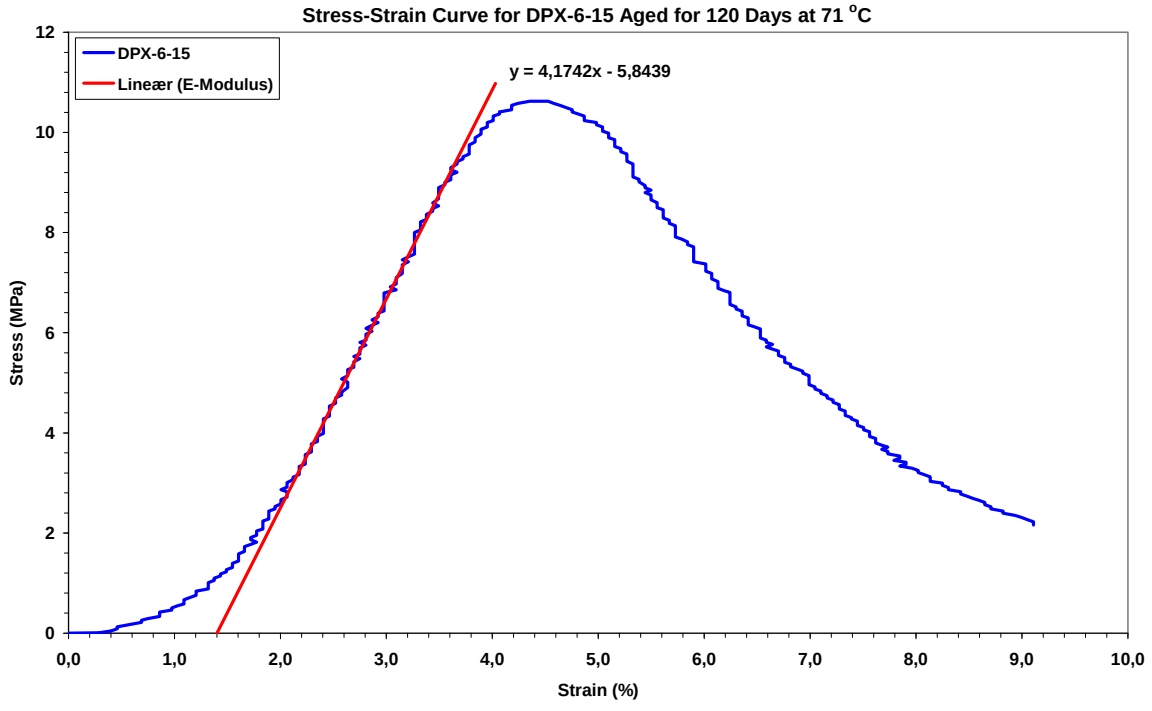
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 8 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.31 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-15 Aged 120 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.640 MPa STRAIN at Max Stress: 4.44 % E-Modulus: 417.42 MPa

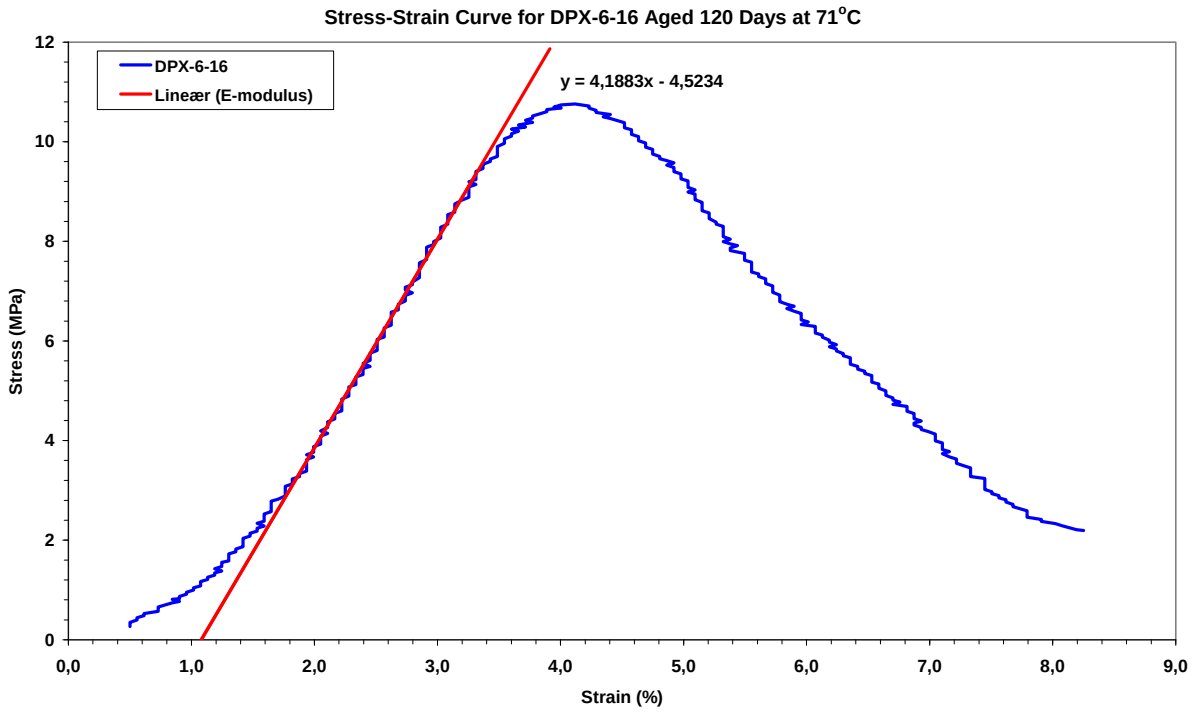
TEST REPORT SHEET
Uniaxial Compressive Test Page 2 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 8 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (^{o}C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.26 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0182
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-16 Aged for 120 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.759 MPa STRAIN at Max Stress: 4.117 % E-Modulus: 418.83 MPa

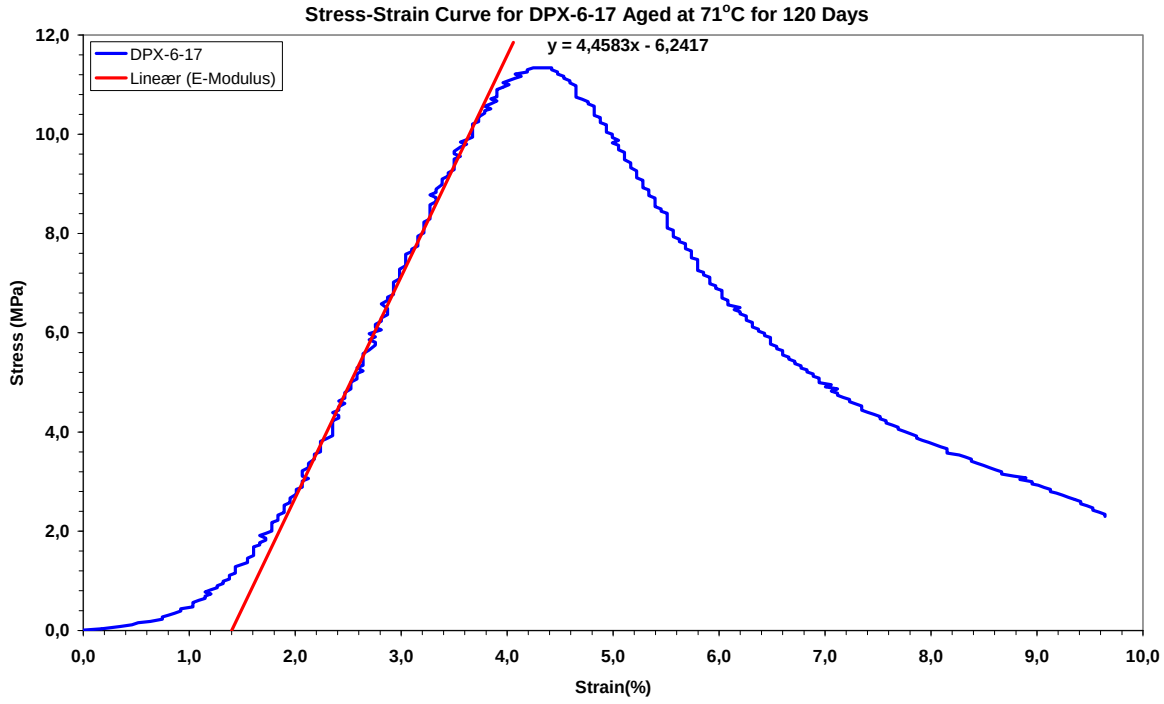
TEST REPORT SHEET
Uniaxial Compressive Test
Page 3 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS ServoHydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.27 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.421
Form: Cylindrical
Preparation Method: As received L/D=1.0192
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-17 Aged for 120 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 11.340 MPa STRAIN at Max Stress: 4.33 % E-Modulus: 445.83 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

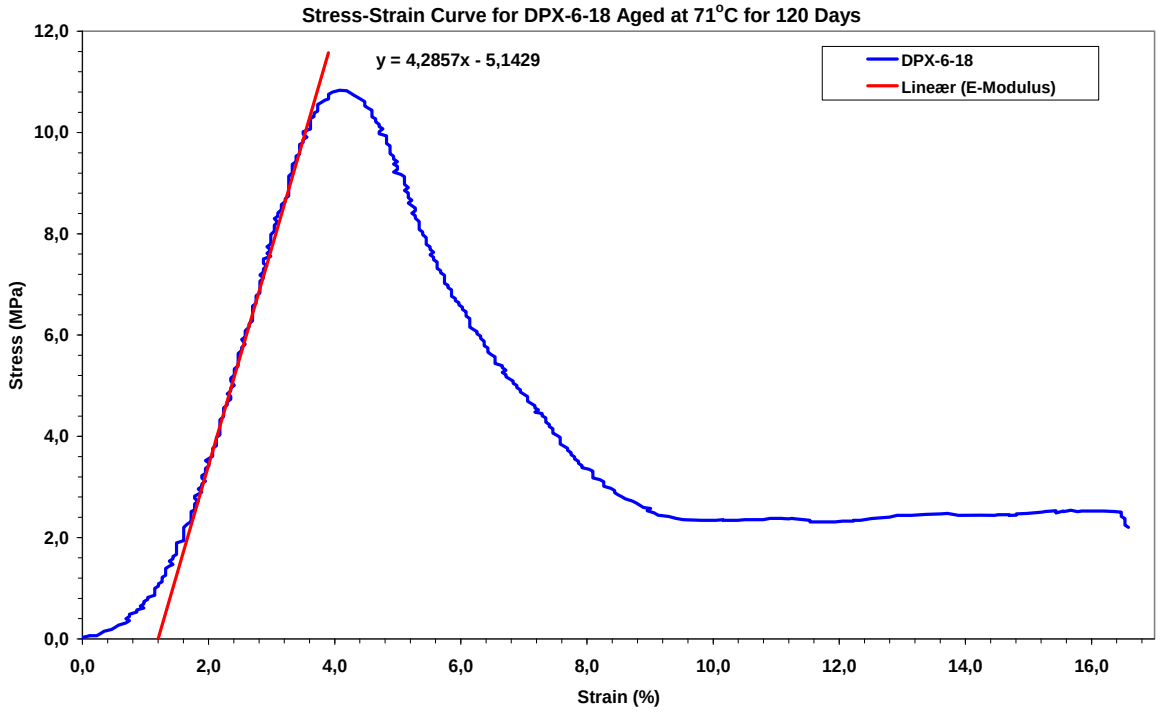
TEST CONDITIONS

Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.34 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0220
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-18 Aged for 120 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.8376 MPa STRAIN at Max Stress: 4.075 % E-Modulus: 428.67 MPa

B.4.2 Low Temperature

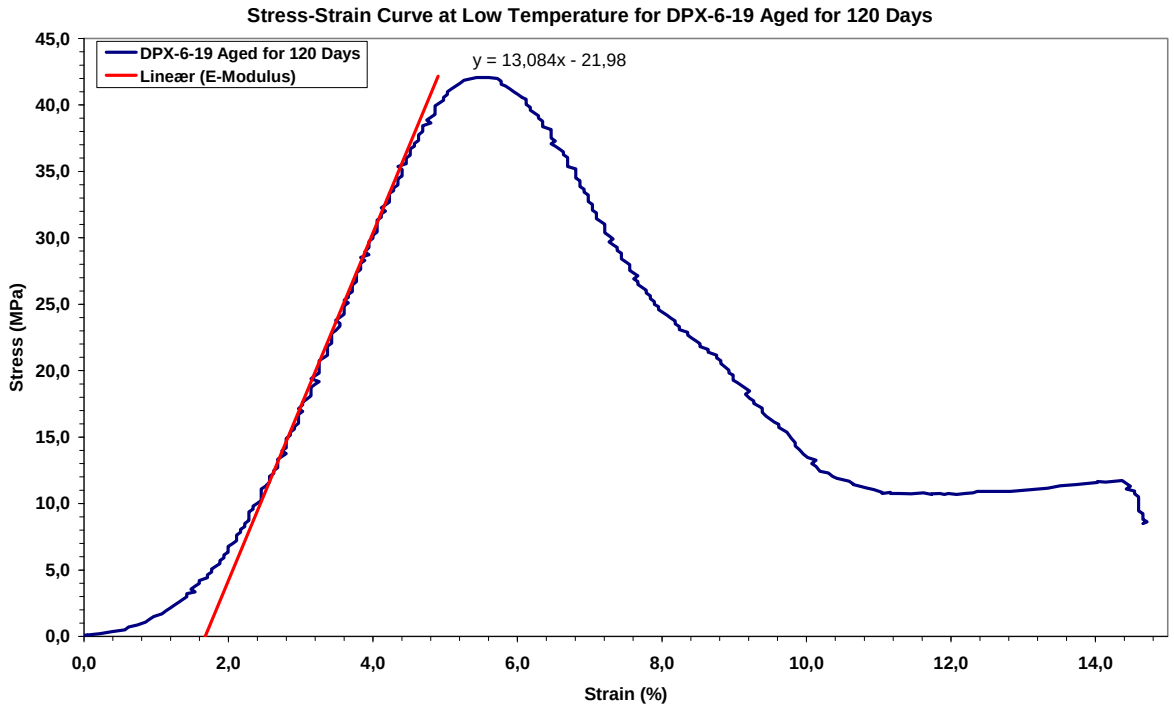
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 3 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.31 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-19 Aged 120 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 42.067 MPa STRAIN at Max Stress: 5.52 % E-Modulus: 1308.4 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

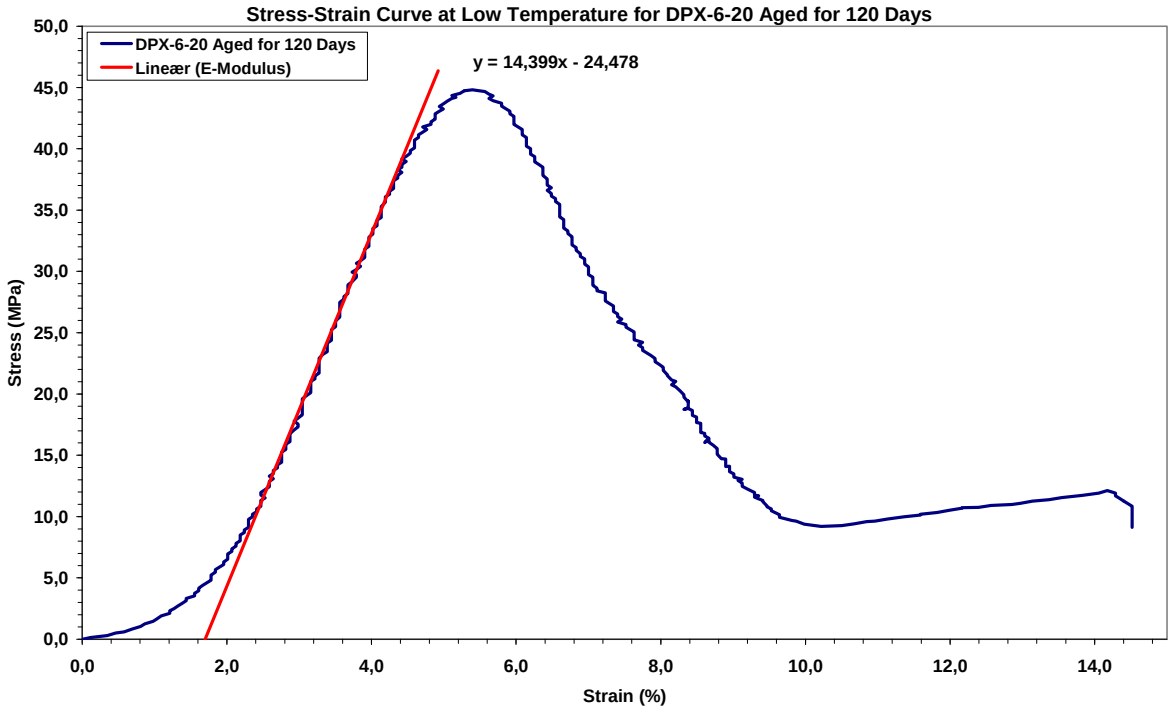
TEST CONDITIONS

Temperature (^{o}C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.28 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0192
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-20 Aged for 120 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 44.812 MPa STRAIN at Max Stress: 5.40 % E-Modulus: 1439.9 MPa

TEST REPORT SHEET
Uniaxial Compressive Test
Page 3 of 3 Pages

TEST SITE INFORMATION

Laboratory: FFI
Date: 11 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

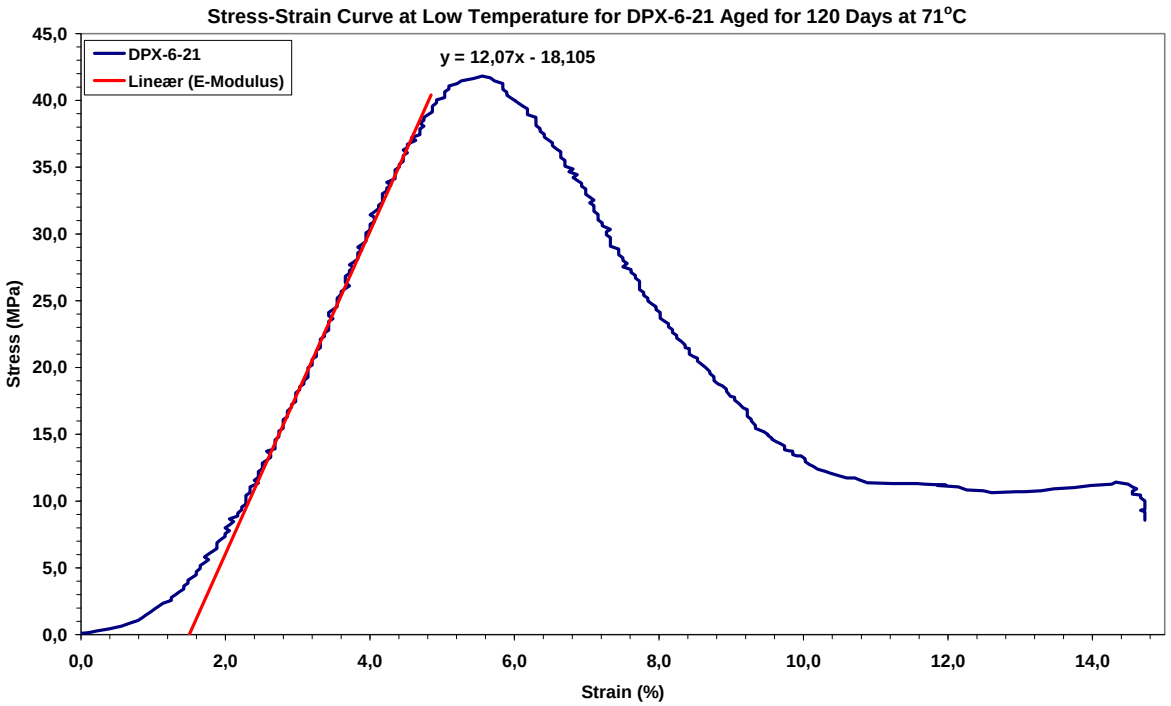
TEST CONDITIONS

Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.29 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0201
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-21 Aged for 120 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 41.822 MPa STRAIN at Max Stress: 5.55 % E-Modulus: 1207.0 MPa

B.5 Pellets Aged for 180 Days

B.5.1 Room Temperature

TEST REPORT SHEET
Uniaxial Compressive Test
Page 1 of 4 Pages

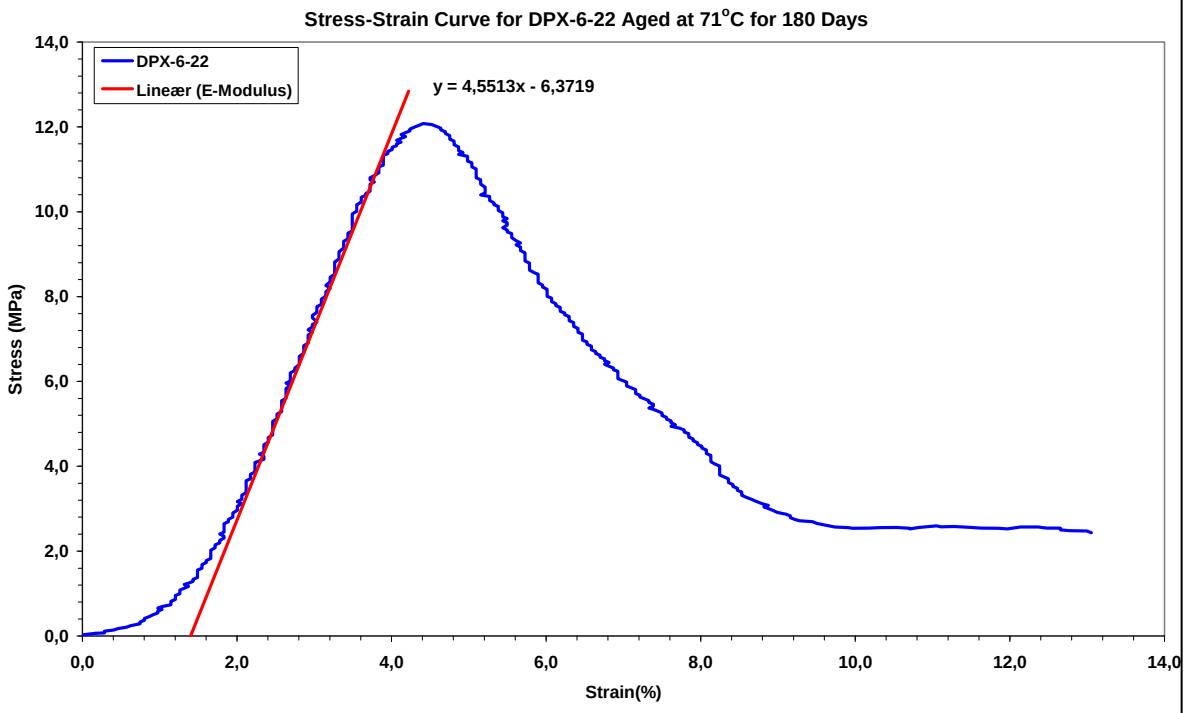
TEST SITE INFORMATION	TEST CONDITIONS
Laboratory: FFI	Temperature (°C): 13
Date: 8 November 2006	Relative Humidity (%): NA
Test Procedure:	X-Head Speed (mm/min): 50
NATO Test Procedure Number: 102.01	Machine Type: MTS Servo Hydraulic Tester
Date Tested: 20 October 2006	Grip Type:
POC: Gunnar Ove Nevstad	Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2). 3.424

Form: Cylindrical
Preparation Method: As received L/D=1.0211
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-22 Aged 180 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 12.078 MPa STRAIN at Max Stress: 4.409 % E-Modulus: 455.13 MPa

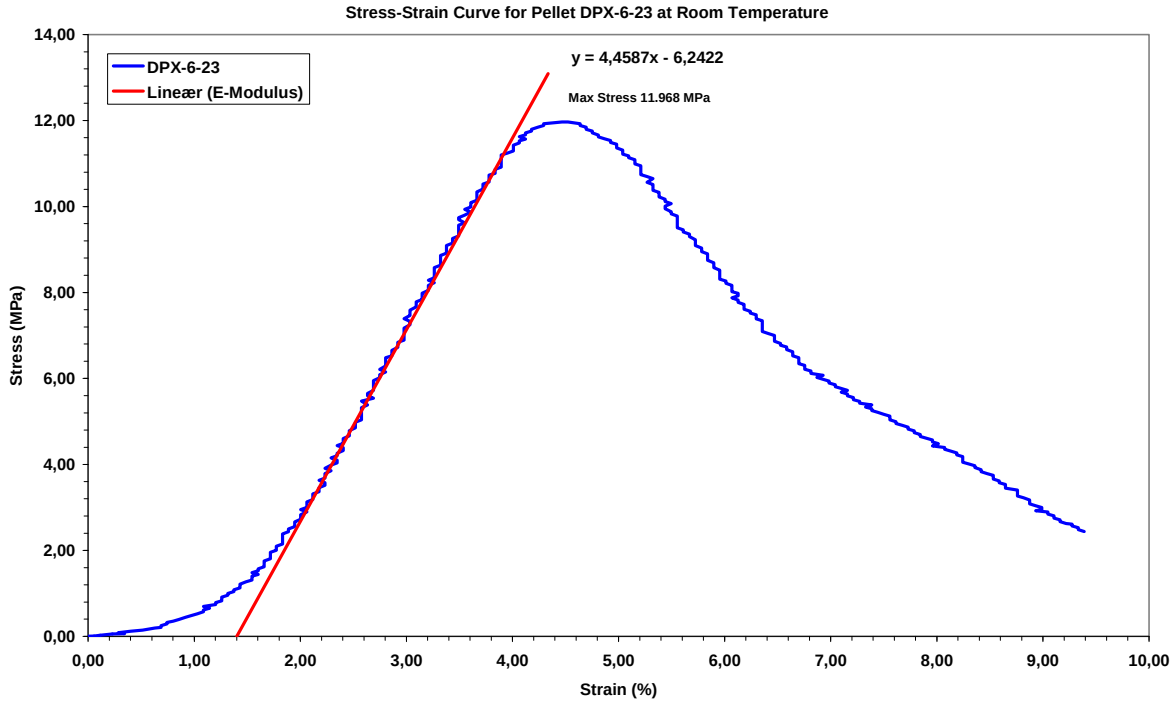
TEST REPORT SHEET
Uniaxial Compressive Test
Page 2 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 8 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 13
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0182
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-23 Aged for 180 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 11.96847 MPa STRAIN at Max Stress: 4.47 % E-Modulus: 445.87 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS

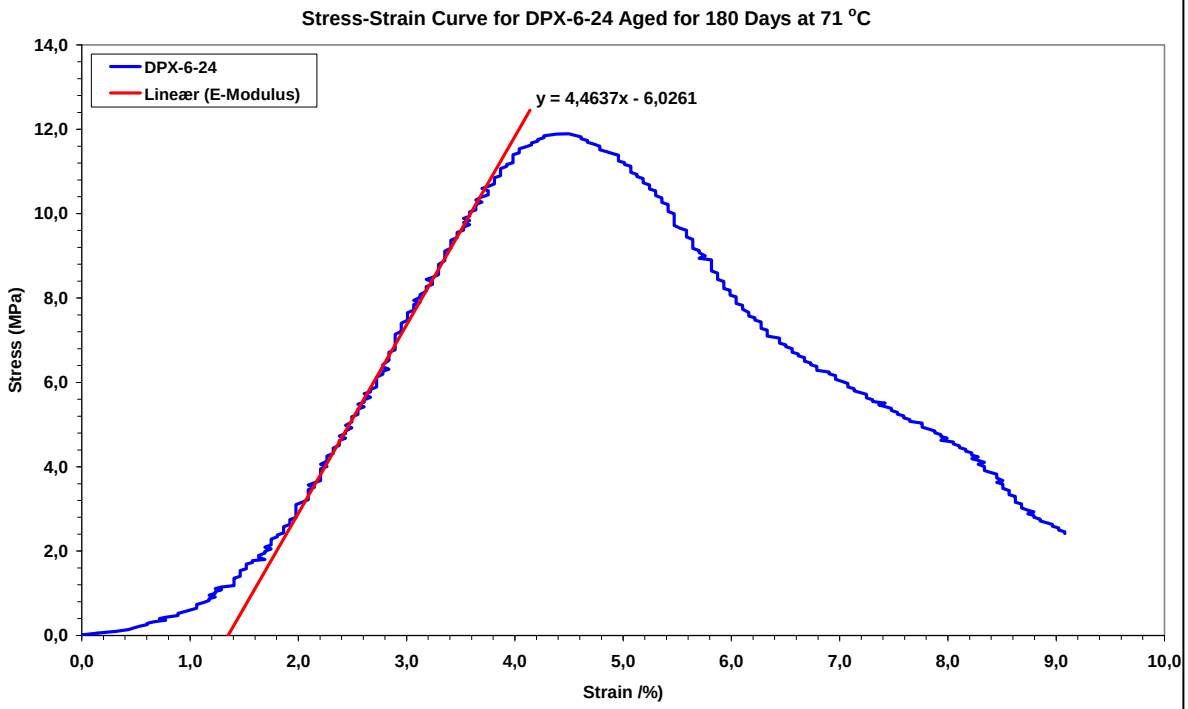
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.31 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0192
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-24 Aged for 180 Days
Preconditioning:
Condition Period:

Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 11.893 MPa STRAIN at Max Stress: 4498 % E-Modulus: 446.37 MPa

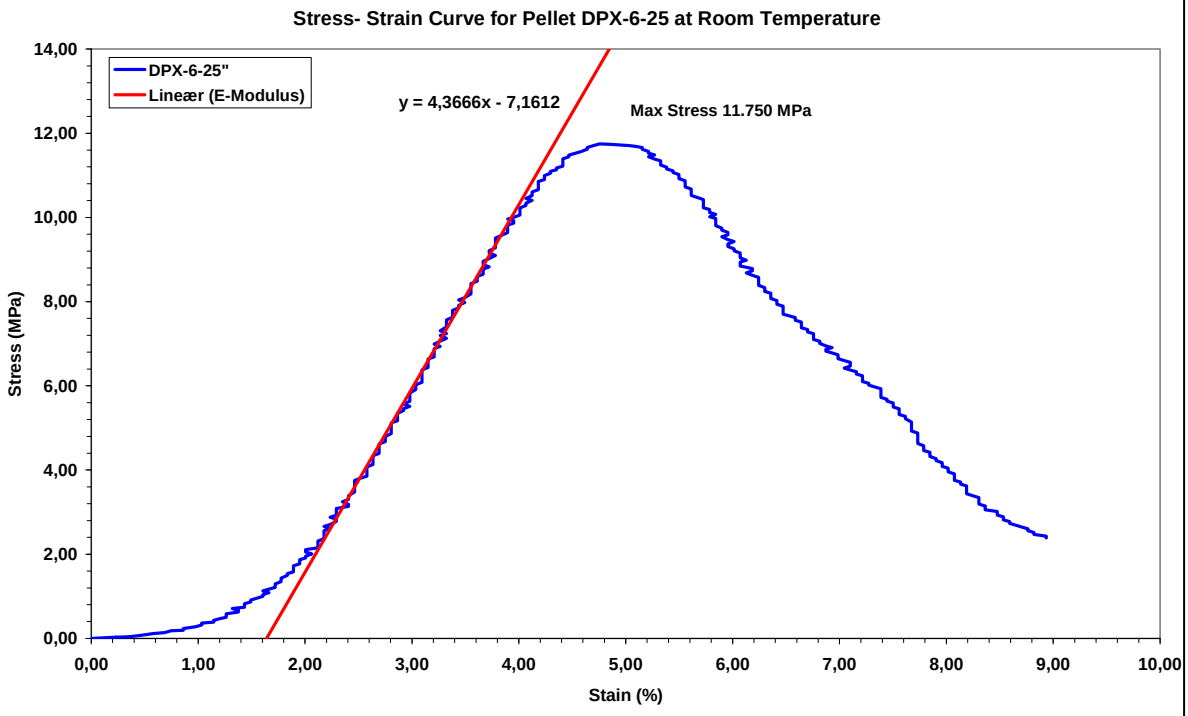
TEST REPORT SHEET
Uniaxial Compressive Test Page 4 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 7 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 20 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 14
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0211
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-25 Aged for 180 Days
Preconditioning:
Condition Period:
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 11.750 MPa STRAIN at Max Stress: 4.75 % E-Modulus: 436.66 MPa

B.5.2 40°C

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 9 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS

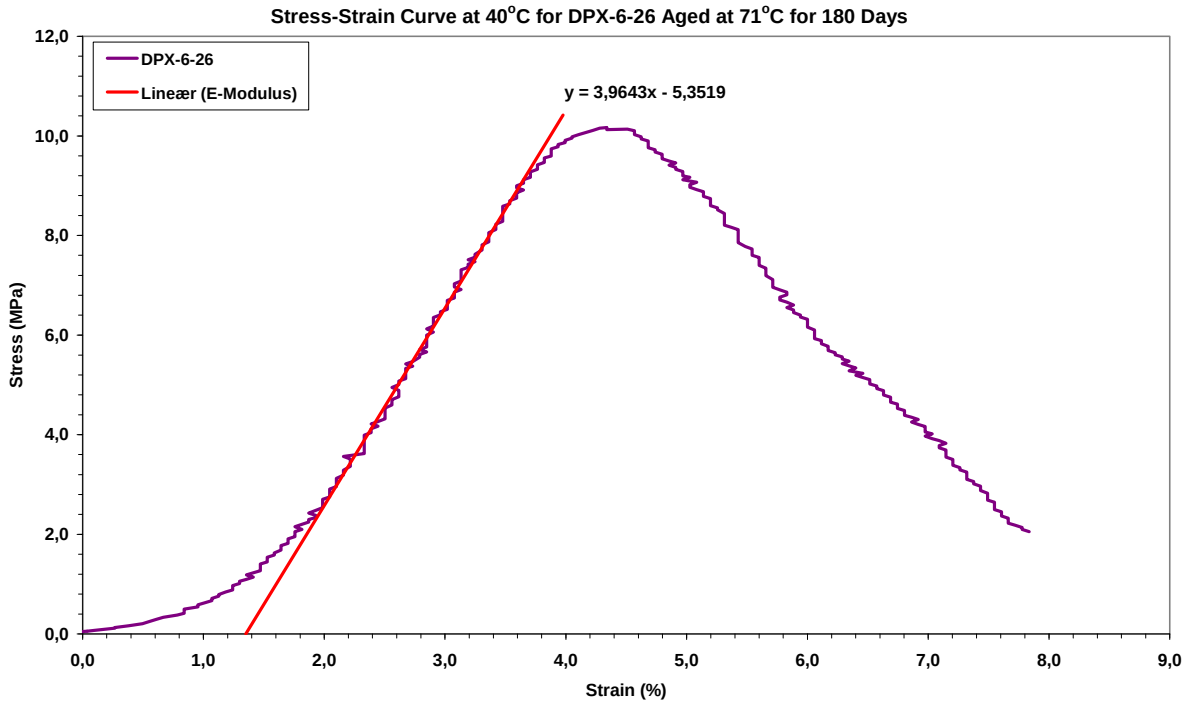
Temperature (°C): 40
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.29 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424

Form: Cylindrical
Preparation Method: As received L/D=1.0196
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-26 Aged 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 10.167 MPa STRAIN at Max Stress: 4.34 % E-Modulus: 396.43 MPa

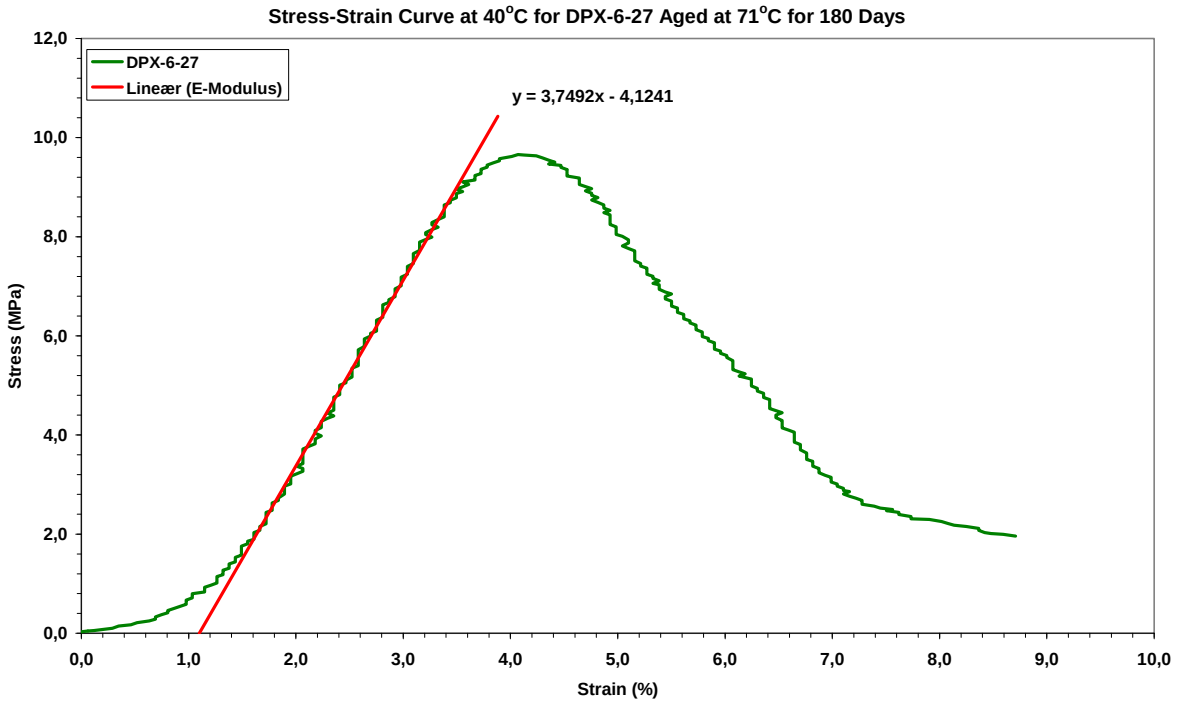
TEST REPORT SHEET
Uniaxial Compressive Test
Page 2 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 9 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 40
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0211
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-27 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 9.661 MPa STRAIN at Max Stress: 4.07 % E-Modulus: 374.82 MPa

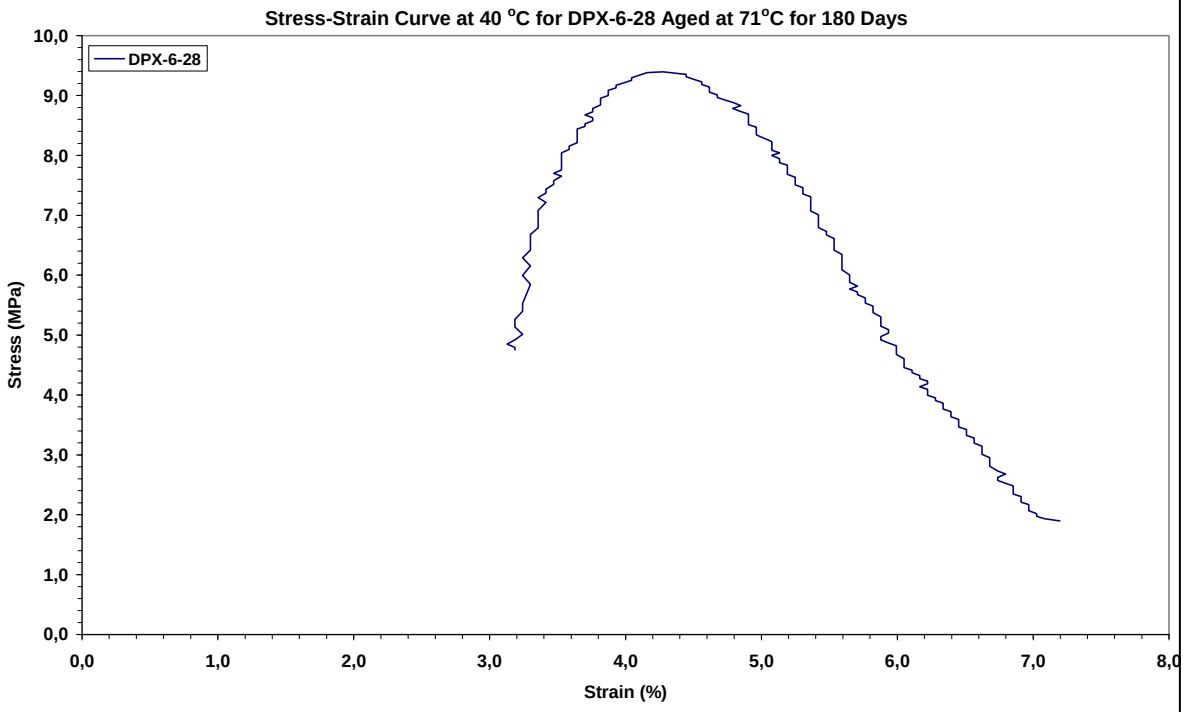
TEST REPORT SHEET
Uniaxial Compressive Test Page 3 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 8 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 40
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0211
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-28 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 9.397 MPa STRAIN at Max Stress: 4.27 % E-Modulus:

TEST REPORT SHEET
Uniaxial Compressive Test
Page 4 of 4 Pages

TEST SITE INFORMATION

Laboratory: FFI
Date: 8 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

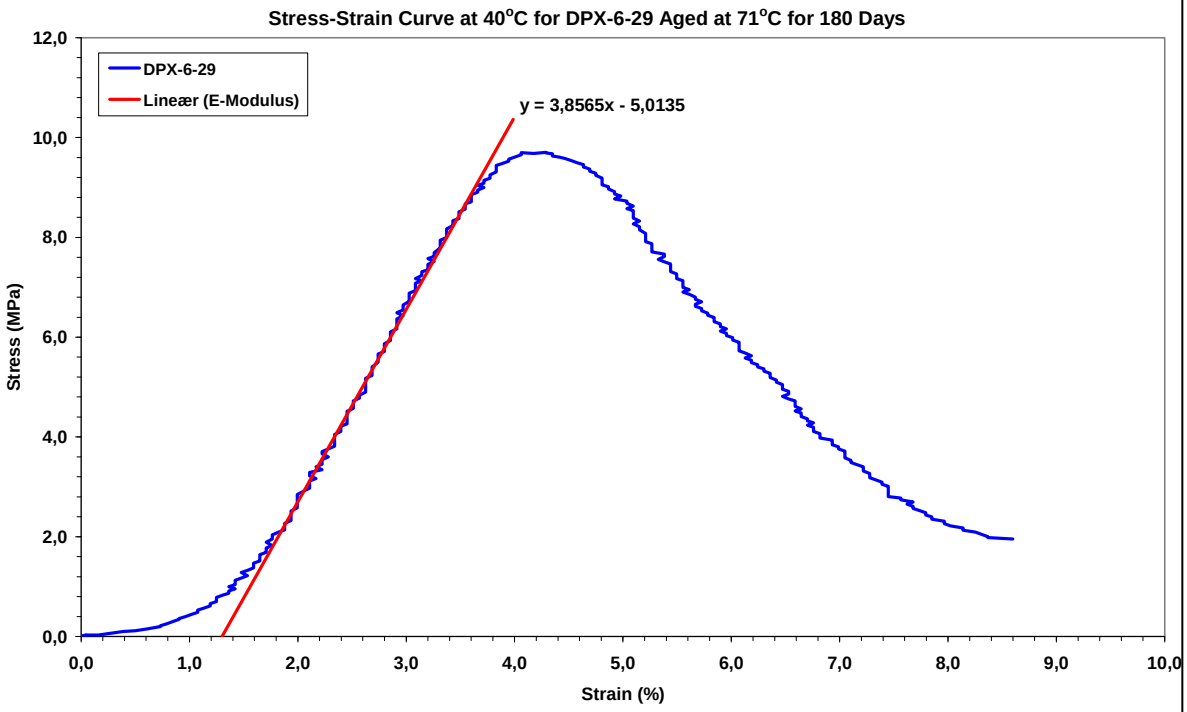
TEST CONDITIONS

Temperature (°C): 40
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.26 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0182
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-29 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 9.704 MPa STRAIN at Max Stress: 4.29 % E-Modulus: 385.65 MPa

B.5.3 60°C

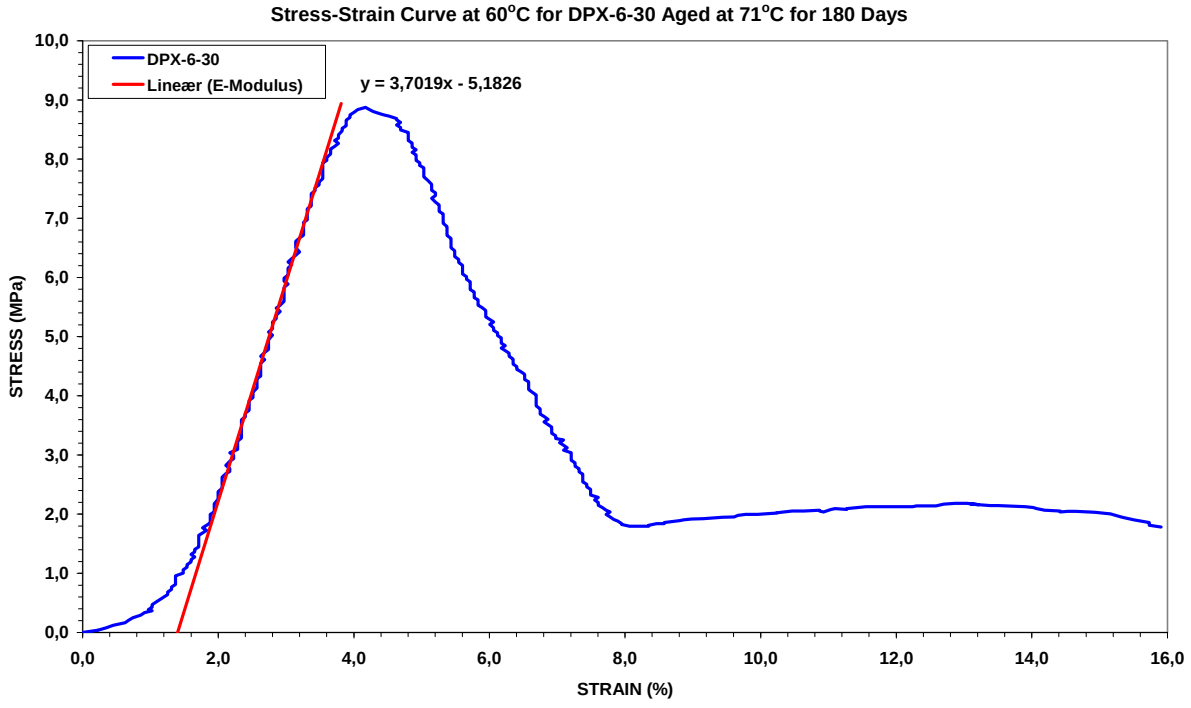
TEST REPORT SHEET
Uniaxial Compressive Test
Page 1 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 60
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.32 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0216
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-30 Aged 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 8.877 MPa STRAIN at Max Stress: 4.17 % E-Modulus: 370.19 MPa

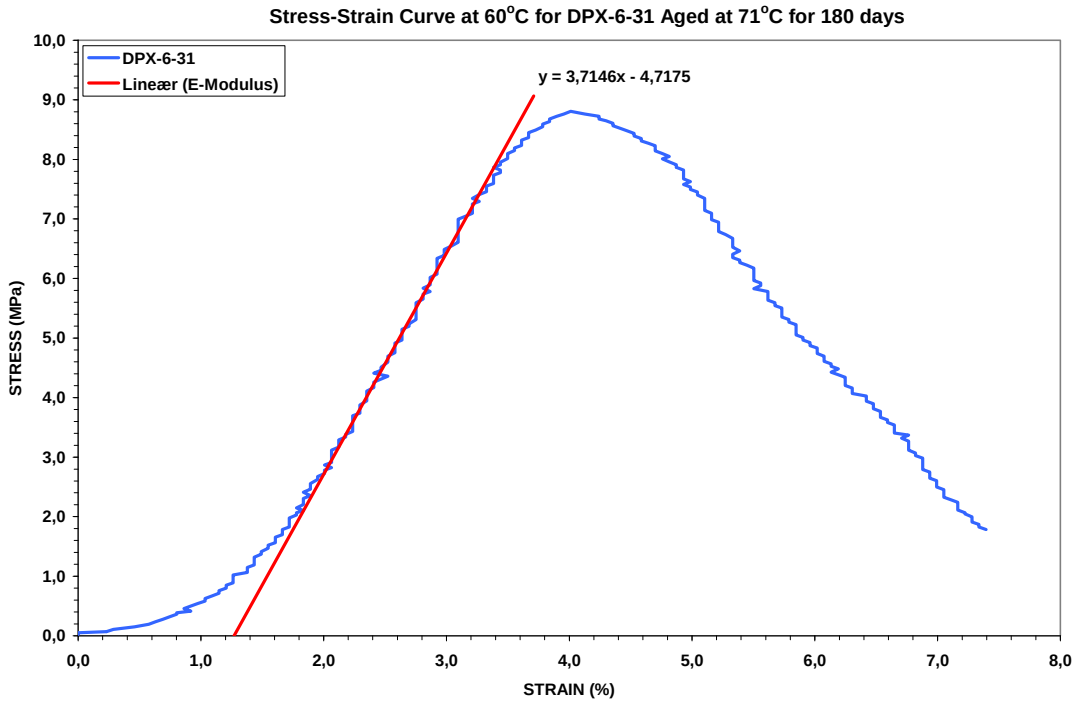
TEST REPORT SHEET
Uniaxial Compressive Test
Page 2 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 60
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.30 mm
Width:
Thickness (Diameter): 20.87 mm
X-Sectional Area (cm^2): 3.421
Form: Cylindrical
Preparation Method: As received L/D=1.0206
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-31 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 8.807 MPa STRAIN at Max Stress: 4.01 % E-Modulus: 371.46 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

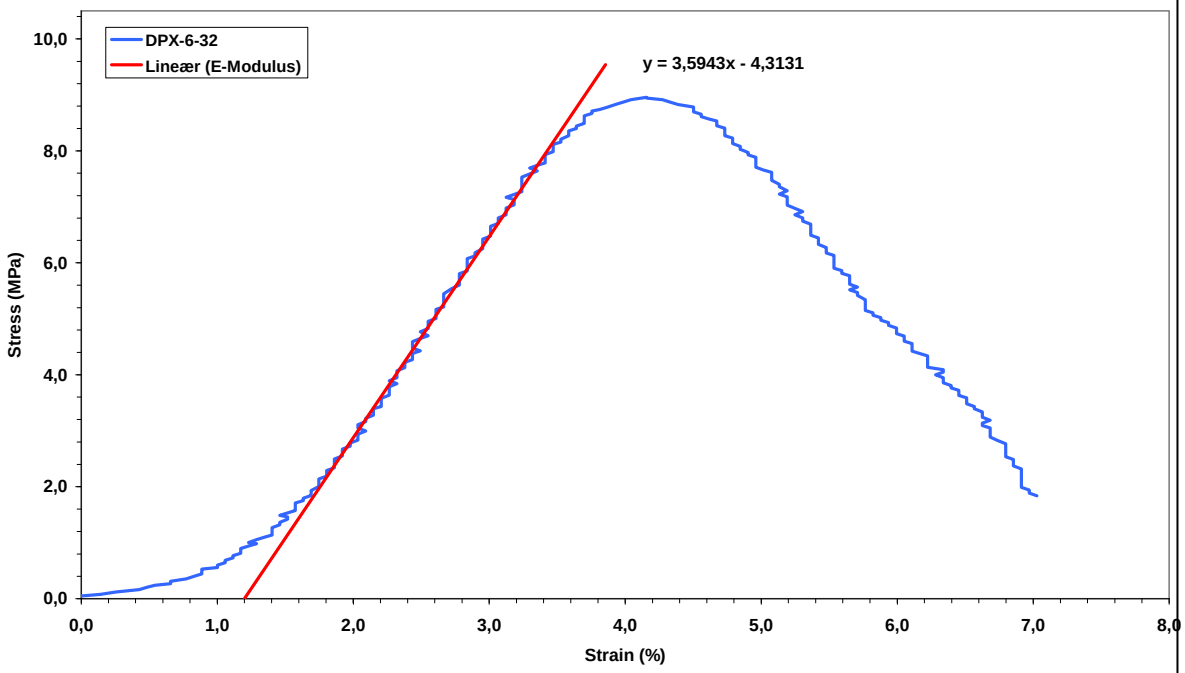
TEST SITE INFORMATION
Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (^{o}C): 60
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.27 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0235
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-32 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1

Stress-Strain Curve at 60°C for DPX-6-32 Aged at 71°C for 180 Days



Max STRESS: 8.955 MPa STRAIN at Max Stress: 4.158 % E-Modulus: 359.43 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

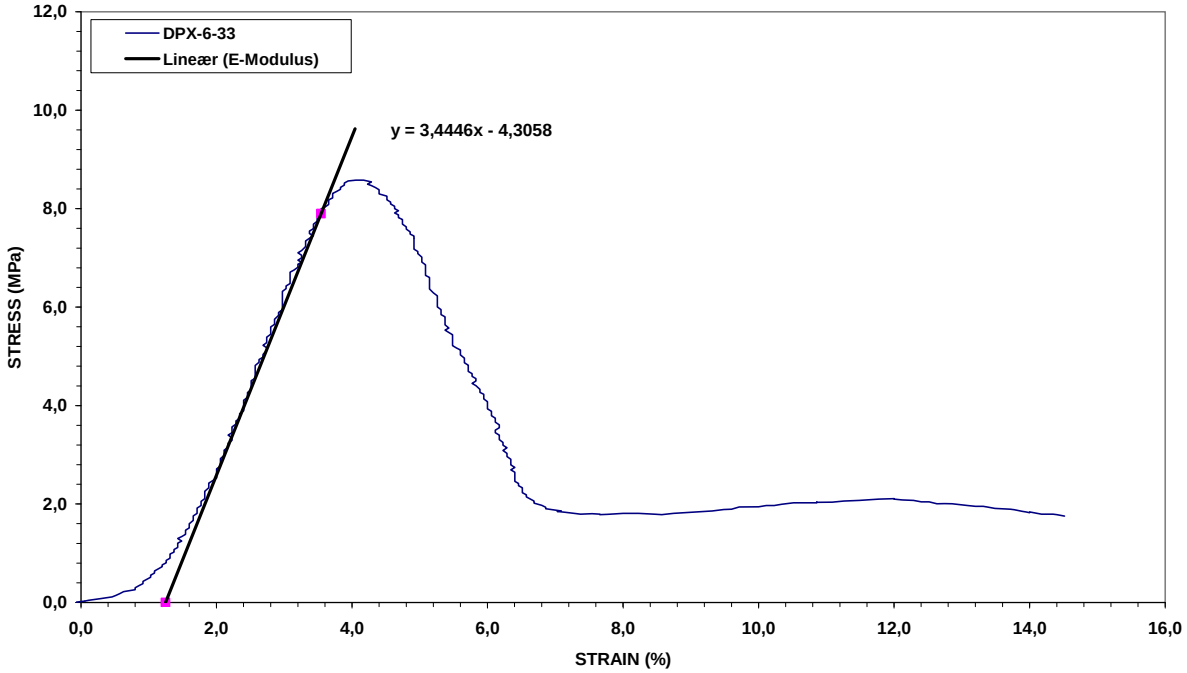
TEST SITE INFORMATION
Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 21 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): 60
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.36 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0230
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-33 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1

Stress-Strain Curve at 60°C for DPX-6-33 Aged at 71°C for 180 Days



Max STRESS: 8.577 MPa STRAIN at Max Stress: 4.115 % E-Modulus: 344.66 MPa

B.5.4 Low Temperature

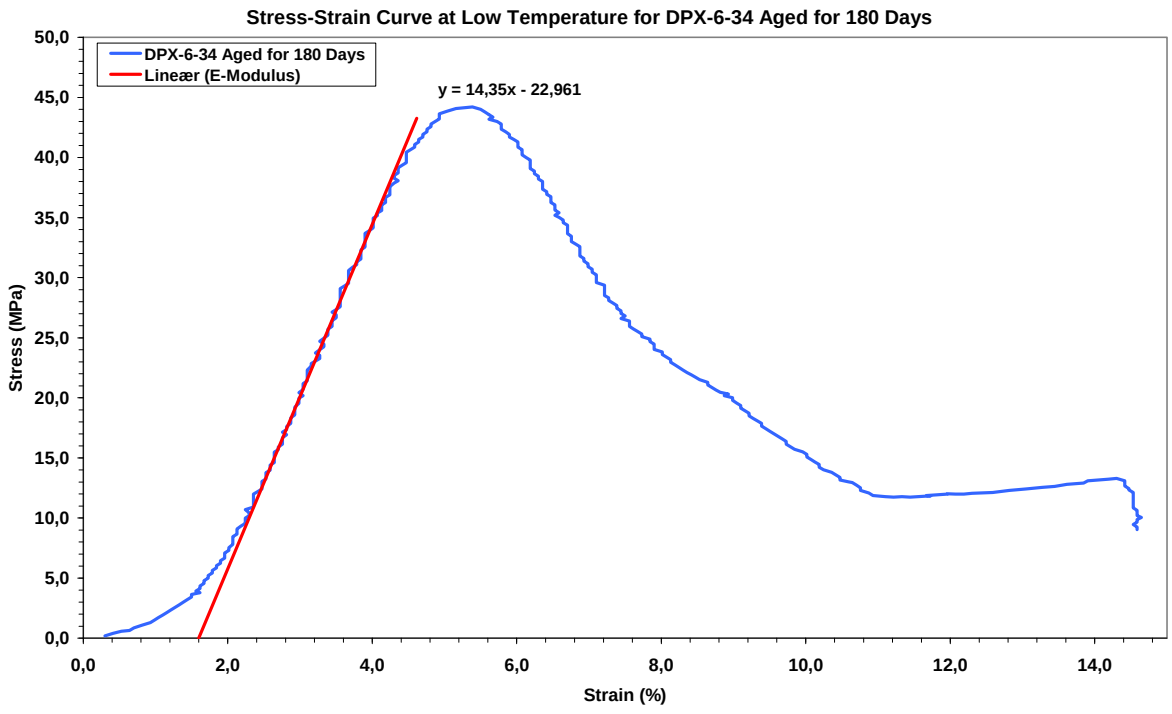
TEST REPORT SHEET
Uniaxial Compressive Test Page 1 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.36 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0230
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-34 Aged 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 44.206 MPa STRAIN at Max Stress: 5.386 % E-Modulus: 1435 MPa

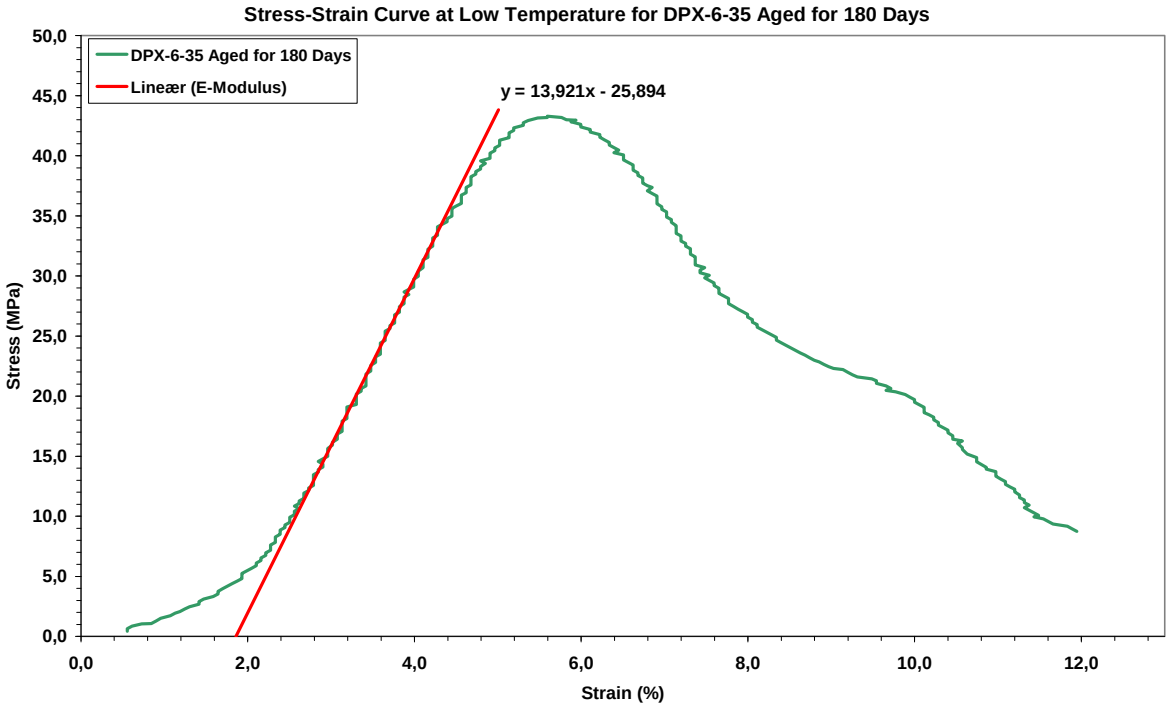
TEST REPORT SHEET
Uniaxial Compressive Test
Page 2 of 4 Pages

TEST SITE INFORMATION
Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION
Dimensions: Length (Gage Length): 21.33mm
Width:
Thickness (Diameter): 20.87mm
X-Sectional Area (cm^2): 3.424
Form: Cylindrical
Preparation Method: As received L/D=1.0220
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-35 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 43.356 MPa STRAIN at Max Stress: 5.59% E-Modulus: 1392.1 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

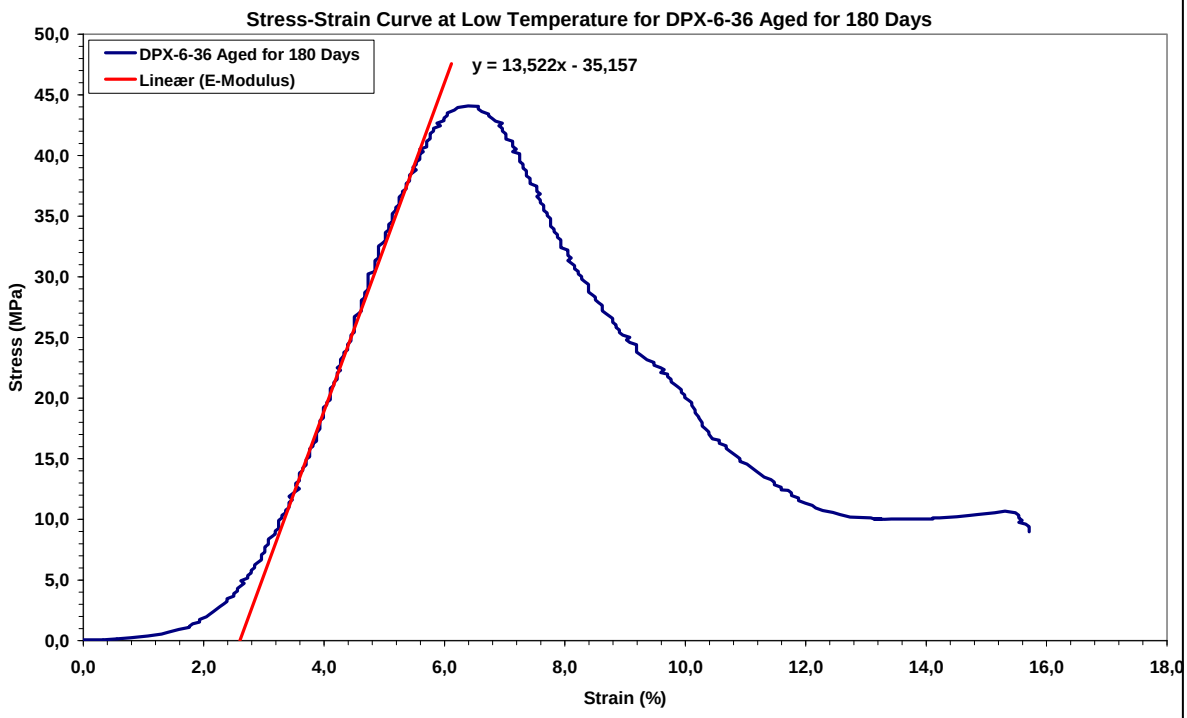
TEST CONDITIONS

Temperature (^{o}C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.35 mm
Width:
Thickness (Diameter): 20.89 mm
X-Sectional Area (cm^2): 3.421
Form: Cylindrical
Preparation Method: As received L/D=1.0220
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-36 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1



Max STRESS: 44.092 MPa STRAIN at Max Stress: 6.39 % E-Modulus: 1352.2 MPa

TEST REPORT SHEET
Uniaxial Compressive Test

TEST SITE INFORMATION

Laboratory: FFI
Date: 10 November 2006
Test Procedure:
NATO Test Procedure Number: 102.01
Date Tested: 28 October 2006
POC: Gunnar Ove Nevstad

TEST CONDITIONS

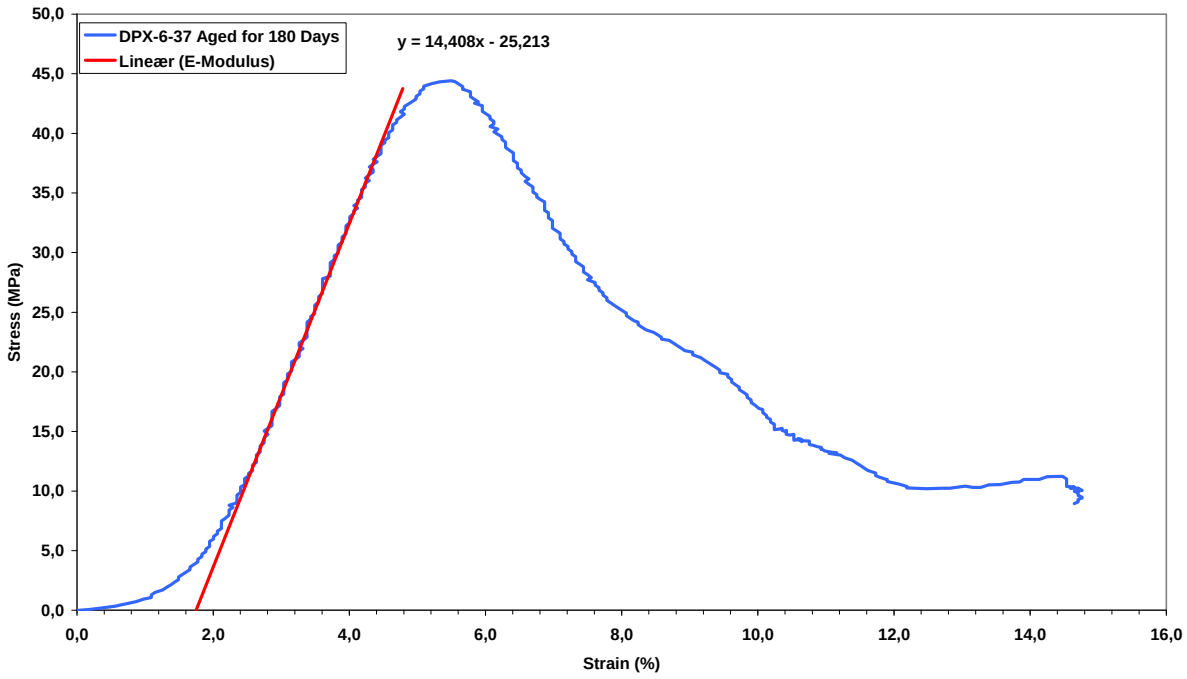
Temperature (°C): -50
Relative Humidity (%): NA
X-Head Speed (mm/min): 50
Machine Type: MTS Servo Hydraulic Tester
Grip Type:
Machine Stiffness (kN/mm):

SPECIMEN INFORMATION

Dimensions: Length (Gage Length): 21.34 mm
Width:
Thickness (Diameter): 20.88 mm
X-Sectional Area (cm^2): 3.427
Form: Cylindrical
Preparation Method: As received L/D=1.0220
Manufacturing Method: Pressed with Vacuum, Dwell time 60 s, Force 2000 kp/cm^2.
Source: Dyno Nobel
Lot or ID Number: Ch 06/05 Pellet No DPX-6-37 Aged for 180 Days
Preconditioning:
Condition Period: 3 hours
Composition: DPX-6

Component	Percent
HMX	50.0
Aluminium	45.9
DOA	3.0
HYTEMP	1.1

Stress-Strain Curve at Low Temperature for DPX-6-37 Aged for 180 Days



Max STRESS: 44.420 MPa STRAIN at Max Stress: 5.50 % E-Modulus: 1440.8 MPa

References

(1) NATO (AC/326 Subgroup 1) (2001): STANAG 4170 Edition 2, "Principles and Methodology for Qualification of Explosive Materials for Military Use".

(2) NATO /AC/326 Subgroup 1) (2004): AOP-7, Edition 2 Rev. 1, "Manual of Data Requirements and Tests for the Qualification of Explosive Materials for Military Use".

(3) NATO /MAS (1998): STANAG 4443 PPS (EDITION 1), "Explosives Uniaxial Compressive Test ". MAS/285-PPS/443, 14 July.