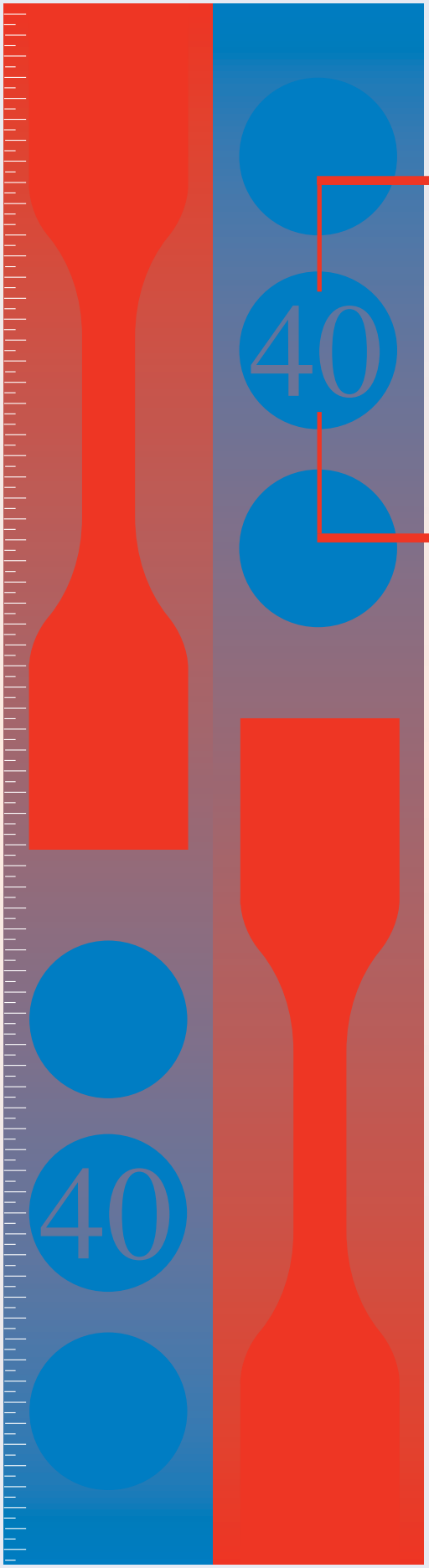

Natural Ageing of Rubber

40 Years

Changes in Physical Properties Over 40 Years

R.P. Brown and T. Butler

RAPRA TECHNOLOGY LTD.

Europe's leading independent plastics and rubber specialists

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This report is an output from the Weathering of Elastomers and Sealants project which forms part of the UK government's Department of Trade and Industry's Degradation of Materials in Aggressive Environments Programme.

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Contents

1 INTRODUCTION

The idea of an extended natural ageing programme was developed in the early postwar years when there was a much wider range of raw rubbers to choose from than there had ever been before and rubber manufacturers were rather bewildered by their wide range of properties. One constantly recurring question was 'How long will it last?' Many of the rubbers had not been in existence long enough for this question to be answered, so it was felt that a systematic storage programme should be set up. Forty years on, the same question is the most frequently asked after those of cost and delivery.

After considerable discussion, it was decided that storage would be carried out under temperate climatic conditions and also under hot-wet and hot-dry conditions in the tropics. A fundamental point debated at length was whether or not test pieces should be exposed outdoors. As quantitative tests on weathered test pieces can be erratic, it was decided to limit the work to indoor exposure under conditions which allowed free access of air but which substantially excluded light. With the exception of a long term compression set annulus, the test pieces were unstrained. Hence, the exposure conditions were intended to simulate shelf storage where care had been taken to exclude light and to avoid distortion of the material but where air at the ambient temperature and humidity could circulate.

Initially, it was thought that 20 years would be a reasonable total time of exposure with samples being tested after the first and second years and subsequently at 2-year intervals. After 11½ years it was decided that, as there was a relatively slow rate of change for most materials, the interval between testing would be increased to 4 years which would mean that the last samples were returned after approximately 27½ years. After 19½ years, the interval was again extended to 10 years to give 40 years' total exposure time.

Results have appeared at intervals in Rapra Members' publications and in reports to sponsors but not in the scientific press. This report covers the full results up to 40 years.

2 MATERIALS

The test pieces used in the programme were produced from compounds with the formulations given in appendix 1. At the time, some technologists felt that compounding would be completely different after 20 years let alone after 40. It is perhaps surprising that compounding has changed relatively little and most of the formulations are relevant today. Most noticeable is the absence of more recent polymers such as EPDM.

Four natural rubber compounds were selected. Compound A was selected as it had been used for many years as a standard material at Rapra which loosely represented a tyre tread or high grade conveyor belt cover compound. Compound B has what became known as an efficient vulcanising system with no elemental sulphur, although the term had not then been coined. Compound C represents a fairly high rubber content non-black filled material. The final natural rubber compound (D) was requested by the electrical side of the industry as a highly loaded, low grade insulation material and was said to exhibit good ageing properties in the dark.

Compounds E and F are styrene butadiene rubbers corresponding to natural rubber compounds A and B whilst G and H are oil-extended versions.

Compounds J and K were referred to as general purpose and good ageing butyl compounds, respectively. They represent the extremes of polymer available, with high and low unsaturation, respectively.

The three polychloroprene compounds came from the polymer supplier and were labelled general purpose (L), natural ageing (M) and heat ageing (N).

The two nitrile rubber compounds were suggested by the main UK supplier at the time to represent a general purpose material (P) and a good ageing formulation (R).

The remaining compounds were also suggested by the relevant suppliers as general purpose materials.

3 PREPARATION OF TEST PIECES

Cure times could not be derived from measurements in a curemeter as these instruments were only in the experimental stage. As a preliminary exercise, the chosen compounds were moulded at four cure times and the physical properties measured. Optimum cure times were derived using a weighted averaging method which gave greater weight to set and tensile strength and less to hardness and modulus. The empirical method utilised had been in use at Rapra for many years. Properties were also measured after oven ageing and the results taken into account in selecting cure times because it was known that the empirical method could underestimate cure which would then show up on ageing.

The cure conditions arrived at are presented along with the compound formulations in appendix 1.

Trial mixes were made and checks carried out to ensure that the chosen conditions did produce adequate cure.

4 PHYSICAL TESTS

Before exposure and at the end of each period of natural ageing, it was intended that the following tests were to be made, where possible in accordance with the relevant part of BS 903 current at the beginning of the project:

- Hardness (Dead load method),
- Volume change after 14 days in benzene at 25°C*,
- Volume change after 14 days in 75/25 iso-octane/toluene at 40°C,
- Resilience (Lupke Pendulum),
- Volume and surface resistivity,
- Tensile strength,
- Elongation at break,
- Stress at 100% and 300% elongation,
- Compression set after 24 hrs at room temperature, 30 min recovery,

- Long term compression set on an annular test piece exposed at 25% compression,
- Low temperature stiffness (Gehman test), and
- Strain using the NBS strain tester*.

*denotes discontinued test which is not reported.

Despite the changes in test equipment and in the standard methods since the start of the programme every effort has been made to use the original test procedure at each stage.

Stress at 300% elongation could not be recorded for all rubbers over the 40 year period simply because for some materials the elongation at break was below 300%. The NBS strain tester measurements were discontinued after 5½ years, presumably because the results were considered of little value and because this method is rarely used in the UK. The swelling in benzene measurements were discontinued after 11½ years because of a policy not to use benzene for health and safety reasons. Measurements of low temperature stiffness and electrical resistivity were not made at all stages because they are time consuming and hence costly, but little change had been seen and the results had a large degree of scatter.

Tests after accelerated ageing were also conducted at the start of the work but these were only single temperature exposure. A full accelerated ageing programme is now being carried out on re-mixed materials.

5 EXPOSURE OF TEST PIECES

Sets of test pieces for each rubber were carefully packed in aluminium boxes, 200 mm x 100 mm x 38 mm, pierced with ventilation holes. The aluminium from which the boxes were made was free from copper and manganese. The test pieces were suspended in the box by aluminium wires and kept apart by ceramic beads. The assembly line production is shown in **Figure 1** and a part completed box in **Figure 2**.

Each box contained six test pieces for tensile stress/strain measurements, two strain test pieces, one test piece for low temperature measurements, two large compression set pieces which also serve for hardness measurements, four small compression set discs for swelling measurements, one Lupke disc for both electrical resistivity and resilience tests and the special compression annulus test piece for long term set. All test pieces except the long term compression set annulus were exposed in the unstrained state. A completed box without the lid is shown in **Figure 3**.

Thirty-three identical boxes were prepared for each of the nineteen rubbers. Eleven of these for each rubber were retained at Shawbury on shelves in a physical testing laboratory. Eleven for each rubber were established in December 1958, with the active co-operation of the Australian Government, at each of the Australian sites: Cloncurry and Cairns. A stack of boxes is shown in **Figure 4** and, in **Figure 5**, a storage shed at Cloncurry.

In 1964, the boxes were moved from Cairns to Innisfail which is 60 miles along the coast and which has a similar climate.

Figure 1

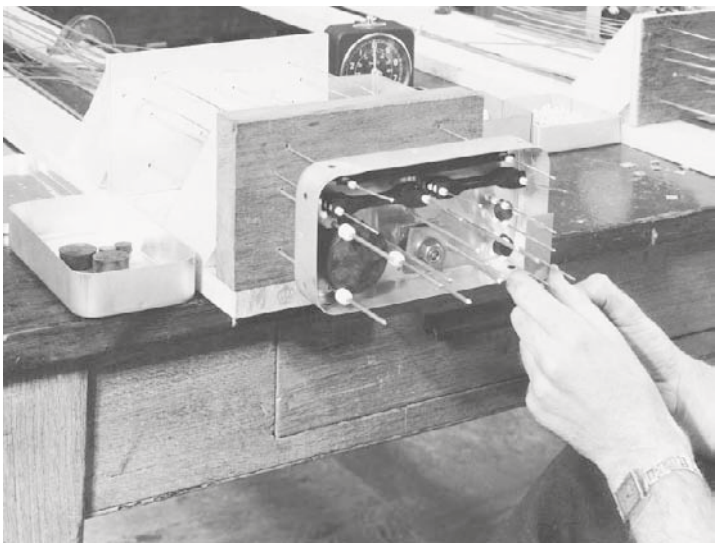


Figure 2

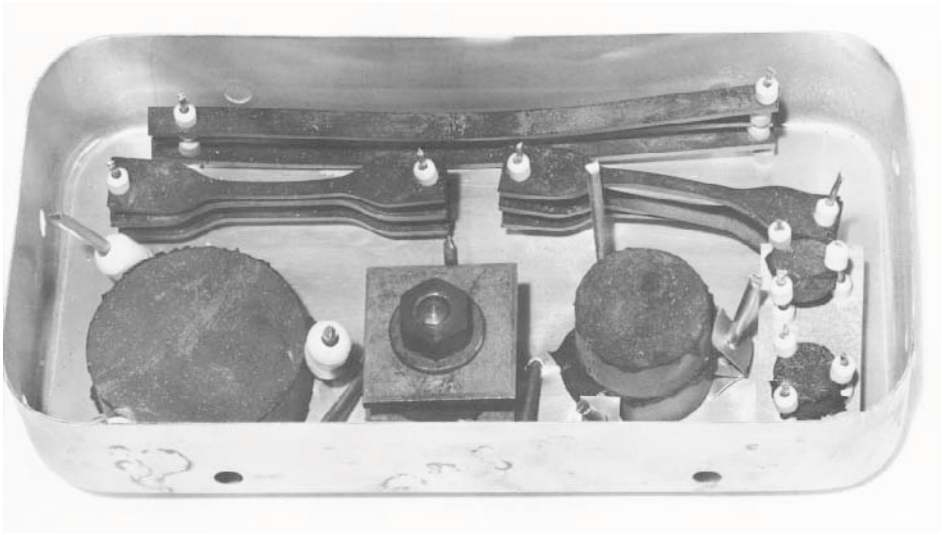


Figure 3

Figure 4

Figure 5

6 CLIMATE

The storage at Shawbury represents a temperate climate and because the location was a laboratory the conditions were relatively constant. The temperature range was 18-25°C which covers the two standard laboratory temperatures in use over the 40 years, 20 ± 2°C and 23 ± 2°C. Humidity was not controlled but was generally 50 ± 10% with a total range of about 35-80%.

The two Australian sites were in Queensland at what was known as the Joint Tropical Science Unit (JTSU). At both sites, the boxes were stored in well ventilated buildings protected from direct sunlight and rainfall.

Cloncurry is about 250 miles from the nearest coast and is representative of hot, dry conditions. Over the years 1963 to 1998 the average daily minimum, mean and maximum temperatures were 18.8°C, 25.6°C and 32.4°C, respectively. In 8 months of the year, temperatures of over 40°C were recorded. The average daily minimum, mean and maximum relative humidities were 29%, 46% and 63%, respectively. It dipped below 10% in every month. Microbiological activity is reported to be insignificant, and in summer months, the site is subject to wind-blown dust.

The site known as Pin Gin Hill, near Innisfail, is a jungle clearing about 6 miles from the coast and is representative of hot, wet conditions. The average daily minimum, mean and maximum temperatures during the period 1963-1998 were 19.8°C, 23.6°C and 28.2°C, respectively. Temperatures above 30°C were experienced every month. The average daily minimum, mean and maximum relative humidities were 61%, 83% and 96%, respectively. The average daily mean was never below 79%. Cairns, where the samples were stored in the earlier years, has a similar climate.

7 RESULTS

7.1 Presentation

The results for each property at each exposure site are plotted as a function of exposure time. For convenience, the results for one property from all three sites are plotted on one sheet.

One test piece was used for the measurement of long term compression set, volume resistivity, low temperature properties and resilience; the resilience results are the means of 3 readings. The tensile properties are the medians of results on 3 test pieces. Values for volume change and compression set are the means of results on 2 test pieces. Hardness results are the means of 2 readings on each of 2 test pieces.

A best fit line was then constructed by computer for each graph. The function used was selected from linear, exponential rise to a maximum, exponential decay and square root of time. The function was selected on an empirical basis except for a property, such as compression set, which must reach a plateau, when the exponential rise to a maximum function was used. Where appropriate, more than one function was tried and that giving the best fit selected. Any obvious 'rogue' data was ignored during the fitting procedure. Generally, the difference between possible alternative functions was usually small in terms of general fit but even small differences

at the beginning and end of the plots can be very significant in terms of the change in property over 40 years. In some cases, it was clear that a more complex function would be required to give a good fit over the whole time scale.

The initial and 40 year values for each property and site were then read off the best fit lines (see exceptions below). This means that these values are not necessarily the same as the initial and final plotted data points and that the initial values are not necessarily the same for each of the sites. This treatment gives no special weighting to the initial unaged data, nor to the final 40 year results. Exceptions were made for plots which clearly needed a more complex function; in these cases, the initial and final points were taken from a best fit line drawn by eye (not illustrated).

From the initial and final values, the differences and the differences expressed as percentage change have been tabulated. Values were generally read to three significant figures and, to avoid misleading rounding errors, the percentage changes are given to two significant figures. This does not imply accuracy to the number of figures recorded. It should be noted that, in many cases, alternative best fit lines could be drawn which would lead to different figures in the tables.

In the case of long term compression set, the plotted curves do not go through the origin because of limitations in fitting fairly simple functions. The tabulated results are the set at 40 years. The intercepts on the y axis (not tabulated) are a measure of set at short times.

Whenever possible, values are quoted for modulus at both 100% and 300%. In some cases, values for 300% were not available for the later years. This necessitated the extrapolation of the best fit line through the forty year point in order to produce an up-to-date percentage change value.

The data collected are presented in appendix 2, by compound.

It is appreciated that the fitting of lines to the data points and the way of expressing the changes used are by no means the only ways in which the results could be analysed.

7.2 Uncertainty

In order to make a realistic assessment of the significance of the results, it is necessary to make an estimation of the variability of the test results. Inevitably, over such a long time period with changes in personnel and equipment, as well as natural variability of the material and of the ageing process, a considerable degree of variability must be expected. It is also extremely difficult to make a sensible assessment of this variability because so many factors are unknown.

One indication of variability can be obtained from tests carried out on reference compounds which had been mixed, vulcanised and tested at Rapra once per week during the period 1959 to 1963. Certain of the compounds selected for the long term ageing programme were identical or similar to these standard reference compounds. As a typical example, the coefficient of variation of the mean results obtained on an SBR tyre tread compound averaged 10% for tensile properties before and after ageing, 20% for compression set and 2.5% for hardness.

These figures include the variability due to repeat mixes which is not applicable to the long term ageing programme, but do not, of course, include the variability ensuing from change of operator and equipment over a very long time scale.

An indication of variability is illustrated on the graphs by means of error bars. These were derived from standard deviations for repeatability taken mostly from precision statements in ASTM and ISO test method standards. The repeatability standard deviations were multiplied by 2 to give the 95% confidence intervals. It will be appreciated that these error bars simply give an idea of the degree of scatter which might generally be expected.

7.3 Interpretation of Results

The tabulated results give a quick snapshot view of the changes which have taken place over the 40 years. However, the figures giving change and percentage change need to be viewed in context with the level of the property measured and the uncertainty. For example, the 100% modulus figures are generally small so that a relatively minor change may appear as a large percentage change and the experimental uncertainty is large.

The graphical presentation allows at least a subjective assessment to be made of the significance of the recorded changes. In some cases, a clear trend is apparent with little masking by scatter of results, in others the scatter appears dominant. Obviously, the cases with very large scatter lead to larger uncertainty in the level of change found.

Care has to be taken in drawing conclusions on the relative performance of materials because of the large uncertainties. Also, the practical significance of the levels of change will to some extent depend on particular products and applications.

8 DISCUSSION

8.1 General

No detailed analysis of each compound, property by property, has been attempted but comment is made on the general picture which emerges for each property. Four overall observations can be made.

The performances in the three different climates do not always rank consistently in the same order. Hence, it is not sensible to rigidly classify the climates covered in terms of severity.

There are considerable differences in the magnitude of the response to ageing as measured by different properties, which illustrates the generally held view that preferably several relevant properties should be investigated in any ageing trial. It is also clear that the experimental scatter varies very significantly between properties.

The ranking of materials is not consistent across different properties which reinforces the need to consider more than one property when characterising or selecting materials.

Generally, the rubbers have withstood ageing remarkably well, better than many people expected. None of the materials has deteriorated to such a degree as to be totally unusable.

8.2 Hardness and Modulus

All the materials increased in hardness or were essentially unchanged. Generally, the increase was no more than 10° with some compounds showing negligible change but nitrile R increased by up to 26°. Hardness measurements were mostly consistent with relatively modest scatter, although W, for example, had several aberrations in the first 10 years.

The figures for stress at 100% elongation were generally compatible with the hardness results in that there was a rise for most materials, typically in the 50 to 100% region. The nitriles P and R (hot dry) and some of the SBR exposures suffered higher rises whereas the values for acrylate S and polysulphide W showed little change and for silicone X decreased.

The results for stress at 300% elongation were less consistent, mostly where the data was incomplete. Where 300% elongation was retained for 40 years, the stress generally increased and compared reasonably with the 100% figures, although the changes were less.

8.3 Tensile Strength and Elongation at Break

The tensile strengths showed linear behaviour or fairly small curvature but the direction varied with compound. In the worst case (natural A), 75% of the strength was lost but generally changes were considerably less than this. Compounds butyl J, butyl K, polychloroprene L, and nitrile P generally showed least change whilst acrylate S, Hypalon T, polysulphide W, and silicone X tended to rise in strength.

For the great majority of compounds, elongation at break decreased, with the greatest drops reaching more than 80% for naturals A and D but most changes were more modest. There were a few instances of a slight rise in elongation: butyl K in the hot dry climate, polysulphide W in the hot dry and temperate climates (negligible change) and silicone X in the hot wet and temperate climates.

The ranking as given by mechanical tests, in particular the product of tensile strength and elongation, will be considered in a subsequent paper.

8.4 Resilience

Generally, changes in resilience are fairly modest although, where the initial level is low, they appear large in percentage terms. Perhaps surprisingly, most compounds increased in resilience. Exceptions are natural A, and acrylate S for which resilience consistently fell. There is no apparent simple pattern of correlation with other properties.

8.5 Low Temperature Stiffness

Considerable scatter is present in many cases and considering the uncertainties involved the changes are not highly significant. Both increases and falls are seen of a few degrees in the temperatures for 2 and 10 times stiffness increase. There is not even a good correlation between the T2 and T10 values, probably because of the scatter.

8.6 Volume Change

Differences in volume change were fairly modest, the level falling in the great majority of cases. Again, small volume changes give large percentage changes. It can be concluded that resistance to volume change is not a problem after ageing and is often slightly improved.

8.7 Resistivity

For such a difficult measurement on a far from ideal test piece, the results are remarkably consistent. The changes of the lower resistivities appear large in percentage terms but generally are modest when expressed as log Ω cm. In terms of Ω cm, the changes are actually as large as an order of magnitude or more but in the insulating region this would not generally be of practical significance. For the compounds with the lowest resisitivities, the changes could be important. Resistivity increased or was unchanged in most cases but a downward trend appeared possible with compounds acrylic S, Hypalon T and polysulphide W in some conditions.

8.8 Compression Set

Due to the conditions chosen, the short term set values are almost all relatively low and so changes, which are very modest, will be exaggerated in percentage terms. The exception is Hypalon T which exhibits very significant set. For a number of the compounds, there is a tendency for set to decrease with ageing which would be associated with increased crosslinking.

The long term set results show that all materials exhibit very high levels of set after 40 years. Many are at, or approaching 100%. The most notable exception is acrylate S where the set is of the order of 30-50%. The set measured for silicone X is about 60% and that for polychloroprene L is very variable between sites with a maximum of about 70%. The SBR compounds perform significantly better than the natural rubber compounds. These high levels of set indicate that the remaining force exerted by the rubbers in a sealing application would be very low.

The other important feature is that all materials show a very rapid increase in set in the initial years with a much smaller rise later on. If it is argued that the majority of the initial set is physical, the relative performance without chemical ageing could be judged from, say, the levels after one year.

9 CONCLUSIONS

A comprehensive natural ageing programme involving 19 rubber compounds exposed at three locations for 40 years has been successfully completed.

The changes in physical properties are very dependant on the property measured, the polymer type and the particular formulation. No single parameter gives a complete picture of ageing performance.

None of the rubbers aged in the unstrained condition are unusable after 40 years shelf storage.

Many rubbers aged in the compressed condition, particularly in the hot climates, have set to such an extent after less than 40 years that their ability to act as an efficient seal is very doubtful.

APPENDIX 1
COMPOUND DETAILS

Natural Rubber		
	Ingredient	**Amount (pphr)**
Compound A - Standard Curing conditions: 35' @141°C	Smoked sheet HAF black Stearic acid Pine tar Zinc oxide CBS PBN Sulphur	100 50 2.5 4.5 5 0.5 1.0 2.5
Compound B - Good Ageing Curing conditions: 30' @148°C	Smoked sheet HAF black Stearic acid Pine tar Zinc oxide TMTD PBN MBT	100 50 0.5 4.5 5 2.5 1.0 1.0
Compound C - Mineral Filler Loaded Curing conditions: 20' @ 141°C	Smoked sheet Stearic acid Petroleum-based softener Zinc oxide CBS PBN Sulphur Precipitated calcium carbonate	100 1.5 5 5 0.5 1.0 2.5 80
Compound D - Mineral Filler (Heavy Loaded) Curing conditions: 20' @ 141°C	Smoked sheet Stearic acid Petroleum-based softener Zinc oxide CBS PBN Sulphur Precipated calcium carbonate	100 1.5 25 5 0.6 1.0 3.2 200

Styrene Butadiene Rubber		
	Ingredient	**Amount (pphr)**
Compound E - General Purpose Curing conditions: 40' @ 153°C	SBR 1500 HAF black Stearic acid Petroleum-based softener Zinc oxide CBS PBN Sulphur	100 50 2 4.5 3 1.0 1.0 1.75
Compound F - Good Ageing Curing conditions: 40' @ 153°C	SBR 1500 HAF black Stearic acid Petroleum-based softener Zinc oxide TMTD PBN MBTS	100 50 2 4.5 3 3 1.0 1.0
Compound G - Oil Extended, General Purpose Curing conditions: 40' @ 153°C	SBR 1710 HAF black Stearic acid Petroleum-based softener Zinc oxide CBS PBN Sulphur	100 50 2 4.5 3 1.0 1.0 1.75
Compound H - Oil Extended, Good Ageing Curing conditions: 50' @ 153°C	SBR 1710 HAF black Stearic acid Petroleum-based softener Zinc oxide TMTD PBN MBTS	100 50 2 4.5 3 3 1.0 1.0

Butyl Rubber		
	Ingredient	**Amount (pphr)**
Compound J - General Purpose Curing conditions: 40' @ 153°C	Polysar 301 (high unsaturation) FEF black Zinc oxide Stearic acid MBT TMT Sulphur	100 50 5 2 0.5 1.0 2
Compound K - Good Ageing Curing conditions: 90' @ 153°C	Polysar 100 butyl (low unsaturation) HAF black Zinc oxide Sulphur MBTS GMF	100 50 25 2 4 2

Polychloroprene		
	Ingredient	**Amount (pphr)**
Compound L - General Purpose Curing conditions: 60' @ 153°C	Neoprene type WRT Light calcined magnesia PBN Stearic acid SRF black Petroleum-based softener Robac 22 Zinc oxide	100 4 2 0.5 40 5 0.75 55
Compound M - Natural Ageing Curing conditions: 60' @ 153°C	Neoprene type WRT Light calcined magnesia Akroflex CD Stearic acid SRF black Petroleum-based softener DOTG TMT-MS Sulphur Zinc oxide	100 4 2 0.5 50 5 0.75 0.75 0.75 5
Compound N - Heat Ageing Curing conditions: 60' @ 153°C	Neoprene type WRT Light calcined magnesia Aranox Akroflex CD Octamine Stearic acid SRF black Precipitated calcium carbonate Low volatile process oil Robac 22 Zinc oxide	100 4 0.5 2 3.5 0.5 30 90 8 1 25

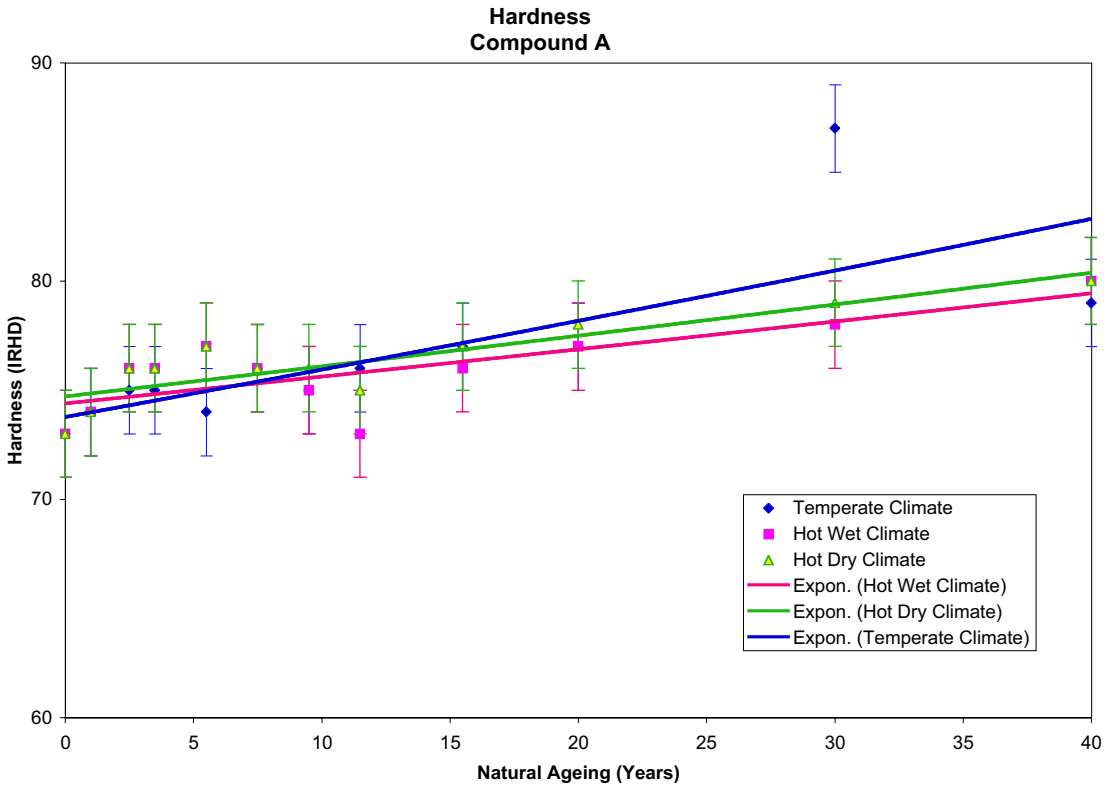
Nitrile Rubber		
	Ingredient	**Amount (pphr)**
Compound P - General Purpose Curing conditions: 40' @ 153°C	Nitrile rubber (ca 25% acrylonitrile) SRF black DOP Zinc oxide Stearic acid PBN MBTS Sulphur	100 50 20 5 1 1 1.5 1.5
Compound R - Good Ageing Curing conditions: 30' @ 153°C	Nitrile rubber (ca 35% acrylonitrile) SRF black DOP Polypropylene adipate Zinc oxide Stearic acid Flectol H TMTD CBS	100 50 10 10 5 1 2 3 3

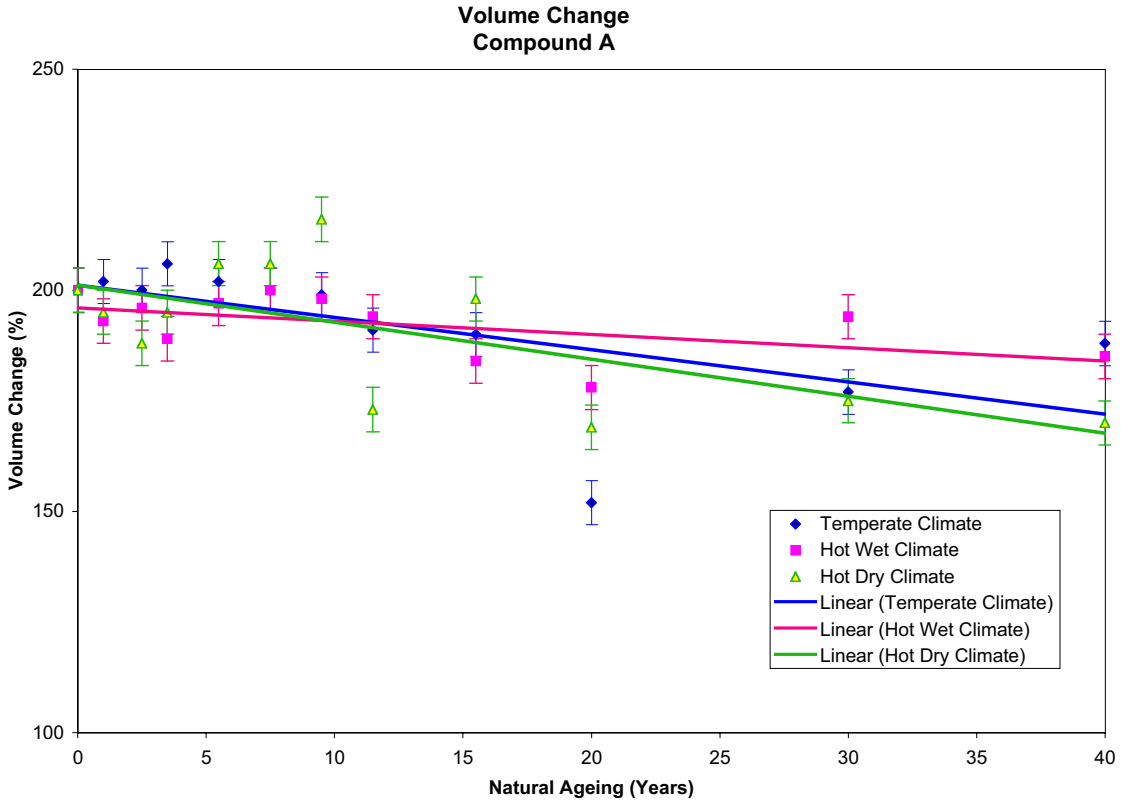
Miscellaneous		
	Ingredient	**Amount (pphr)**
Compound S - Acrylate Rubber Curing conditions: 90' @ 153°C	Hycar 4021 SRF black Stearic acid Triethylene tetramine TMTM Sulphur	100 50 1 2 1 3
Compound T - Chlorosulphonated polyethylene Curing conditions: 30' @ 153°C	Hypalon 20 Precipitated calcium carbonate Hydrogenated wood rosin Litharge MBTS Flectol H Process oil Robac P25 Light calcined magnesia	100 45 5 20 0.5 2 10 0.75 10
Compound W - Polysulphide Rubber Curing conditions: 30' @ 141°C	Thiokol St SRF black Stearic acid GMF Zinc oxide	100 60 3 1.5 0.5
Compound X - Silicone Rubber Curing conditions: 10' @ 135°C Post cure 1 h @ 150°C, 24 h @ 250°C in air	Dimethyl silicone gum (slightly unsaturated) Diatomaceous silica Fine silica Ferric oxide 2:4-dichlorobenzoyl peroxide in silicone fluid	100 45 36 1 2

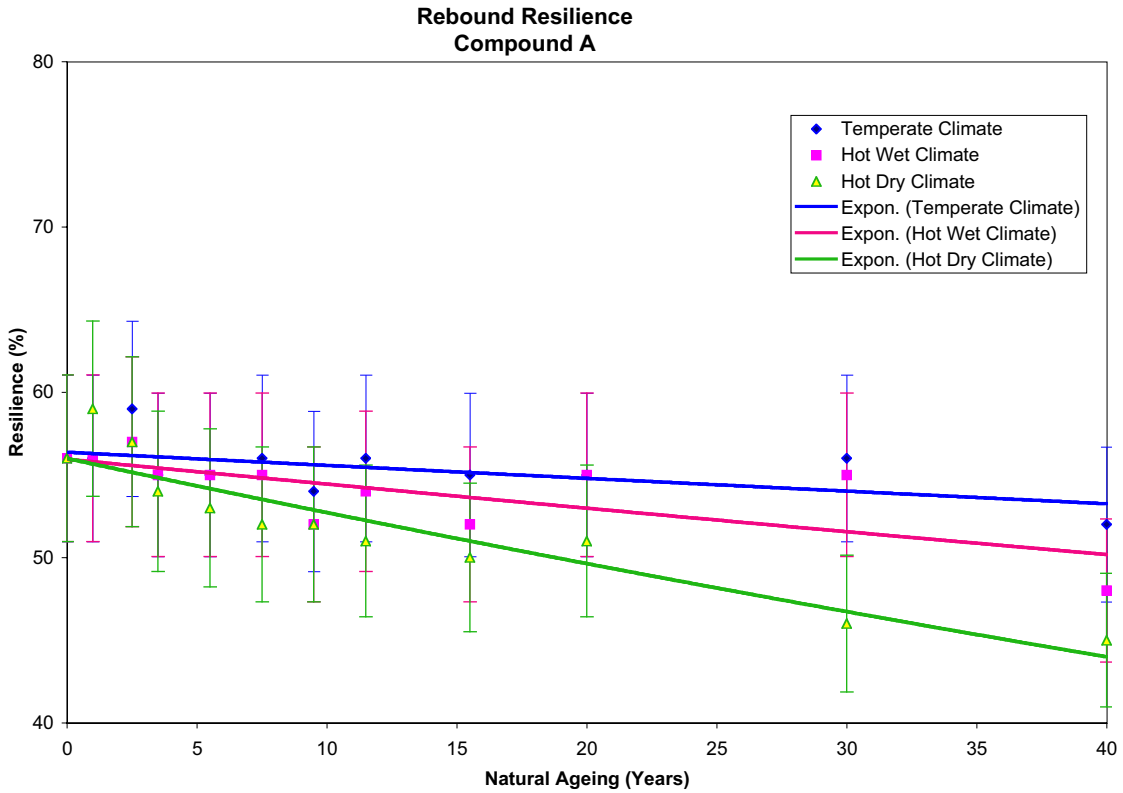
APPENDIX 2
RESULTS

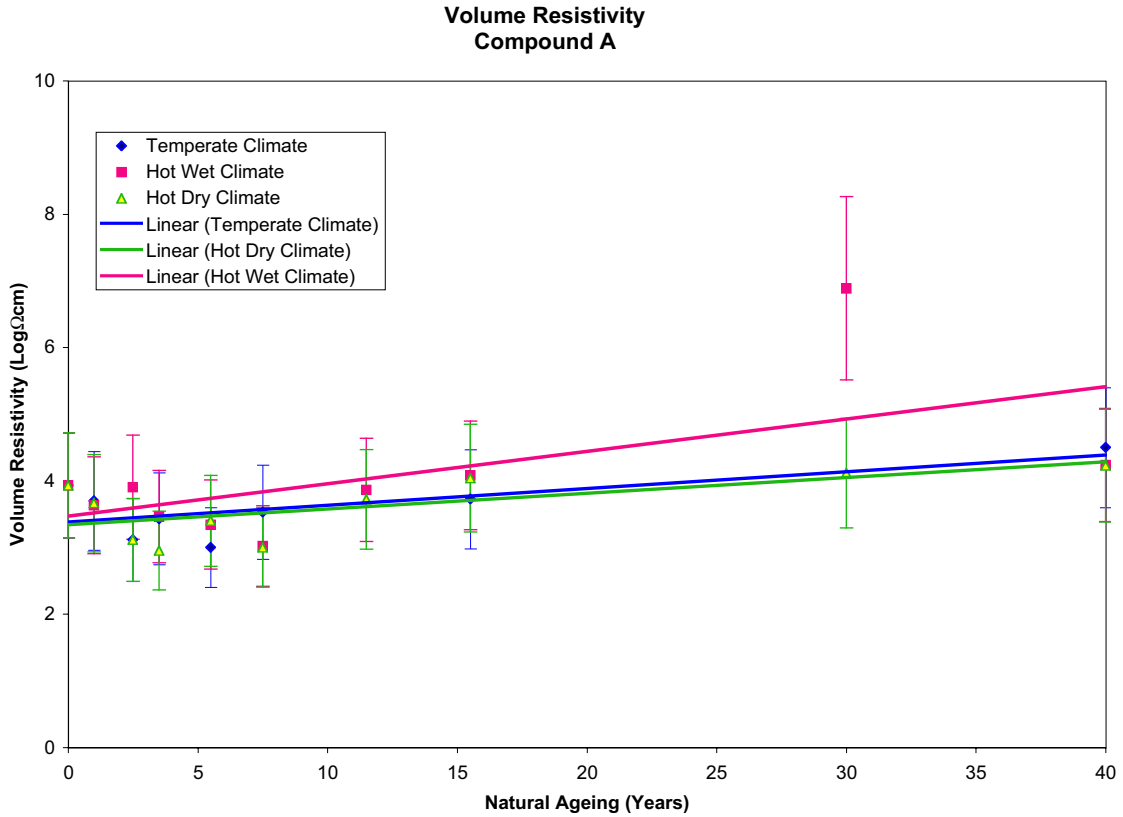
Extrapolated unaged and 40 years natural ageing data: Compound A (natural rubber - standard)

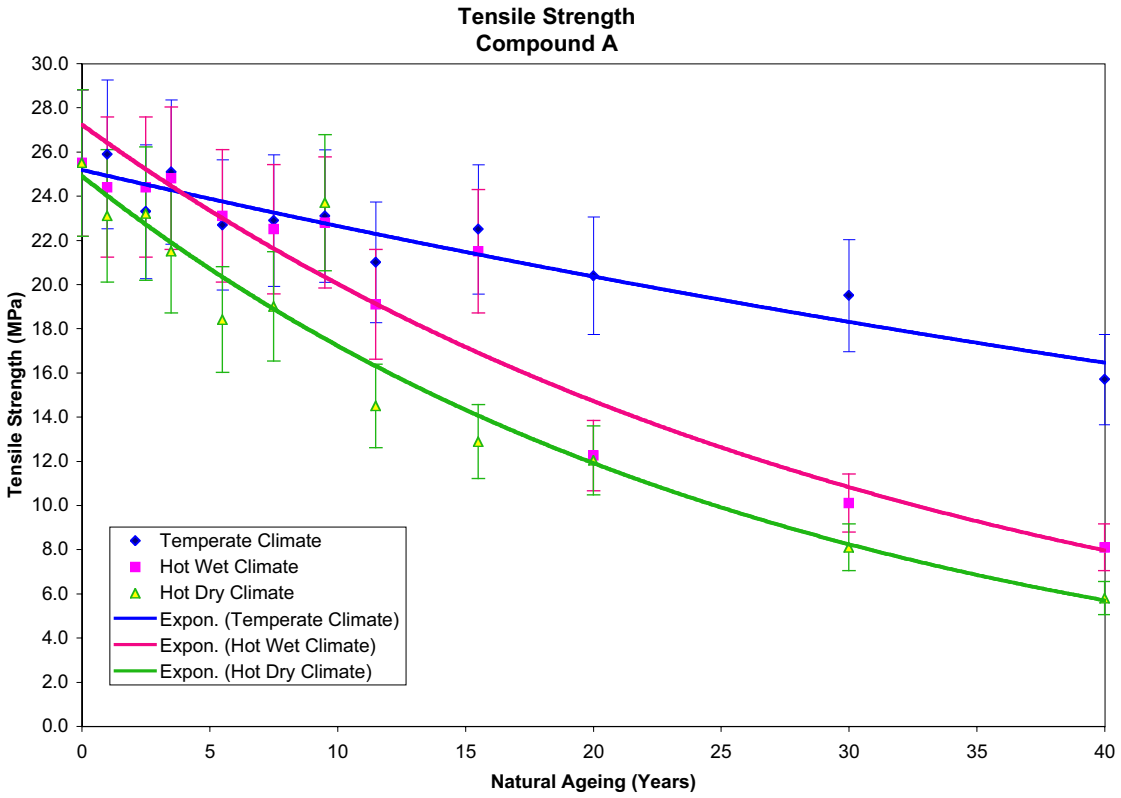
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	73.9	82.9	9.0	12	74.5	79.5	5.0	6.7	74.8	80.5	5.7	7.6
Volume Change (%)	201	173	-29	-14	196	184	-12	-6.1	201	168	-33	-16
Rebound Resilience (%)	56.3	53.3	-3.0	-5.3	56.0	50.3	-5.7	-10	56.0	44.0	-12	-21
Volume Resistivity (LogΩcm)	3.42	4.42	1.0	29	3.37	4.29	0.92	27	3.50	5.42	1.9	55
Tensile Properties												
Tensile Strength (MPa)	25.3	16.5	-8.8	-35	27.3	8.00	-19	-71	25.0	5.75	-19	-77
Elongation at Break (%)	428	223	-205	-48	438	128	-310	-71	405	77.5	-328	-81
Modulus at 100% (MPa)	4.42	6.38	2.0	44	4.58	6.21	1.6	36	5.17	7.42	2.3	44
Modulus at 300% (MPa)	18.3	24.8	6.5	36	18.5	22.9	4.4	24	17.8	25.8	8.0	45
Compression Set												
Short Term (%)	7.42	8.75	1.3	18	7.08	12.8	5.7	81	6.67	13.9	7.2	108
Long Term (%)	0.0	100			0.0	104			0.0	110		
Low Temperature Properties												
T2 Value (K)	245	255	11	4.3	247	254	7.5	3.0	248	264	17	6.7
T10 Value (K)	223	223	-0.40	-0.2	223	222	-0.50	-0.2	225	229	4.3	1.9

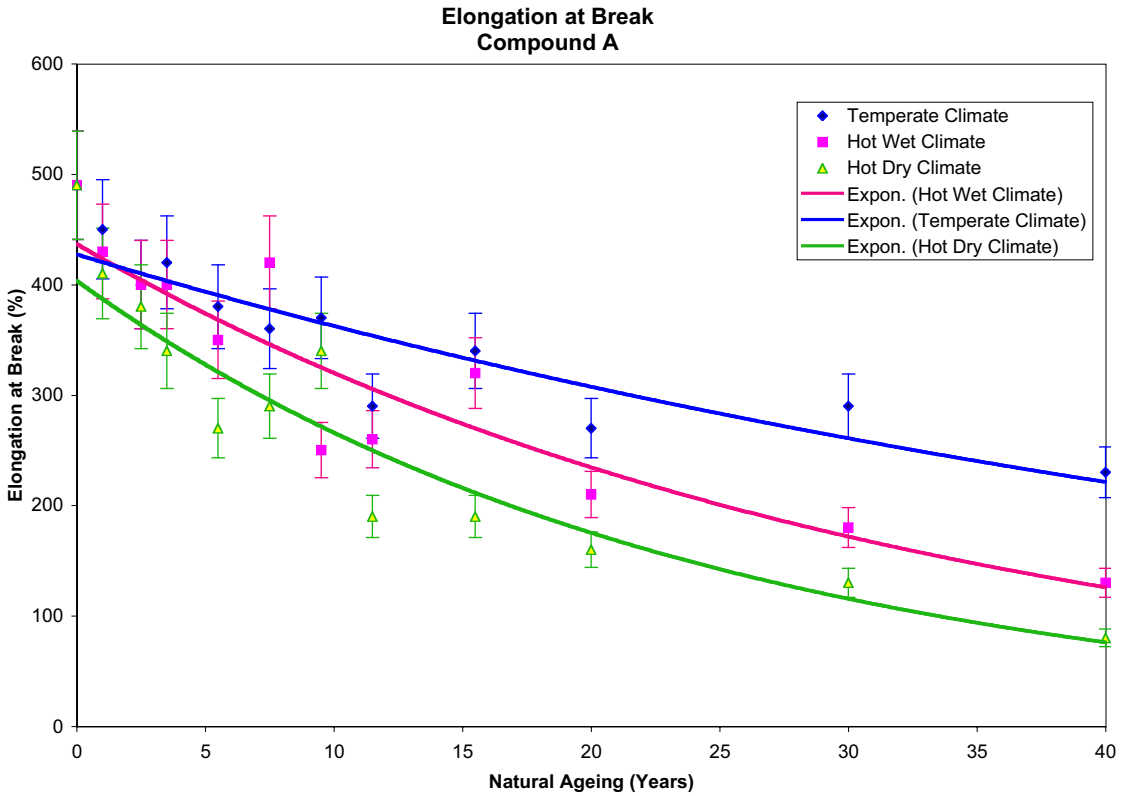

Hardness
Compound A
Hardness (IRHD)
Natural Ageing (Years)
90
80
70
60
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
Expon. (Temperate Climate)

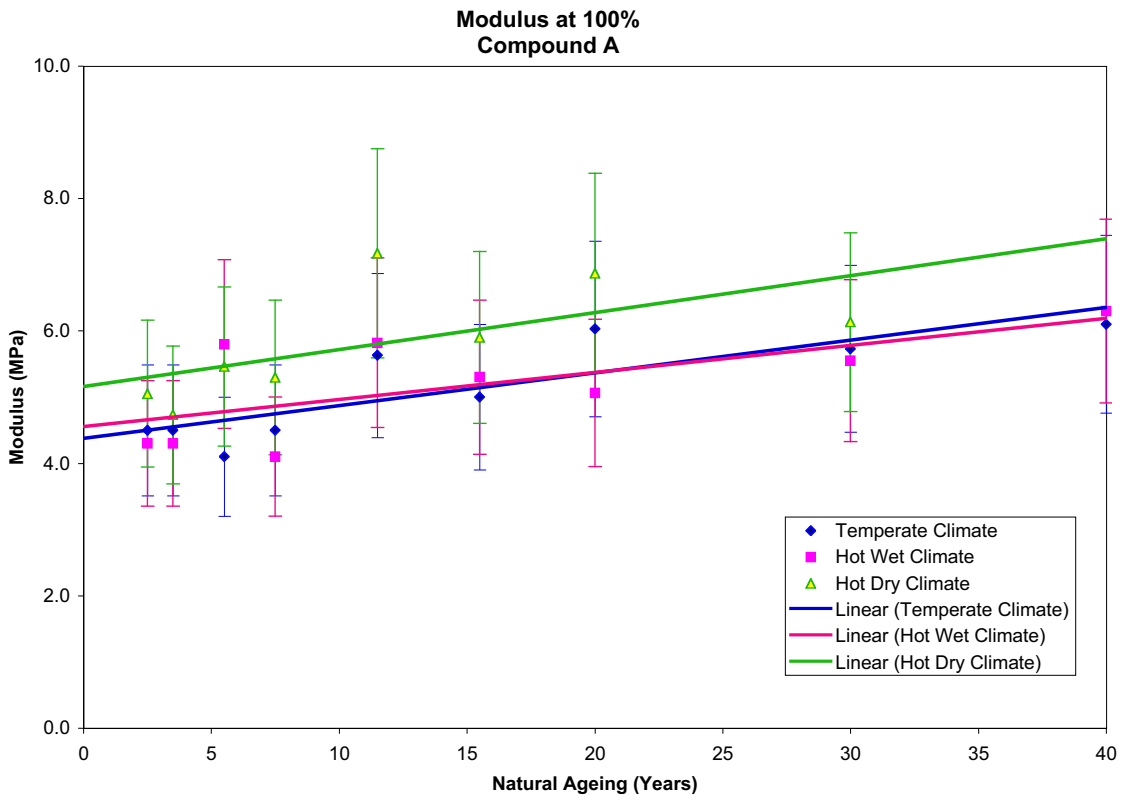

Volume Change
Compound A
Volume Change (%)
Natural Ageing (Years)
250
200
150
100
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

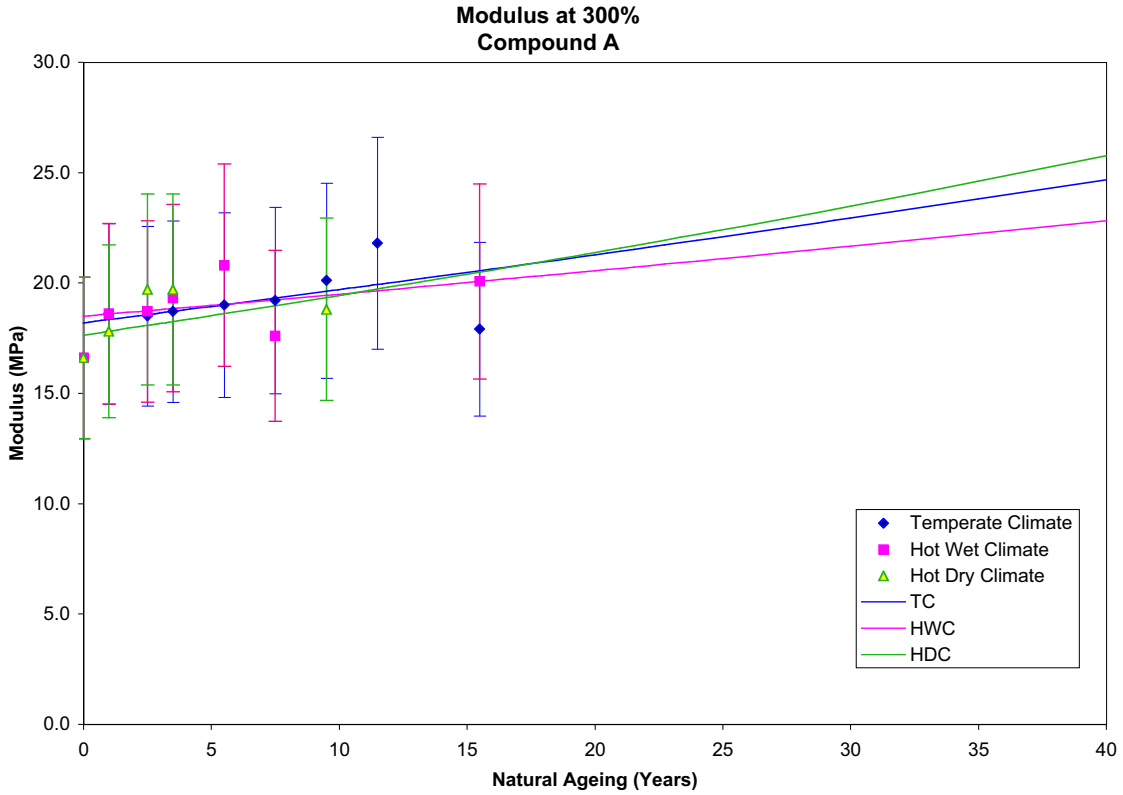


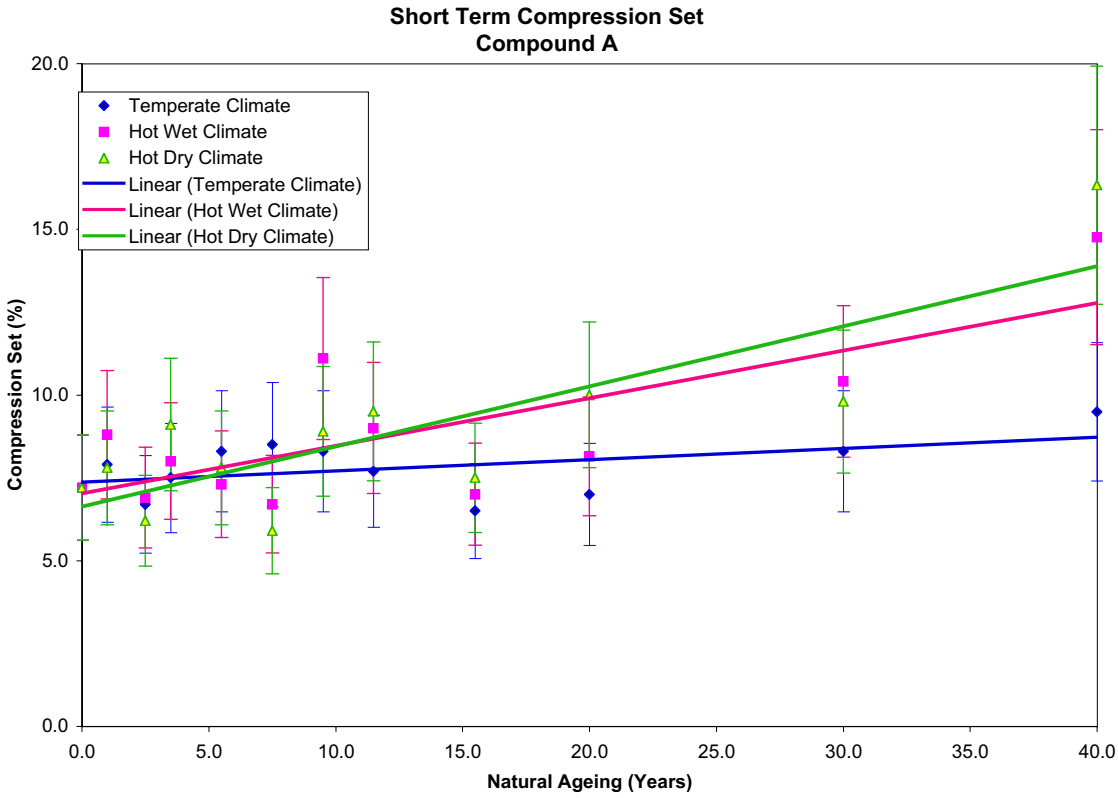


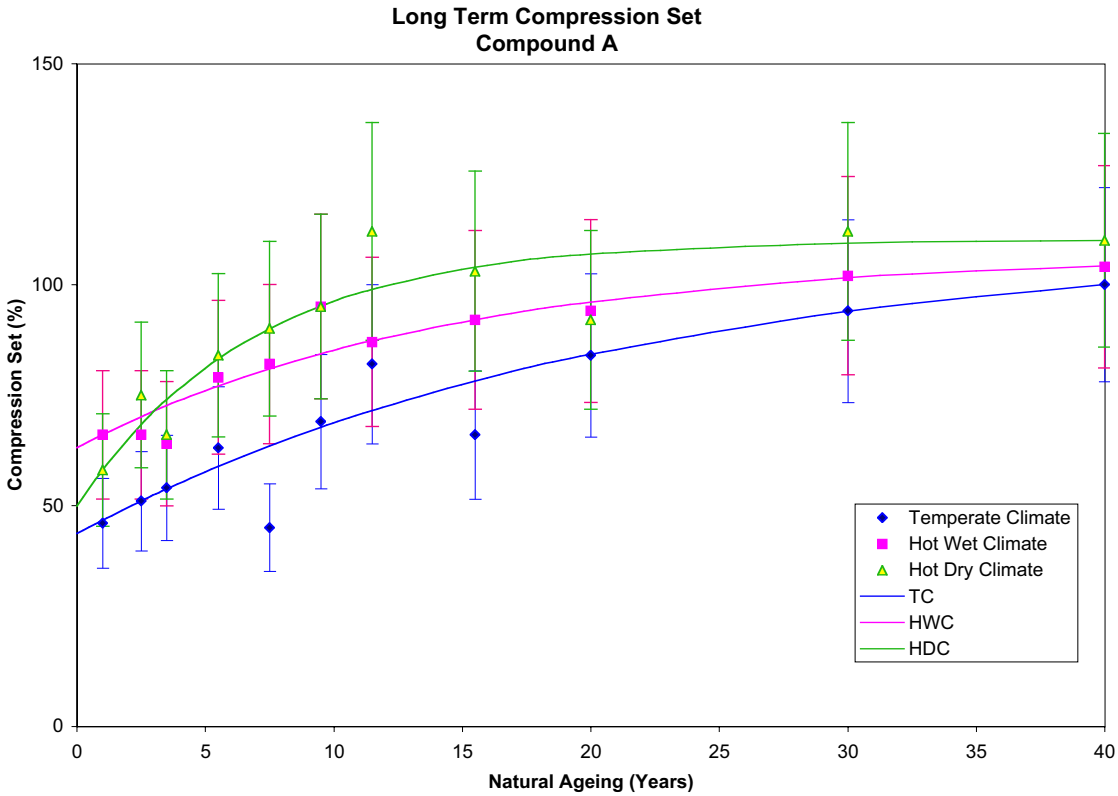

Tensile Strength
Compound A
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

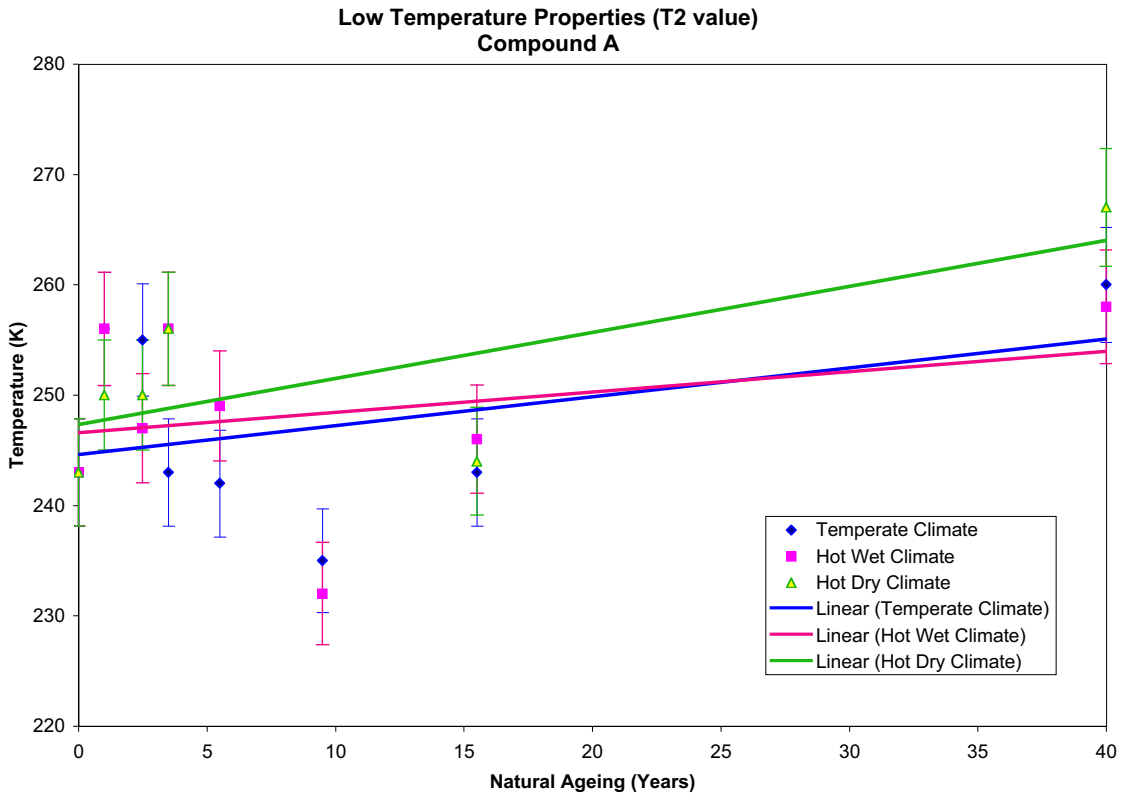

Elongation at Break
Compound A
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

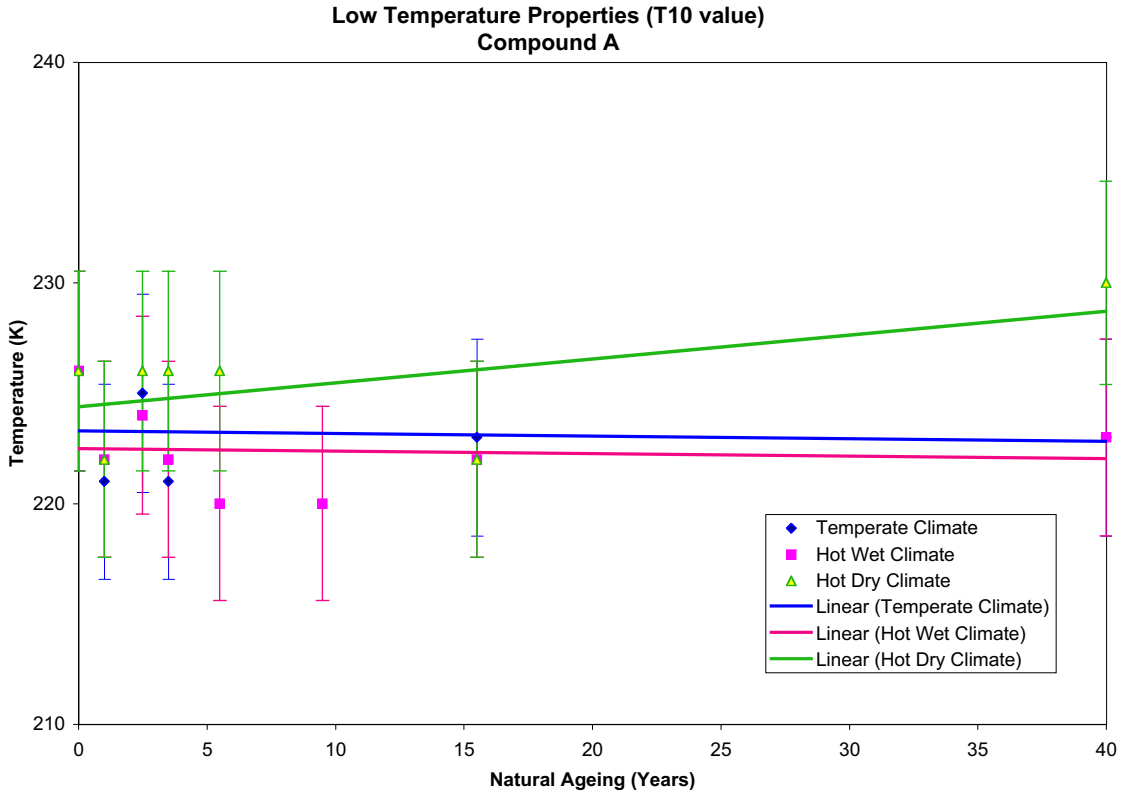





Short Term Compression Set
Compound A
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)
Compression Set (%)
Natural Ageing (Years)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

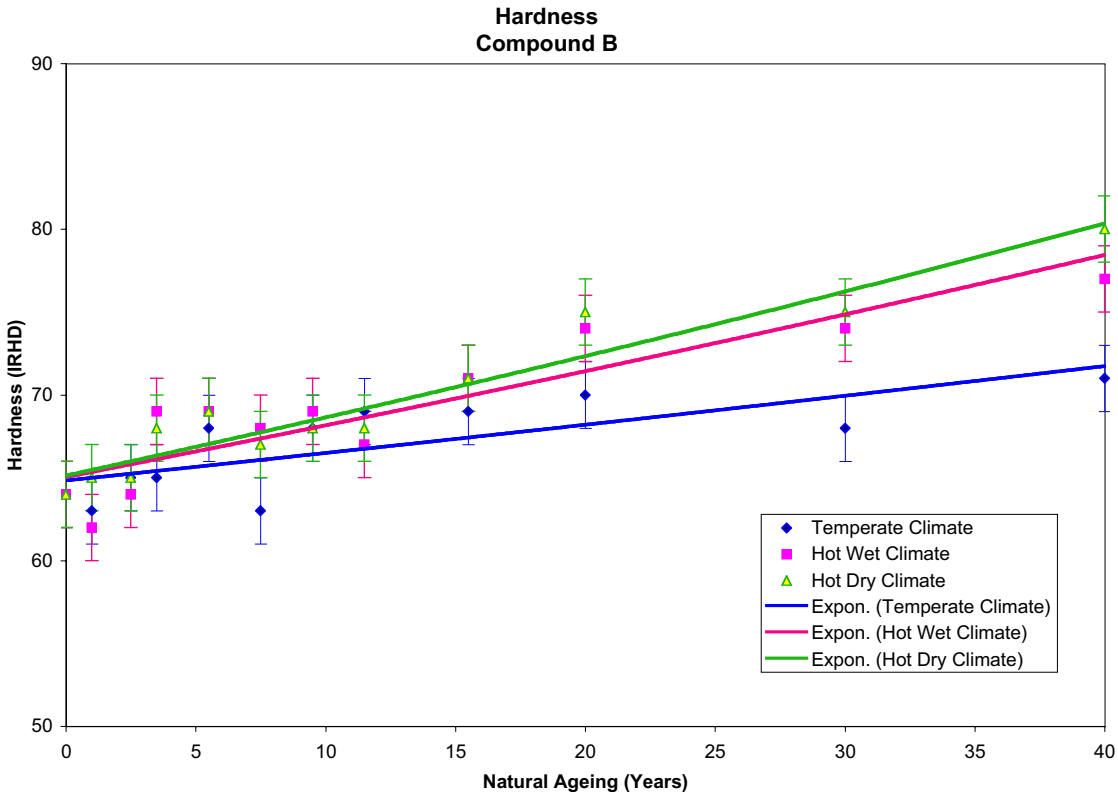

Long Term Compression Set
Compound A
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
Compression Set (%)
Natural Ageing (Years)
0
50
100
150
0
5
10
15
20
25
30
35
40

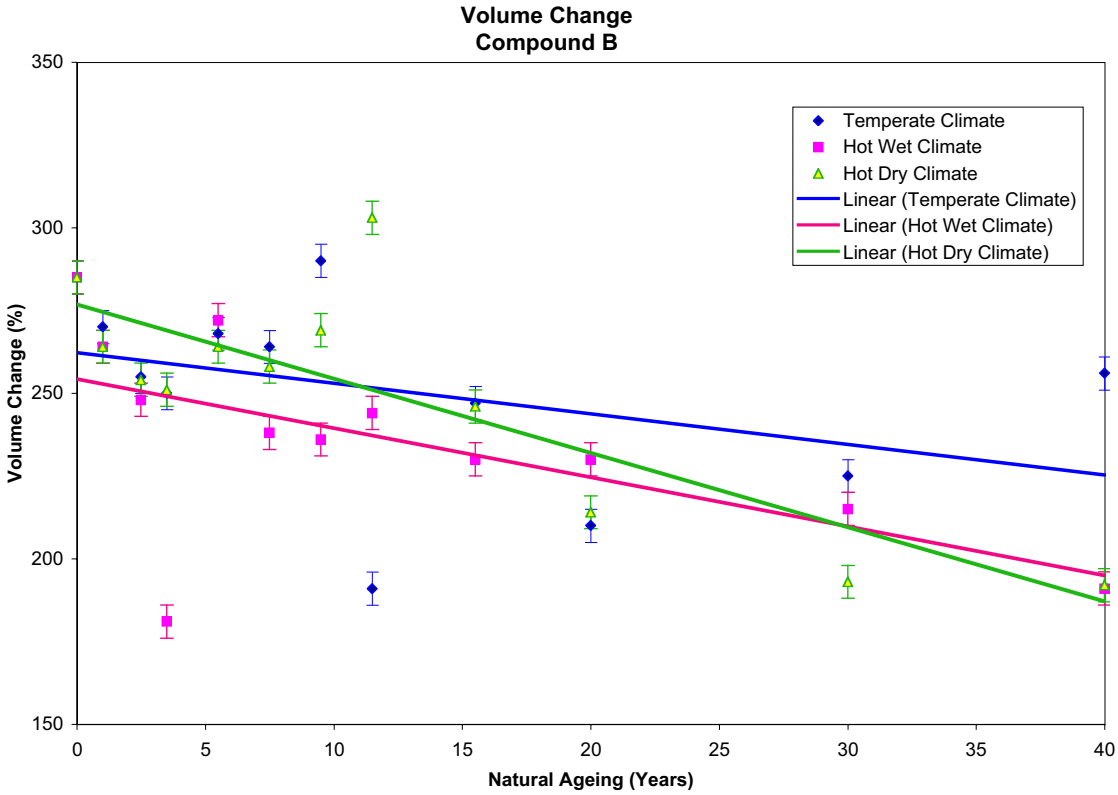


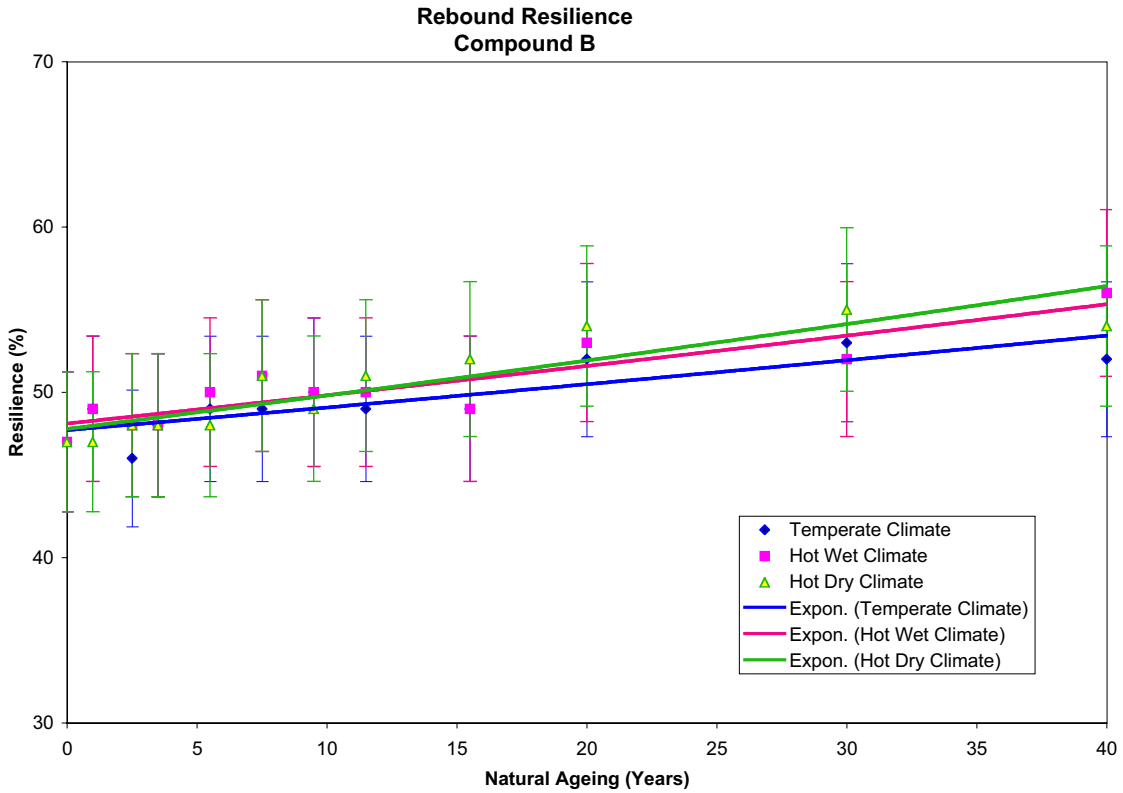


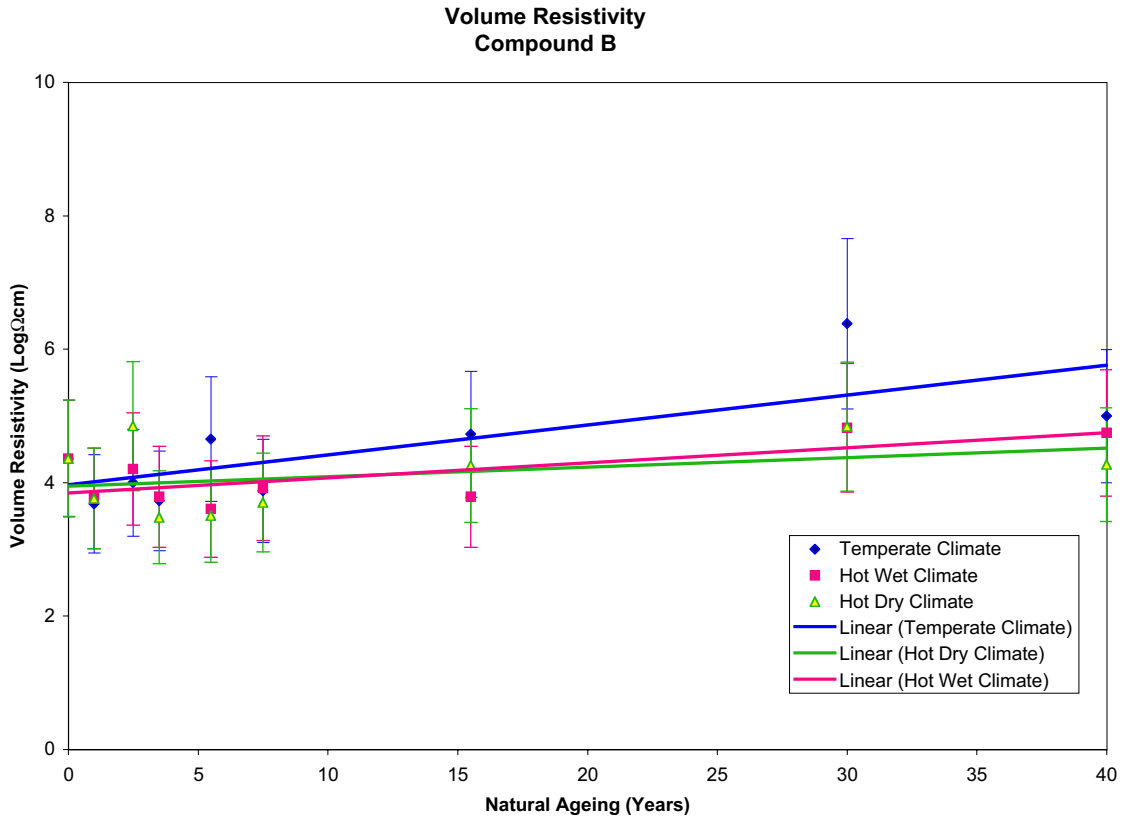
Extrapolated unaged and 40 years natural ageing data: Compound B (natural rubber - good ageing)

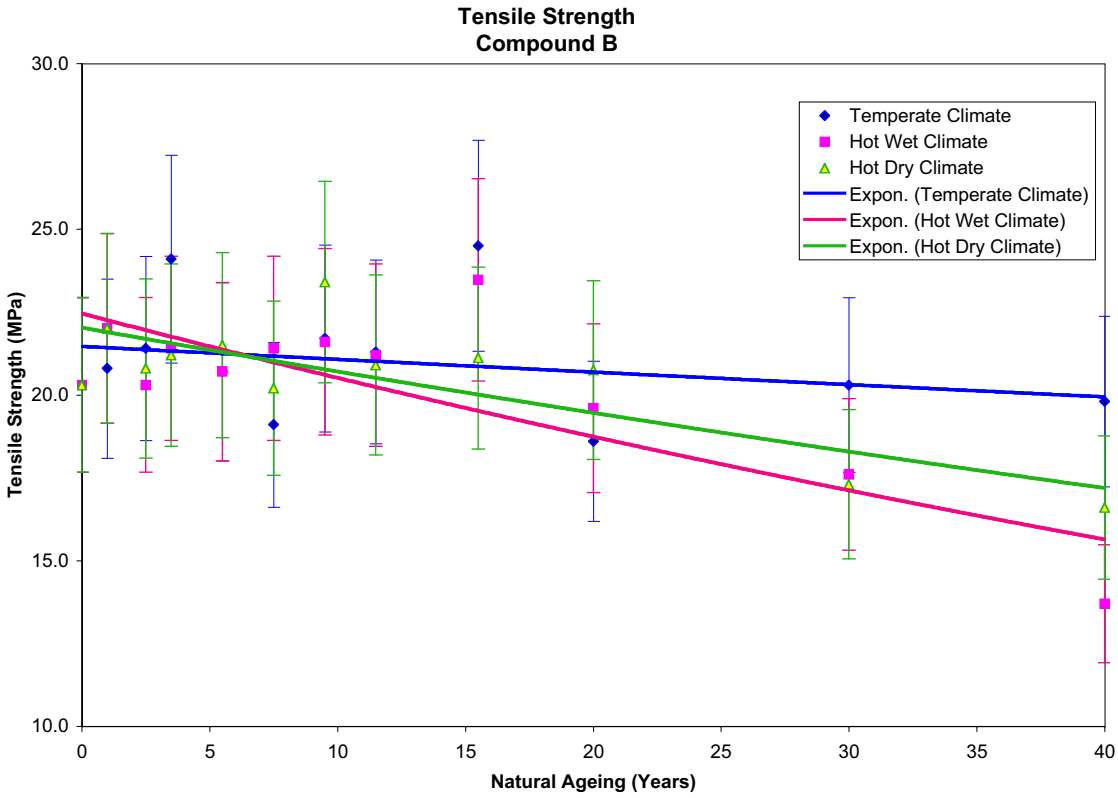
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	65.0	71.8	6.8	10	65.0	78.5	14	21	65.0	80.3	15	24
Volume Change (%)	263	226	-37	-14	255	195	-60	-24	277	188	-89	-32
Rebound Resilience (%)	47.7	53.5	5.8	12	48.2	55.3	7.1	15	47.7	56.5	8.8	18
Volume Resistivity (LogΩcm)	4.00	5.75	1.8	44	3.87	4.75	0.88	23	3.96	4.50	0.54	14
Tensile Properties												
Tensile Strength (MPa)	22.5	20.0	-2.5	-11	22.5	14.8	-7.7	-34	22.5	17.2	-5.3	-24
Elongation at Break (%)	570	495	-75	-13	608	365	-243	-40	600	370	-230	-38
Modulus at 100% (MPa)	1.69	2.96	1.3	75	1.85	3.60	1.8	95	1.79	3.96	2.2	121
Modulus at 300% (MPa)	9.90	12.6	2.7	27	10.1	13.1	3.0	30	10.1	11.5	1.4	14
Compression Set												
Short Term (%)	15.3	12.9	-2.4	-16	15.2	11.8	-3.4	-22	15.8	9.69	-6.1	-39
Long Term (%)	0.0	92.0			0.0	98.9			0.0	89.5		
Low Temperature Properties												
T2 Value (K)	248	255	7.6	3.1	247	241	-6.0	-2.4	248	252	7	1.5
T10 Value (K)	221	219	-2.0	-0.9	221	216	-5.2	-2.4	221	217	-3.5	-1.6

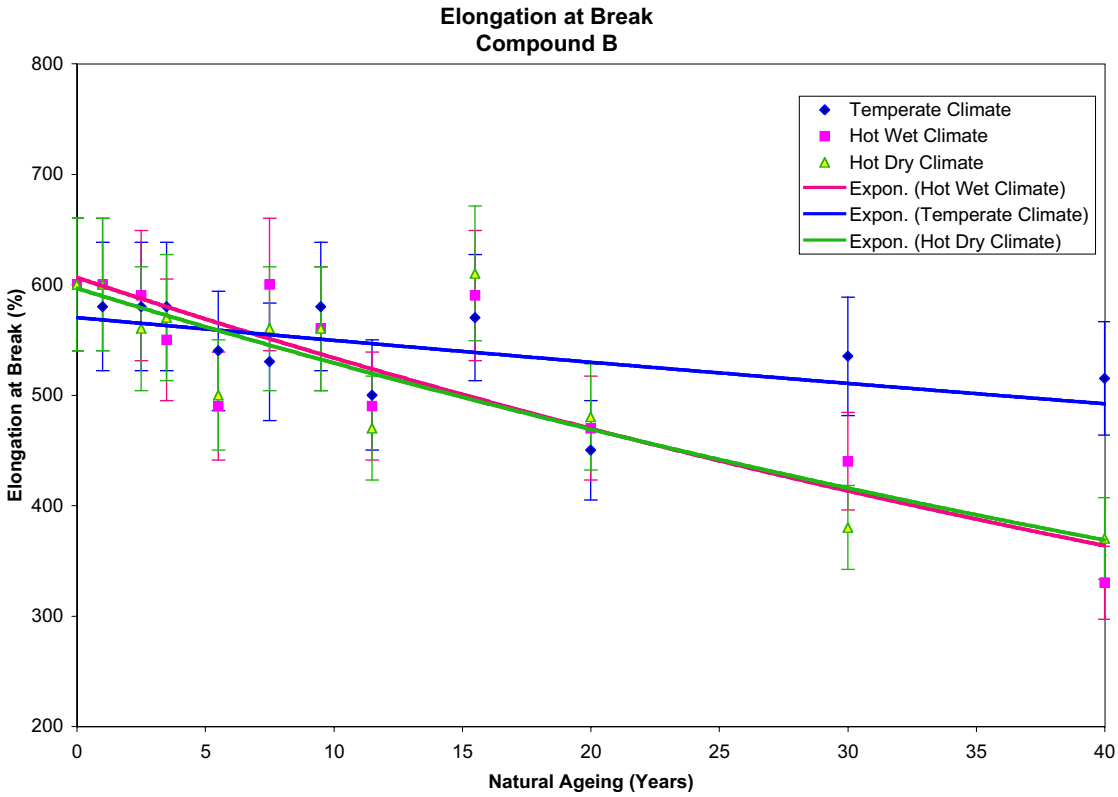

Hardness
Compound B
Hardness (IRHD)
Natural Ageing (Years)
90
80
70
60
50
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

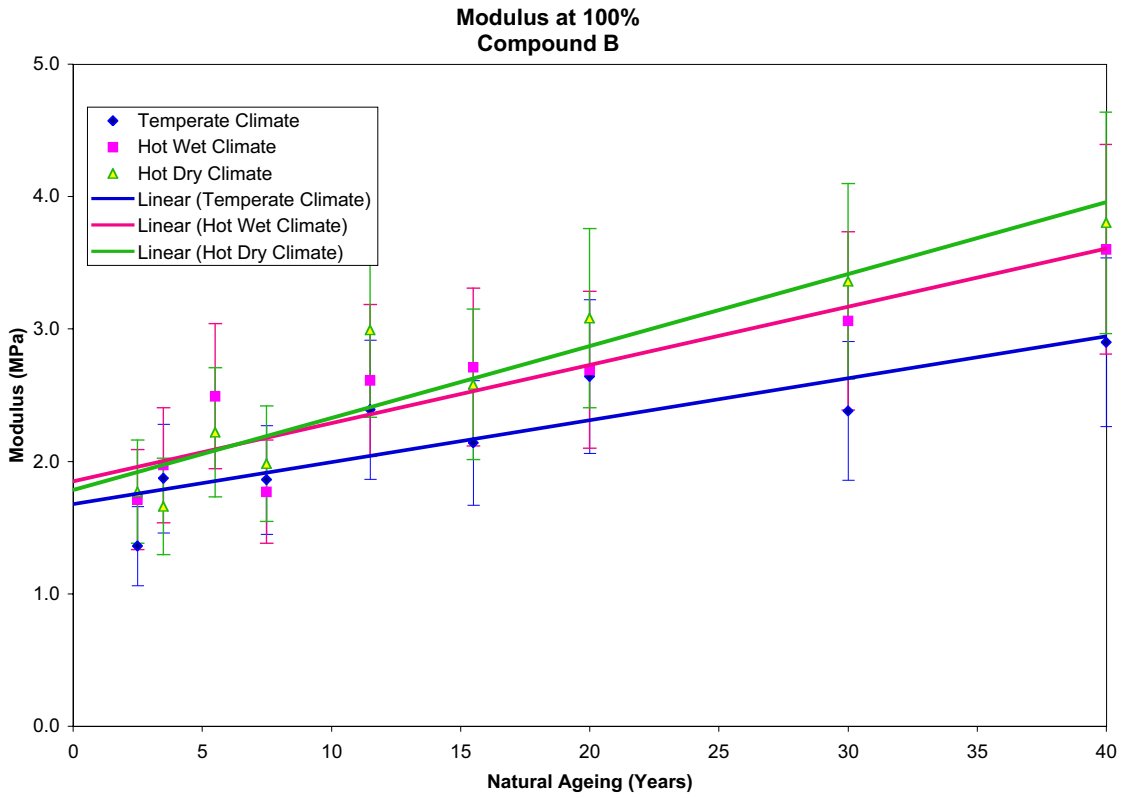

Volume Change
Compound B
Volume Change (%)
Natural Ageing (Years)
350
300
250
200
150
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

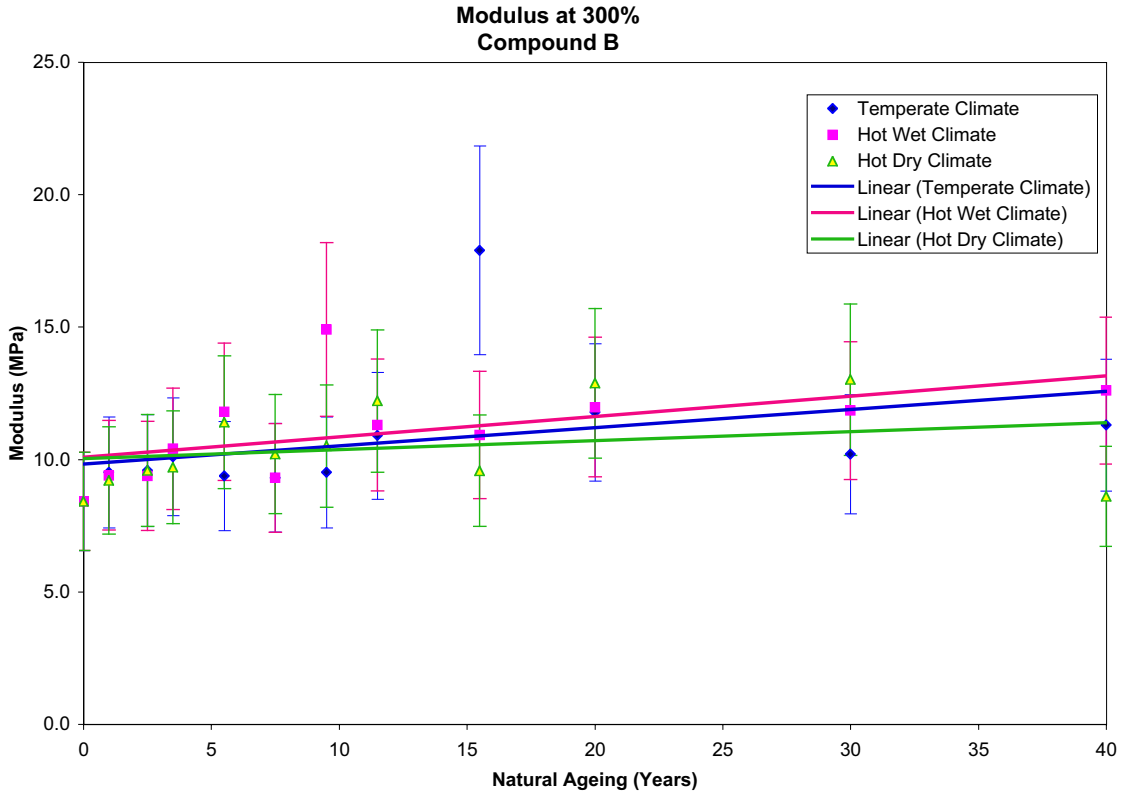


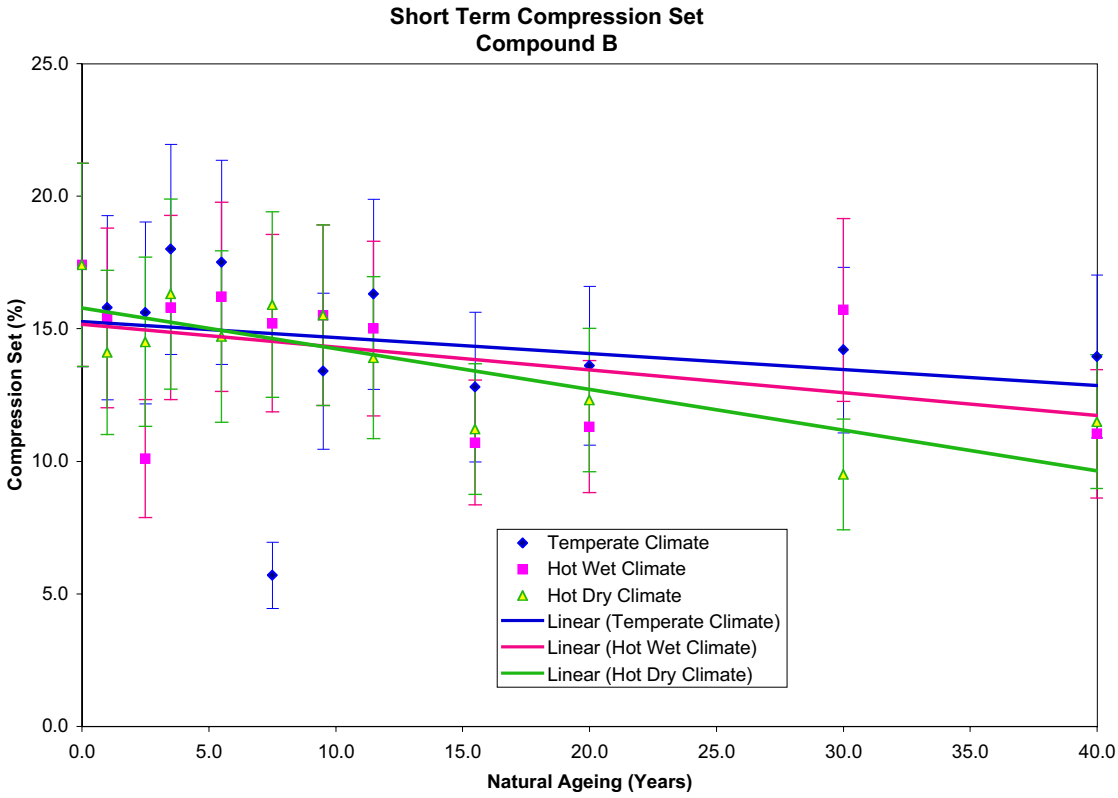


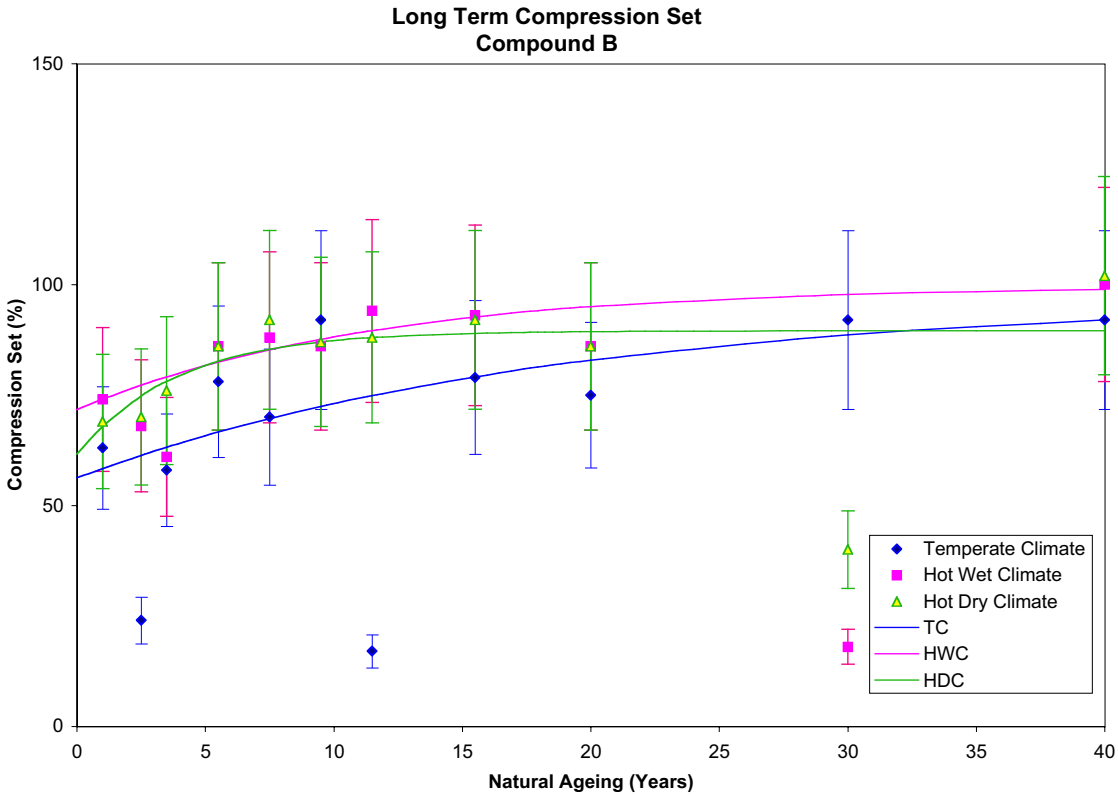

Tensile Strength
Compound B
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
30.0
25.0
20.0
15.0
10.0
0
5
10
15
20
25
30
35
40

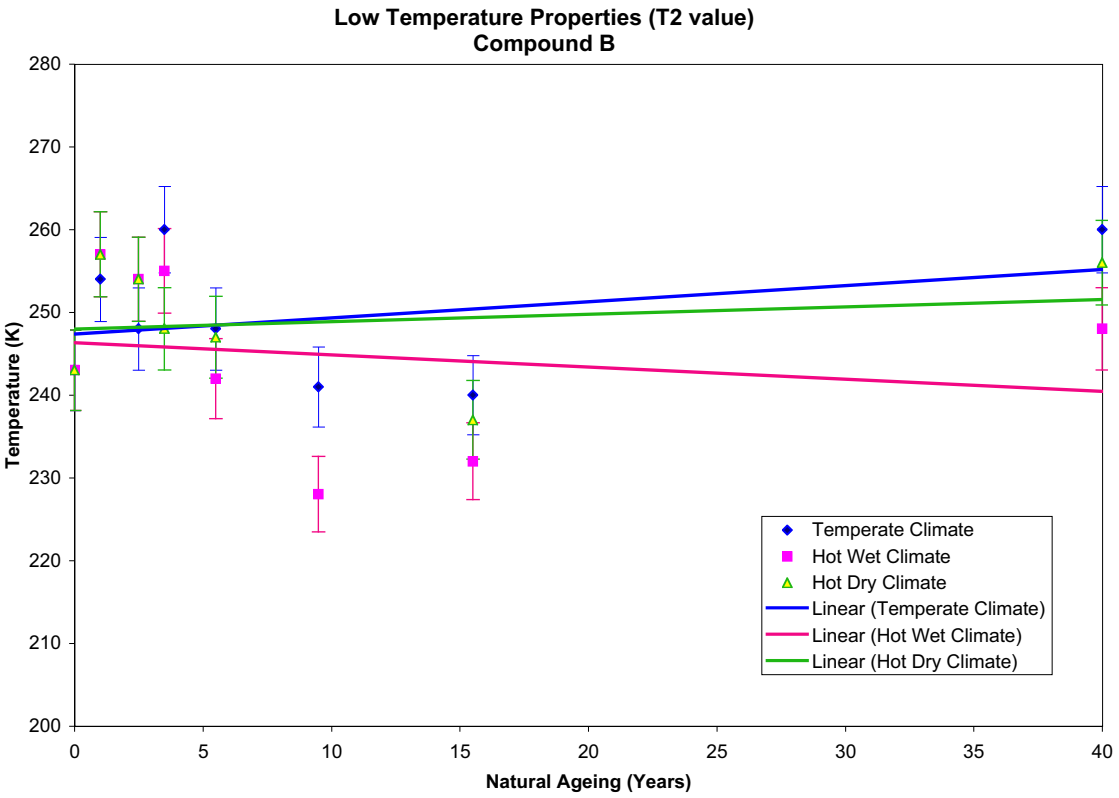

Elongation at Break
Compound B
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)
800
700
600
500
400
300
200
0
5
10
15
20
25
30
35
40

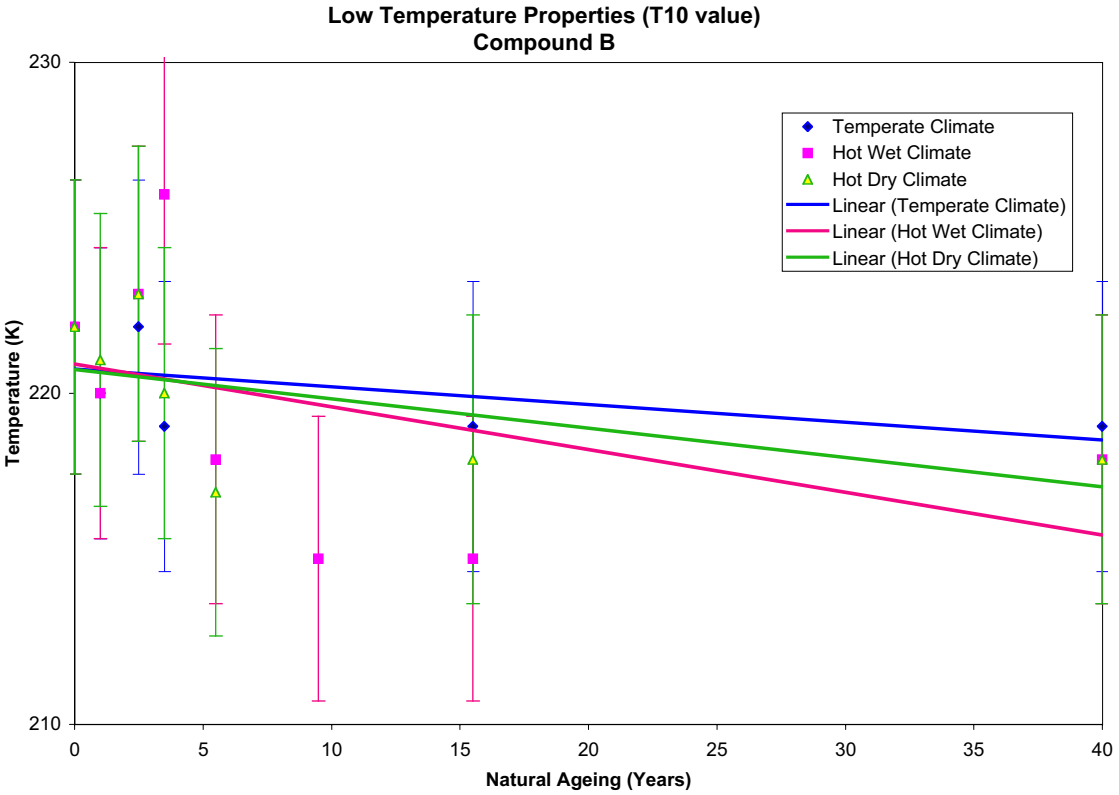





Short Term Compression Set
Compound B
Compression Set (%)
Natural Ageing (Years)
25.0
20.0
15.0
10.0
5.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

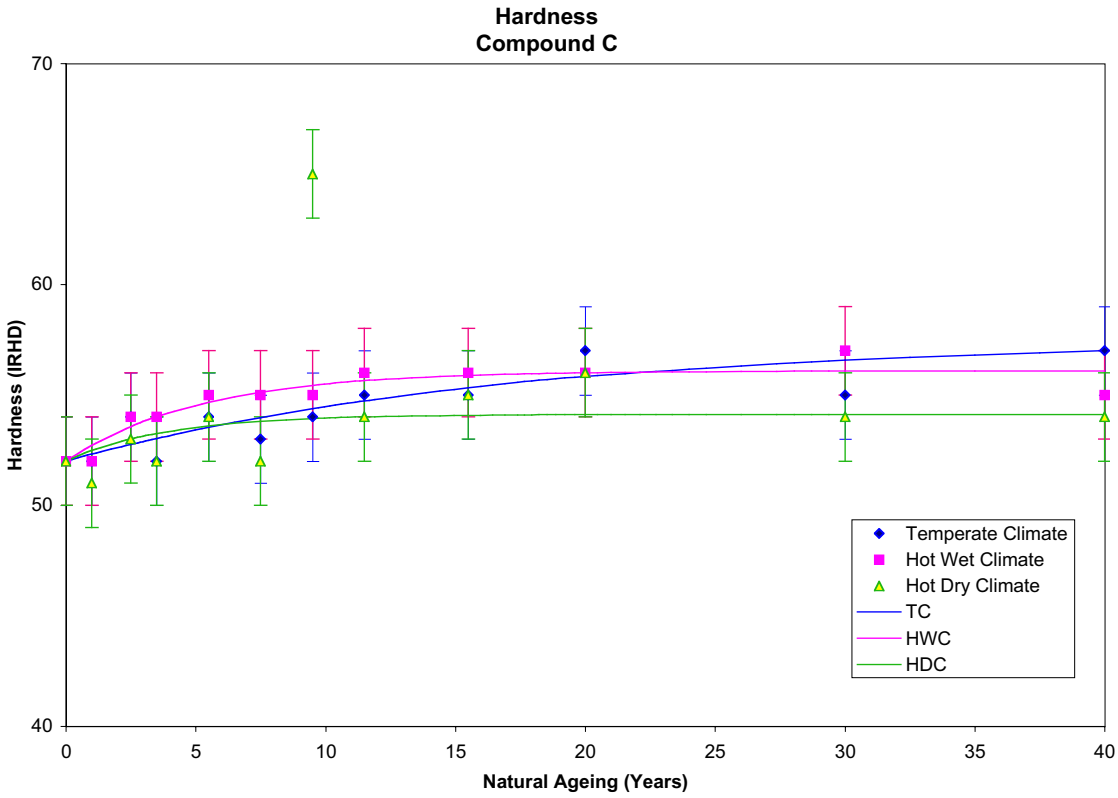

Long Term Compression Set
Compound B
Compression Set (%)
Natural Ageing (Years)
150
100
50
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

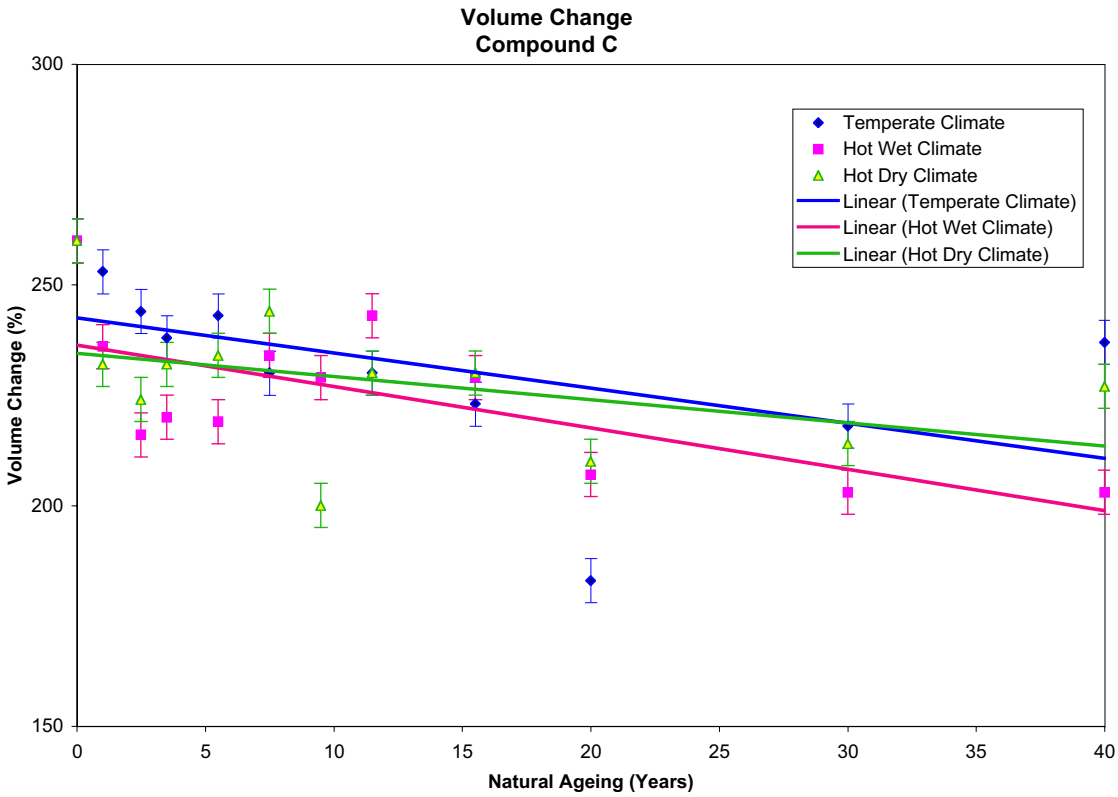


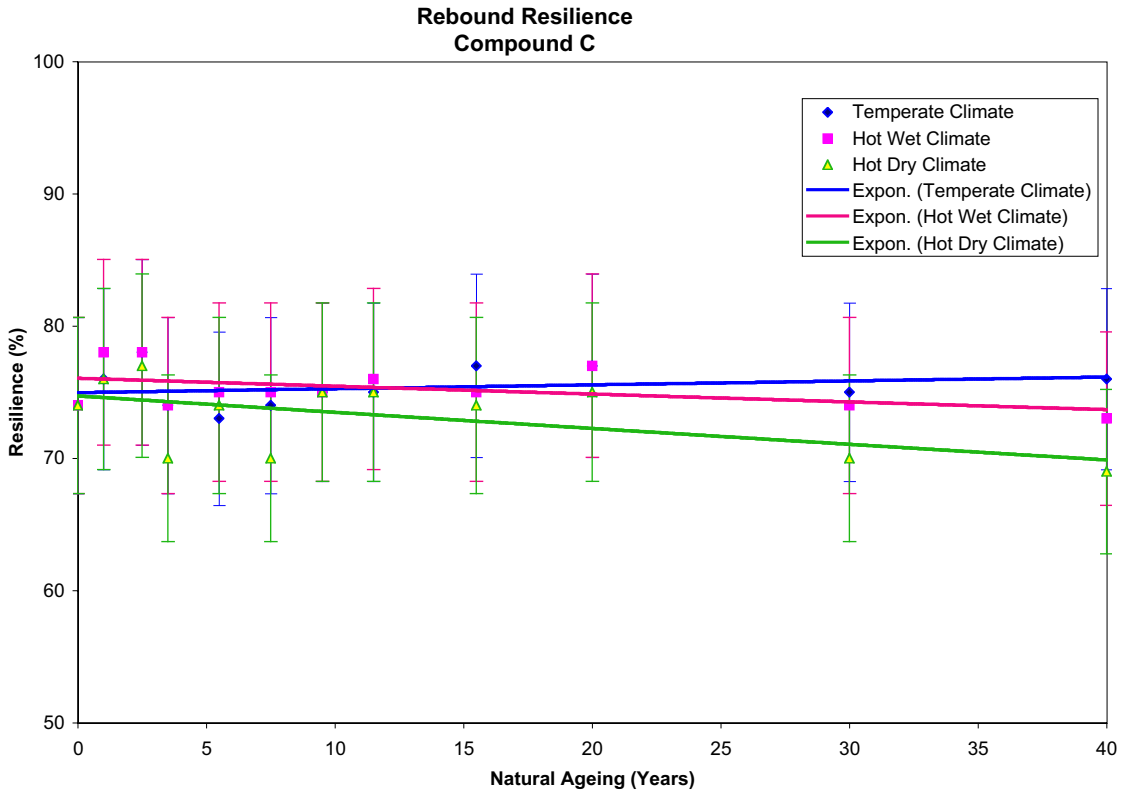


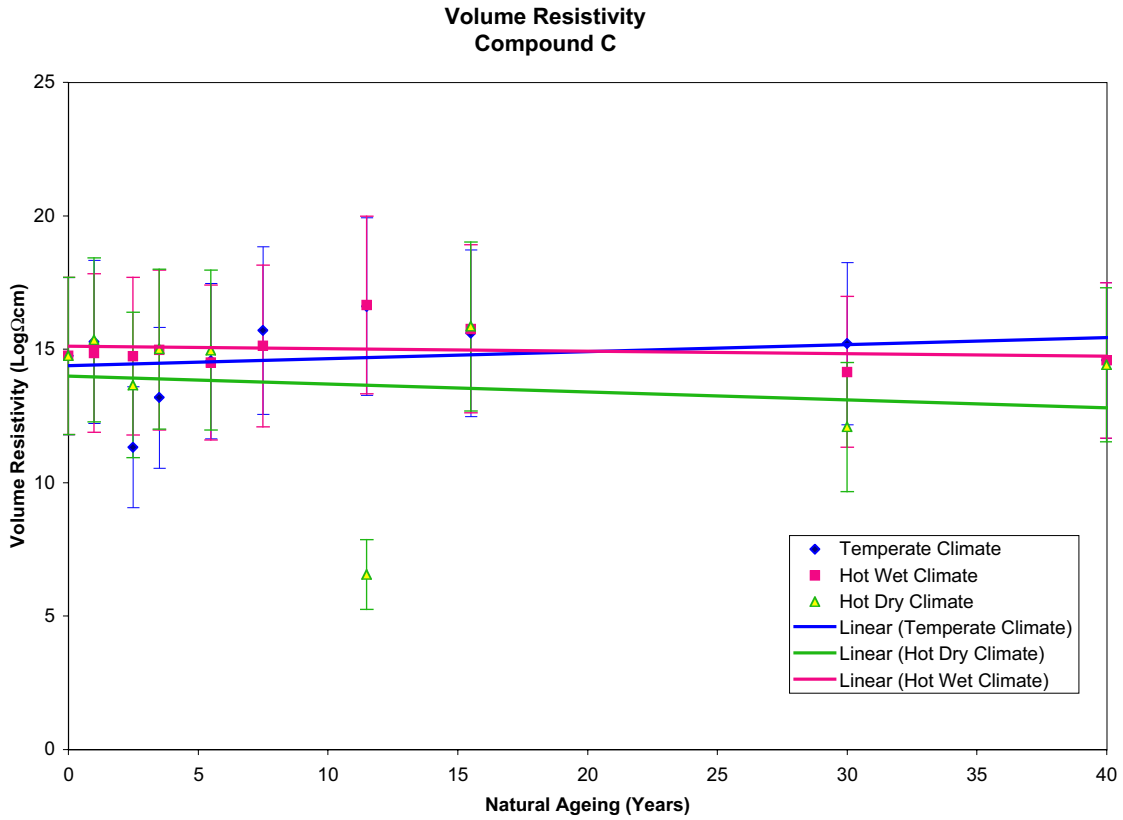
Extrapolated unaged and 40 years natural ageing data: Compound C (natural rubber - mineral filler loaded)

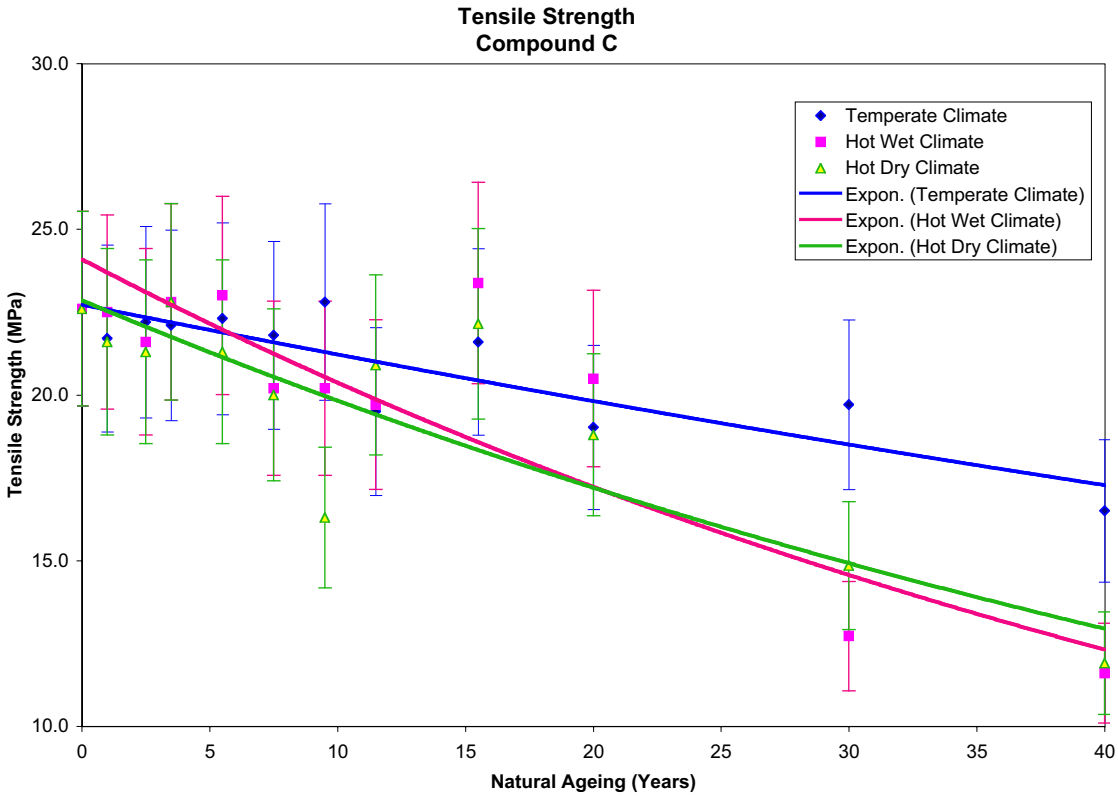
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	52.0	57.0	5.0	10	52.0	56.1	4.1	7.9	52.0	54.1	2.1	4.0
Volume Change (%)	243	211	-32	-13	237	199	-38	-16	235	214	-21	-9.0
Rebound Resilience (%)	75.0	76.3	1.3	1.7	76.3	73.8	-2.5	-3.3	75.0	70.0	-5.0	-6.7
Volume Resistivity (LogΩcm)	14.4	15.5	1.1	7.7	15.2	14.8	-0.37	-2.4	14.0	12.8	-1.2	-8.2
Tensile Properties												
Tensile Strength (MPa)	22.8	17.3	-5.5	-24	24.2	12.3	-12	-49	22.8	13.0	-9.8	-43
Elongation at Break (%)	569	504	-65	-11	583	442	-142	-24	573	471	-102	-18
Modulus at 100% (MPa)	1.23	2.13	0.90	73	1.55	2.03	0.48	31	1.30	2.00	0.70	54
Modulus at 300% (MPa)	4.92	7.17	2.3	46	5.75	5.67	-0.08	-1.4	5.21	5.50	0.29	5.6
Compression Set												
Short Term (%)	2.25	2.75	0.50	22	2.75	3.88	1.1	41	2.63	5.88	3.3	124
Long Term (%)	0.0	71.1			0.0	86.5			0.0	98.8		
Low Temperature Properties												
T2 Value (K)	230	225	-4.6	-2.0	232	224	-8.6	-3.7	230	231	1.2	0.5
T10 Value (K)	222	218	-3.8	-1.7	223	217	-6.0	-2.7	221	219	-1.9	-0.9

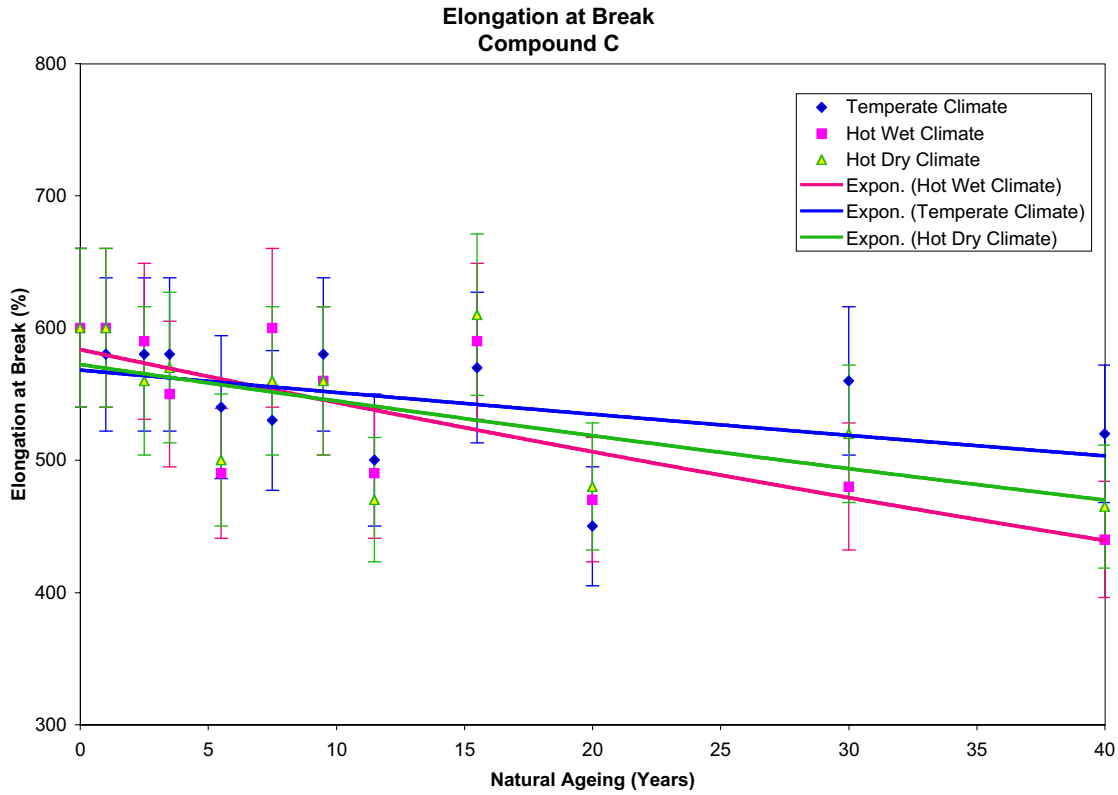

Hardness
Compound C
Hardness (IRHD)
70
60
50
40
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

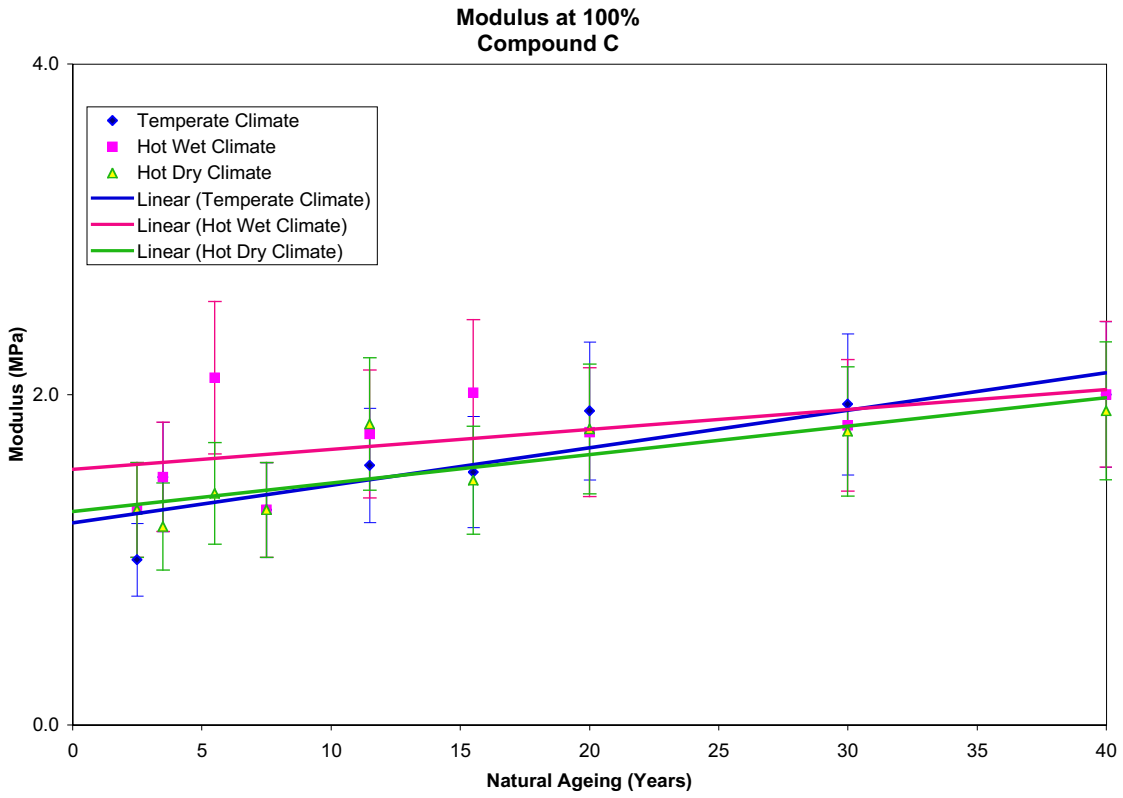

Volume Change
Compound C
Volume Change (%)
300
250
200
150
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

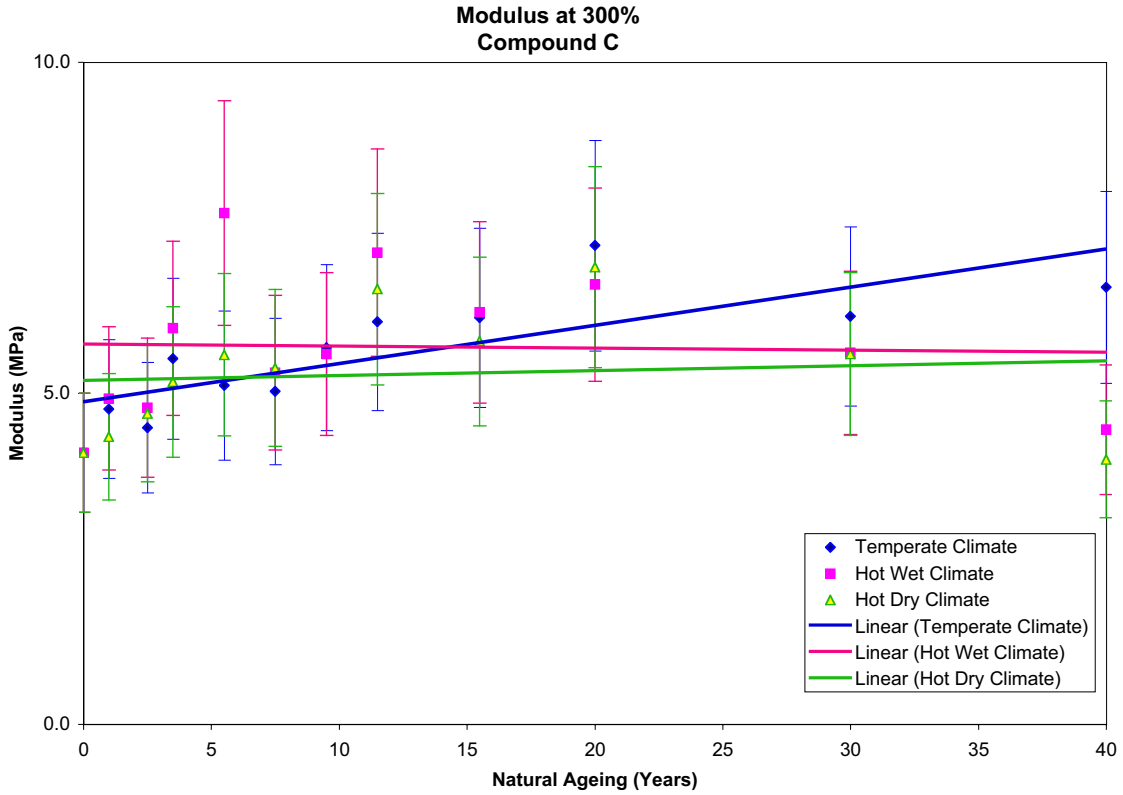


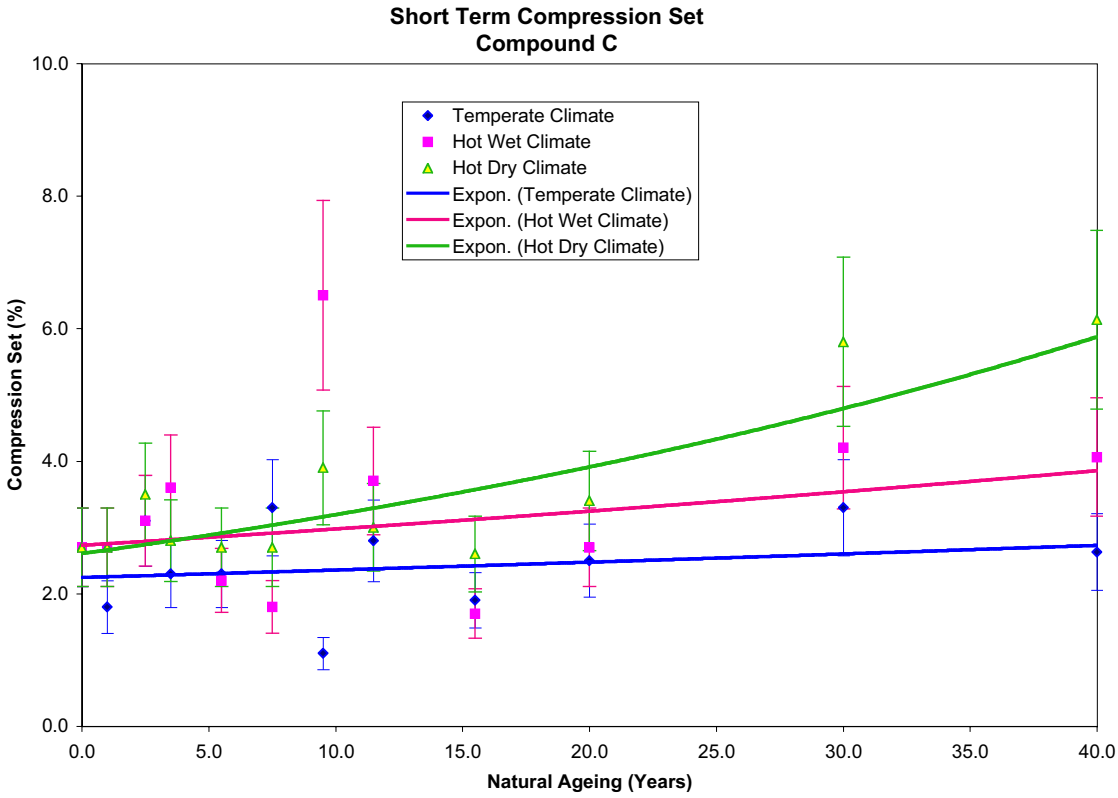


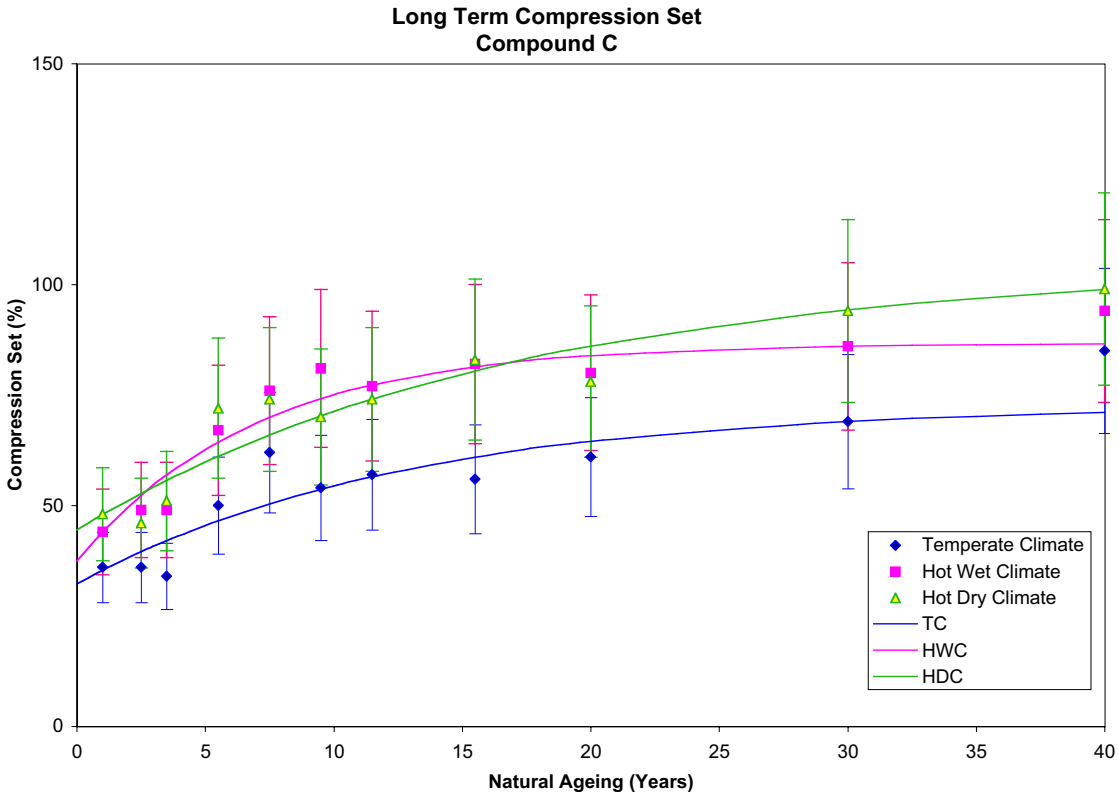

Tensile Strength
Compound C
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
30.0
25.0
20.0
15.0
10.0
0
5
10
15
20
25
30
35
40

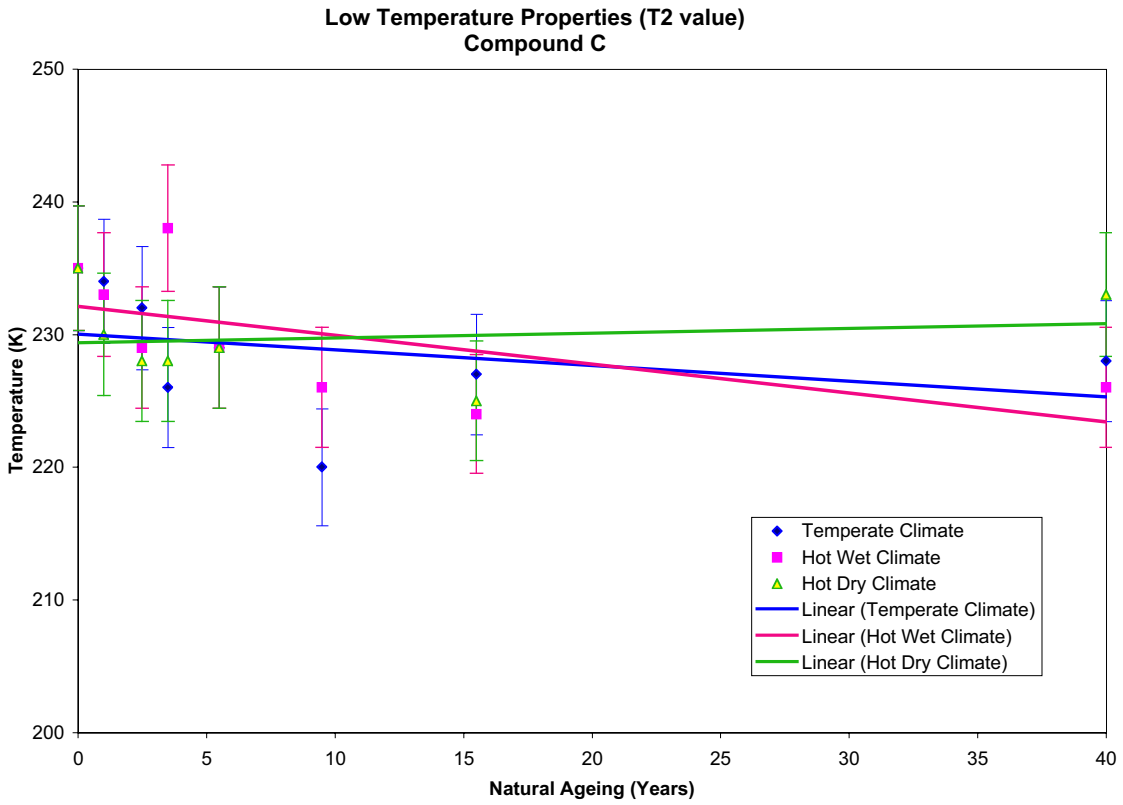

Elongation at Break
Compound C
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)
800
700
600
500
400
300
0
5
10
15
20
25
30
35
40

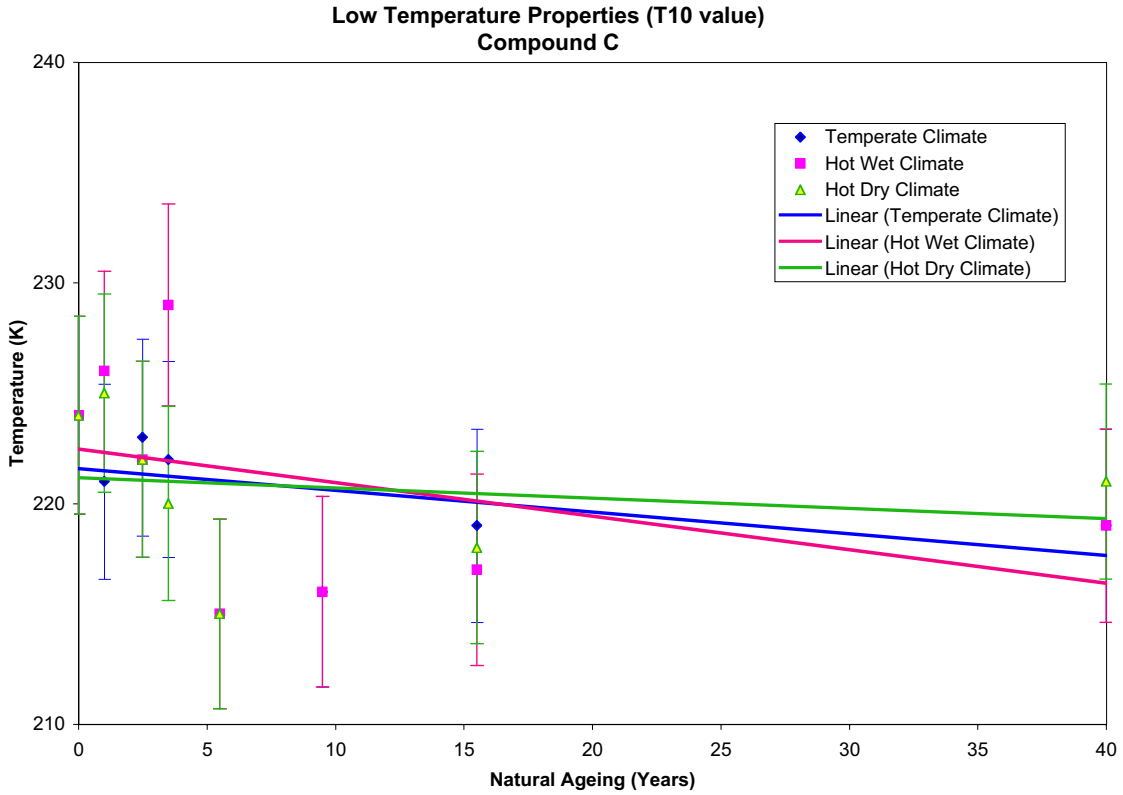





Short Term Compression Set
Compound C
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
Compression Set (%)
Natural Ageing (Years)
0.0
2.0
4.0
6.0
8.0
10.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

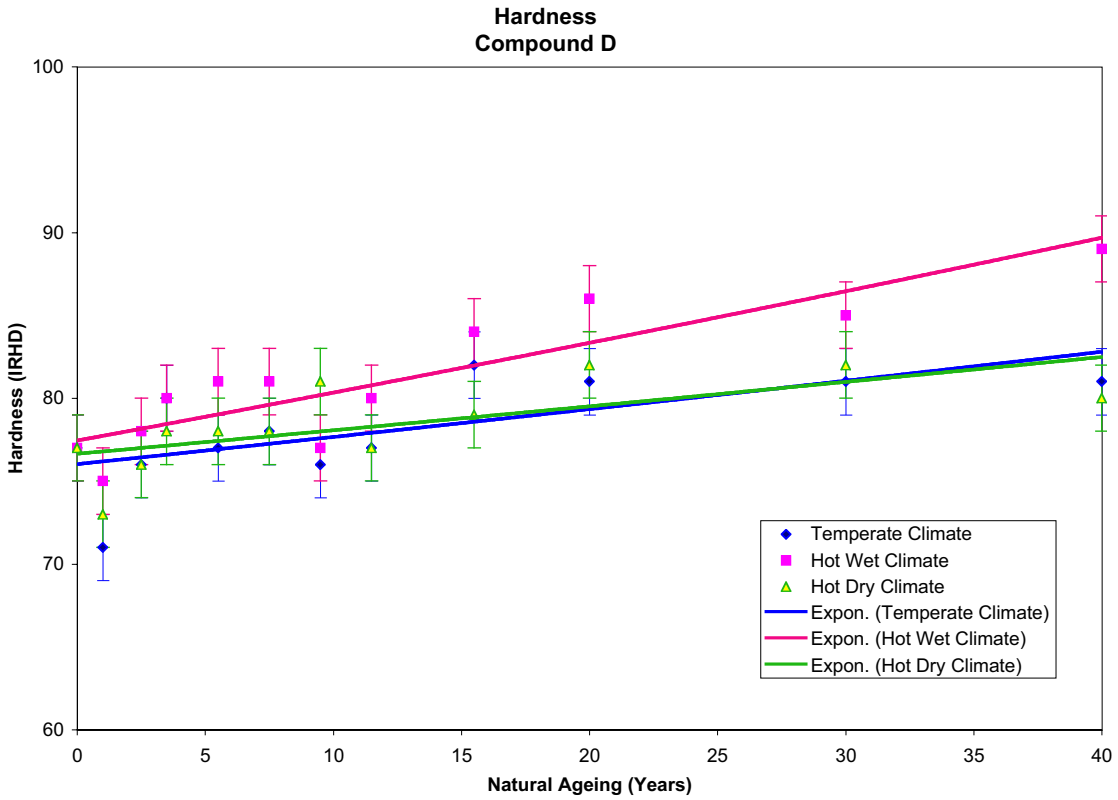

Long Term Compression Set
Compound C
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
Compression Set (%)
Natural Ageing (Years)
0
50
100
150
0
5
10
15
20
25
30
35
40

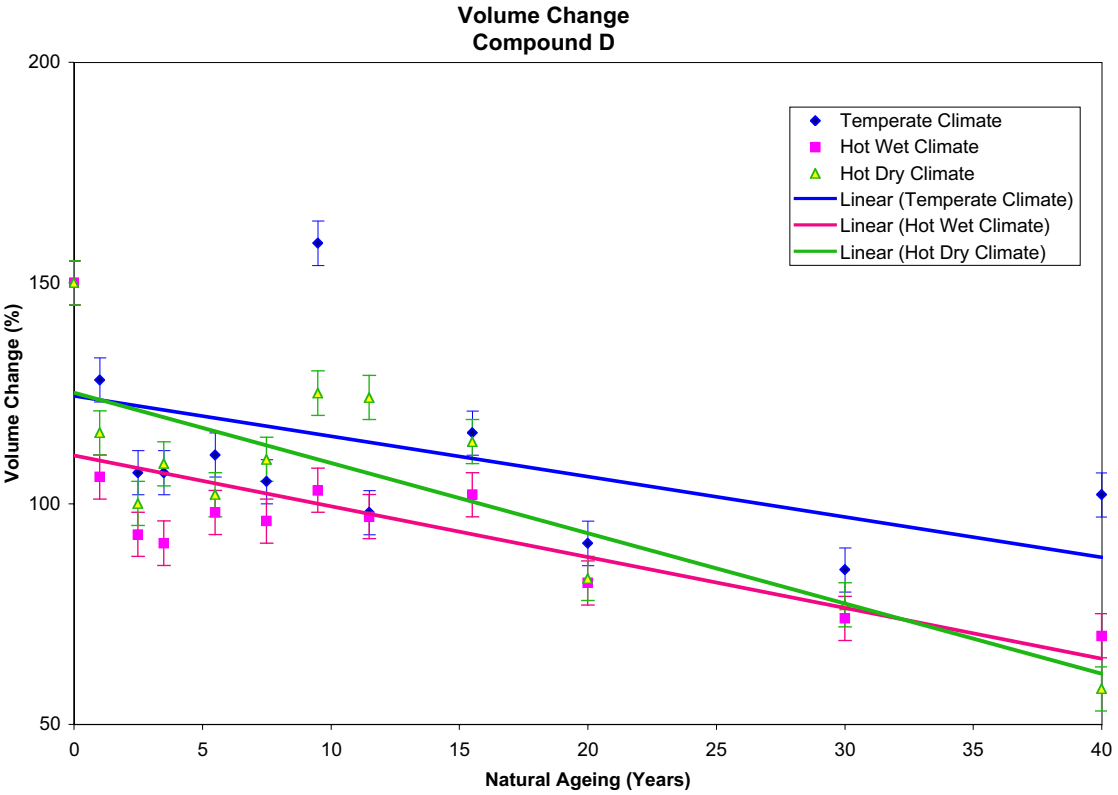


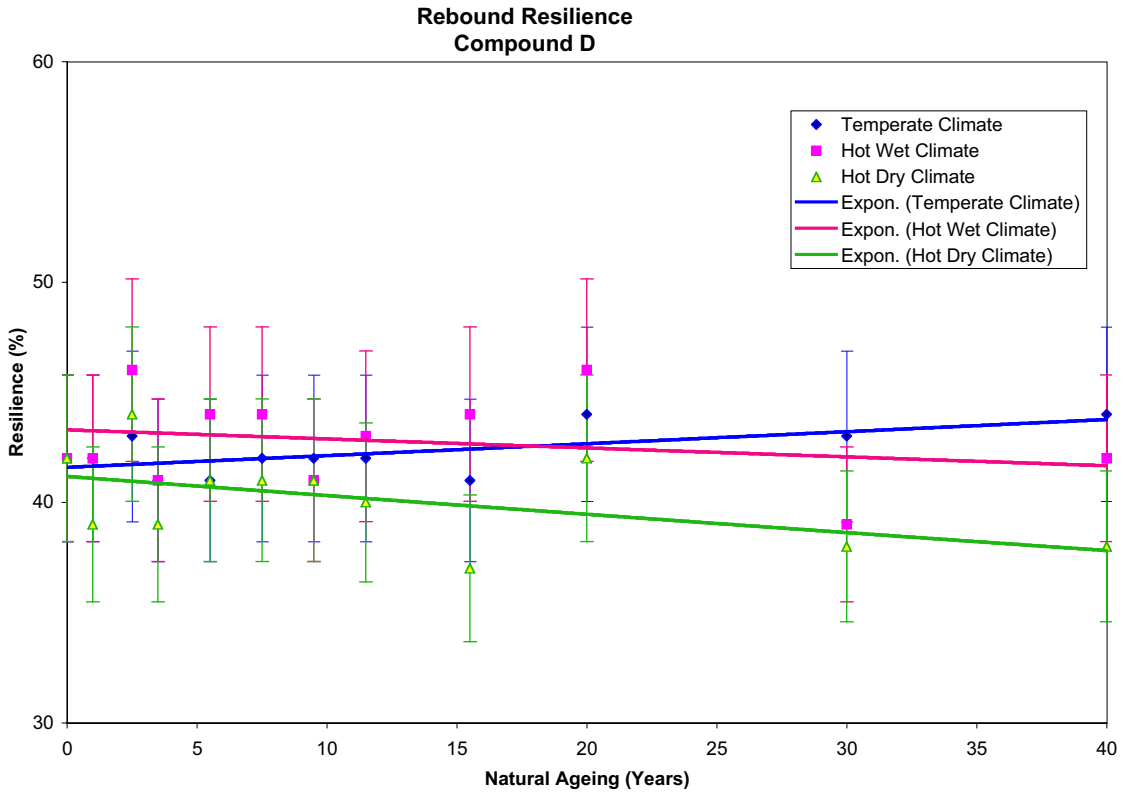


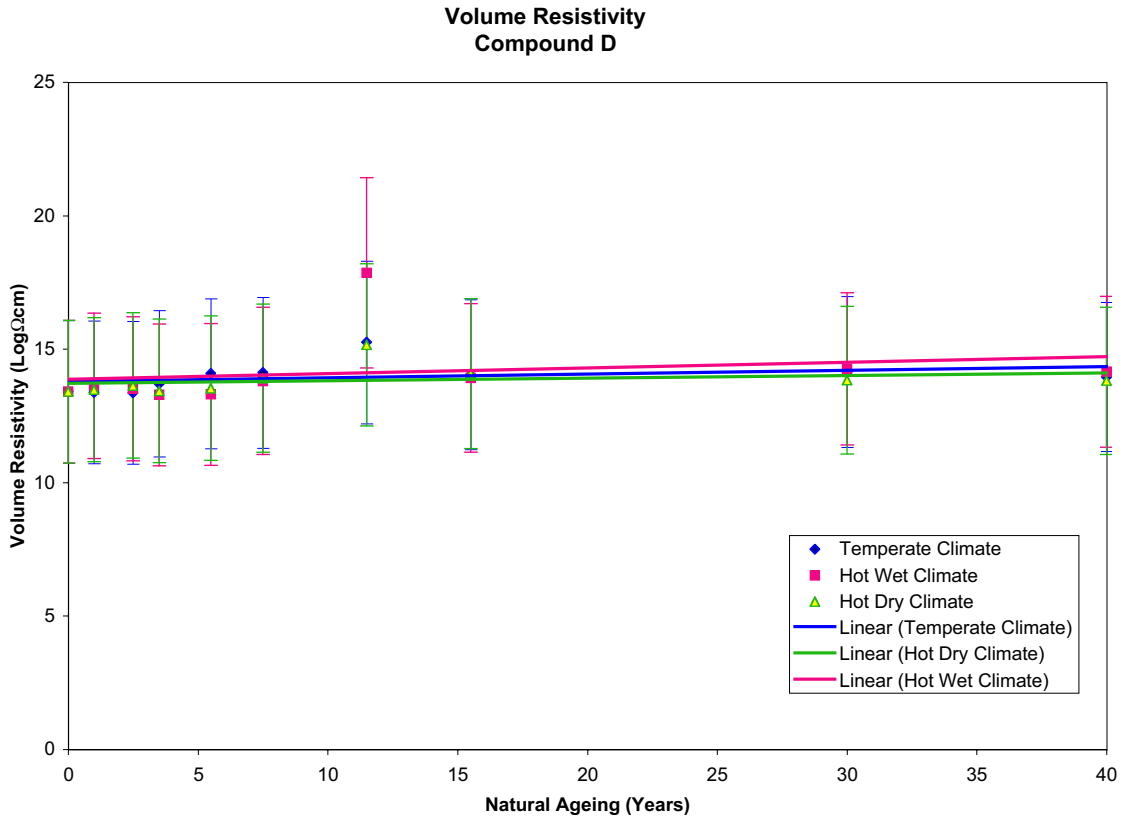
Extrapolated unaged and 40 years natural ageing data: Compound D (natural rubber - mineral filler (heavy loaded))

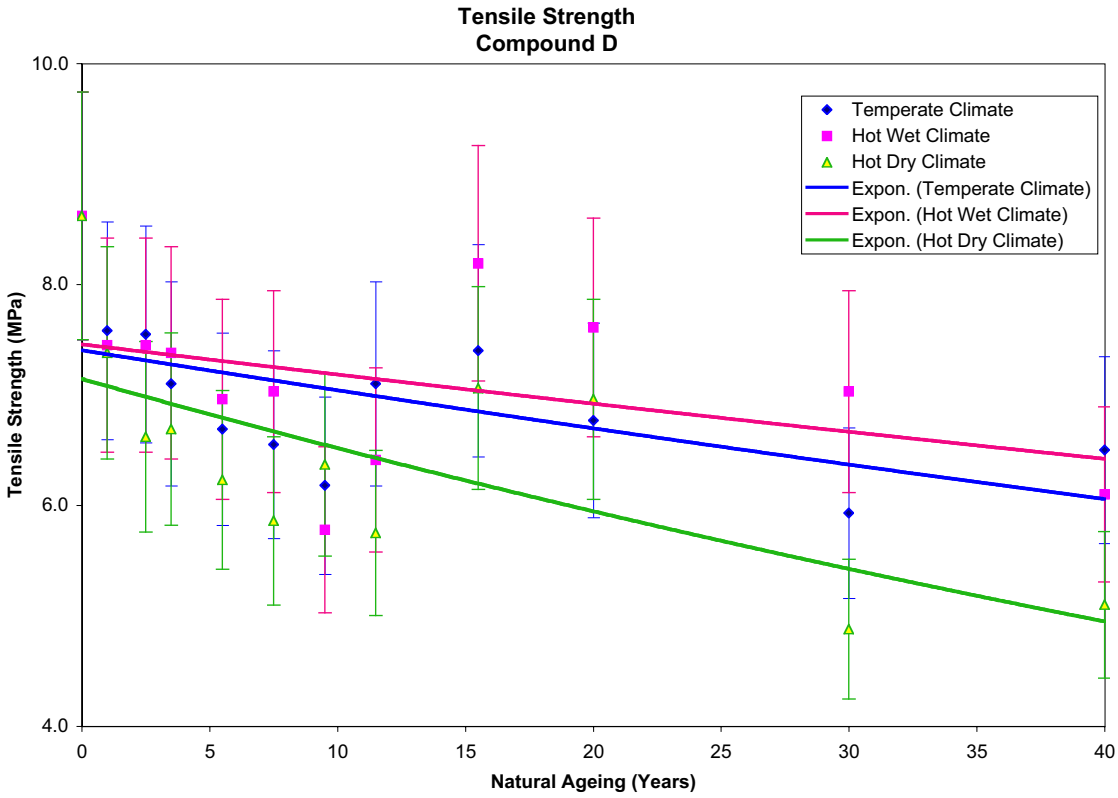
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	76.0	82.8	6.8	8.9	78	89.7	12	16	76.7	82.5	5.8	7.6
Volume Change (%)	125	88.1	-37	-30	111	65.0	-46	-42	125	61.3	-64	-51
Rebound Resilience (%)	41.6	43.8	2.2	5.3	43	41.8	-1.5	-3.5	41.3	37.9	-3.4	-8.2
Volume Resistivity (LogΩcm)	13.9	14.4	0.52	3.8	14	14.8	0.83	5.9	13.8	14.2	0.42	3.1
Tensile Properties												
Tensile Strength (MPa)	7.43	6.05	-1.4	-19	7.48	6.43	-1.1	-14	7.15	4.95	-2.2	-31
Elongation at Break (%)	490	130	-360	-73	460	70.0	-390	-85	460	62.5	-398	-86
Modulus at 100% (MPa)	3.17	5.79	2.6	83	3.8	8.25	4.4	115	3.67	6.33	2.7	72
Modulus at 300% (MPa)	5.25	10.1	4.9	92	5.9	7.63	1.8	30	5.38	8.00	2.6	49
Compression Set												
Short Term (%)	9.33	8.17	-1.2	-12	9.4	7.33	-2.1	-22	10.6	11.7	1.1	10
Long Term (%)	0.0	98.2			0.0	102			0.0	106		
Low Temperature Properties												
T2 Value (K)	255	255	0.0	0.0	253	252	-1.5	-0.6	255	261	6.0	2.4
T10 Value (K)	231	229	-2.1	-0.9	229	227	-2.0	-0.9	230	233	3.0	1.3

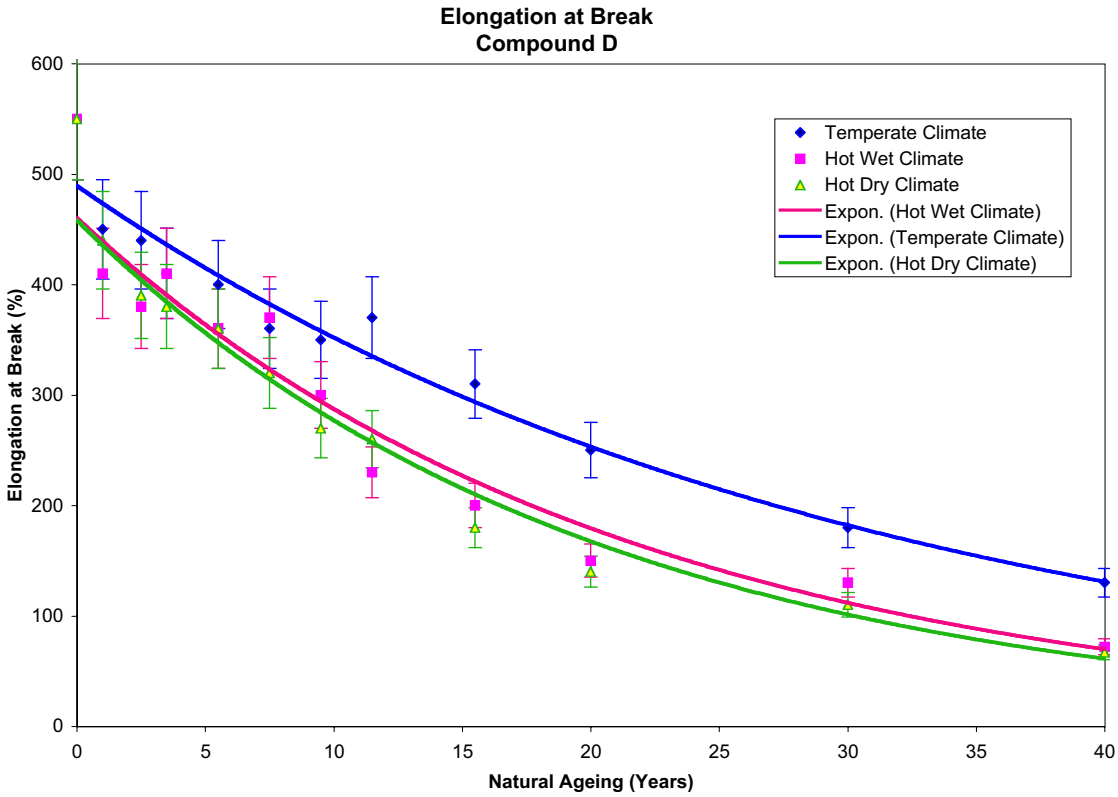

Hardness
Compound D
Hardness (IRHD)
Natural Ageing (Years)
100
90
80
70
60
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

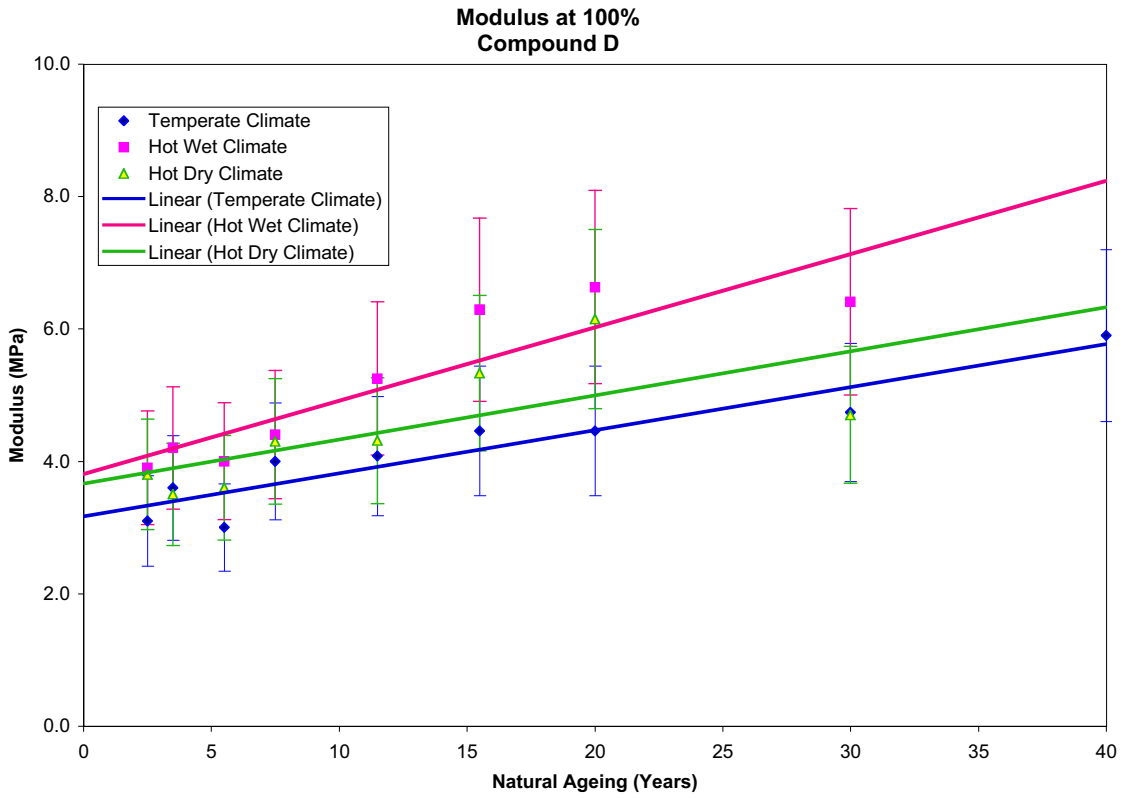

Volume Change
Compound D
Volume Change (%)
Natural Ageing (Years)
200
150
100
50
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

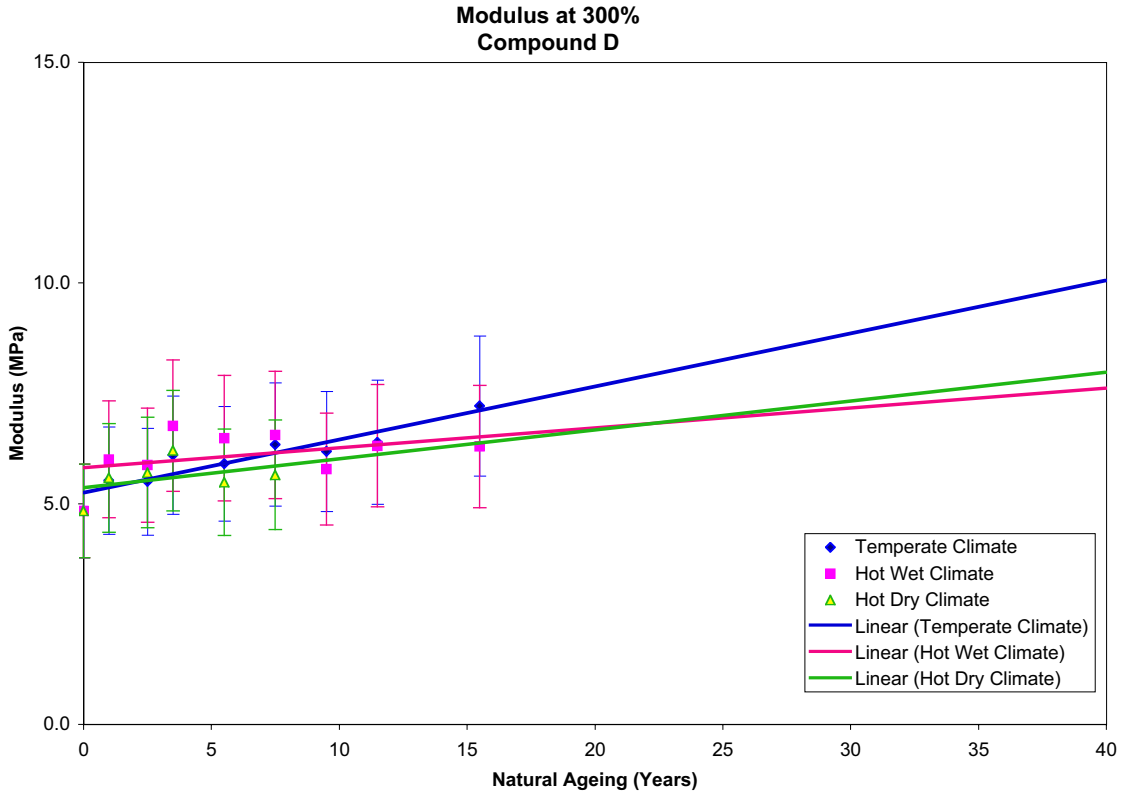


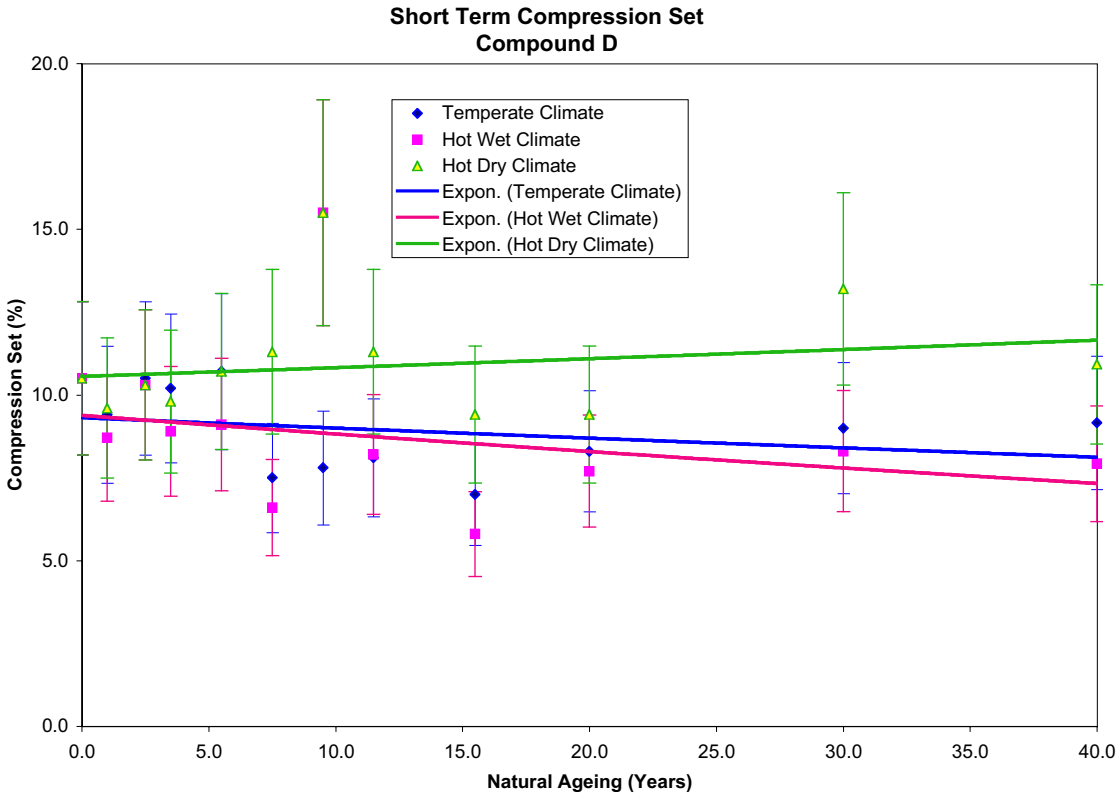


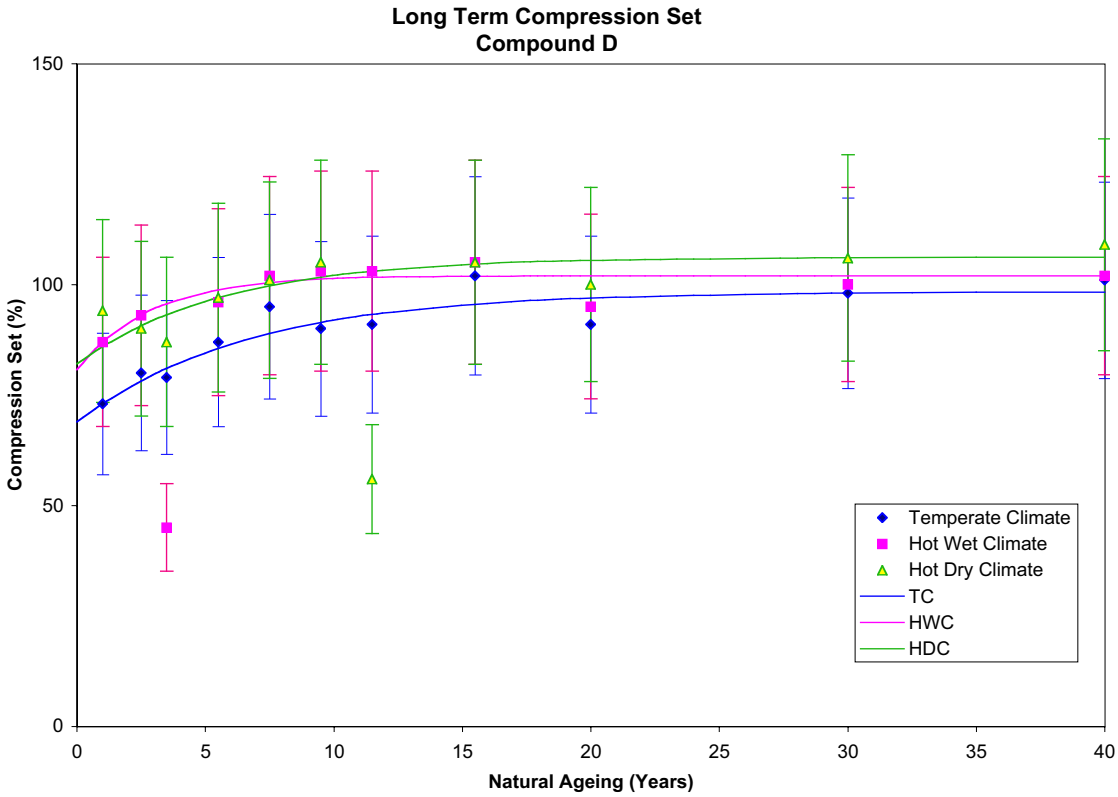

Tensile Strength
Compound D
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
10.0
8.0
6.0
4.0
0
5
10
15
20
25
30
35
40

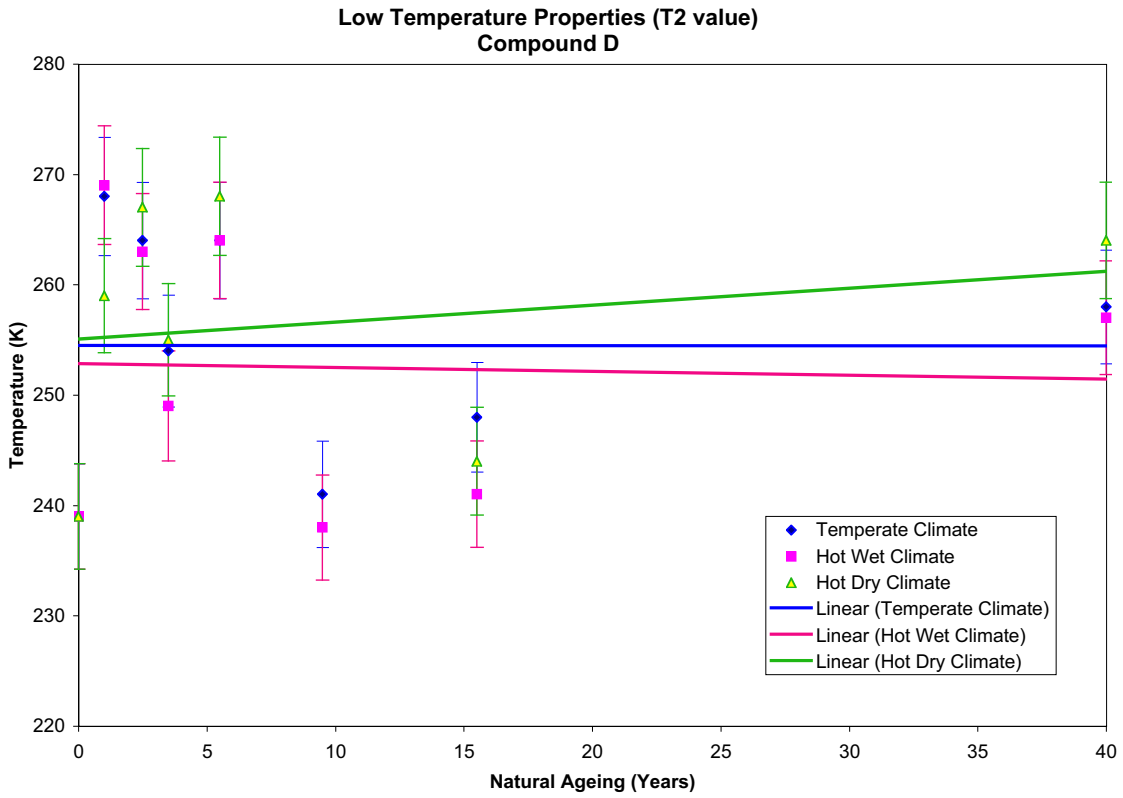

Elongation at Break
Compound D
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40

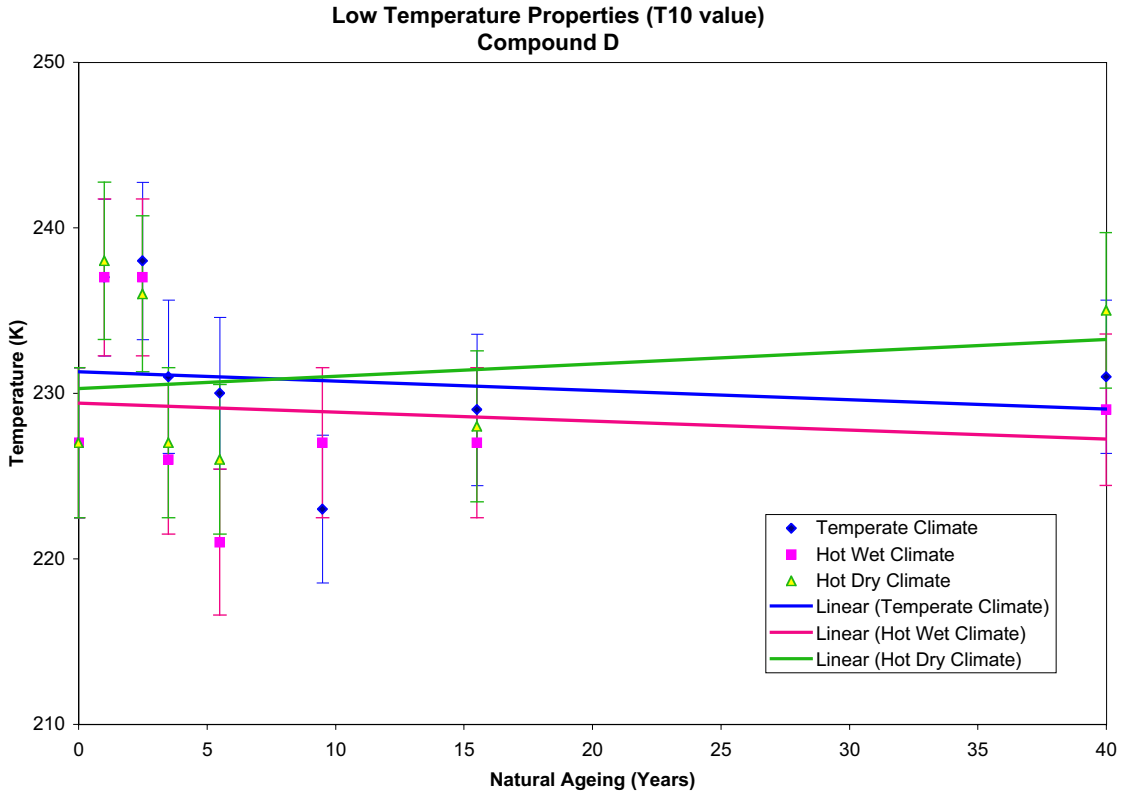





Short Term Compression Set
Compound D
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
Compression Set (%)
Natural Ageing (Years)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

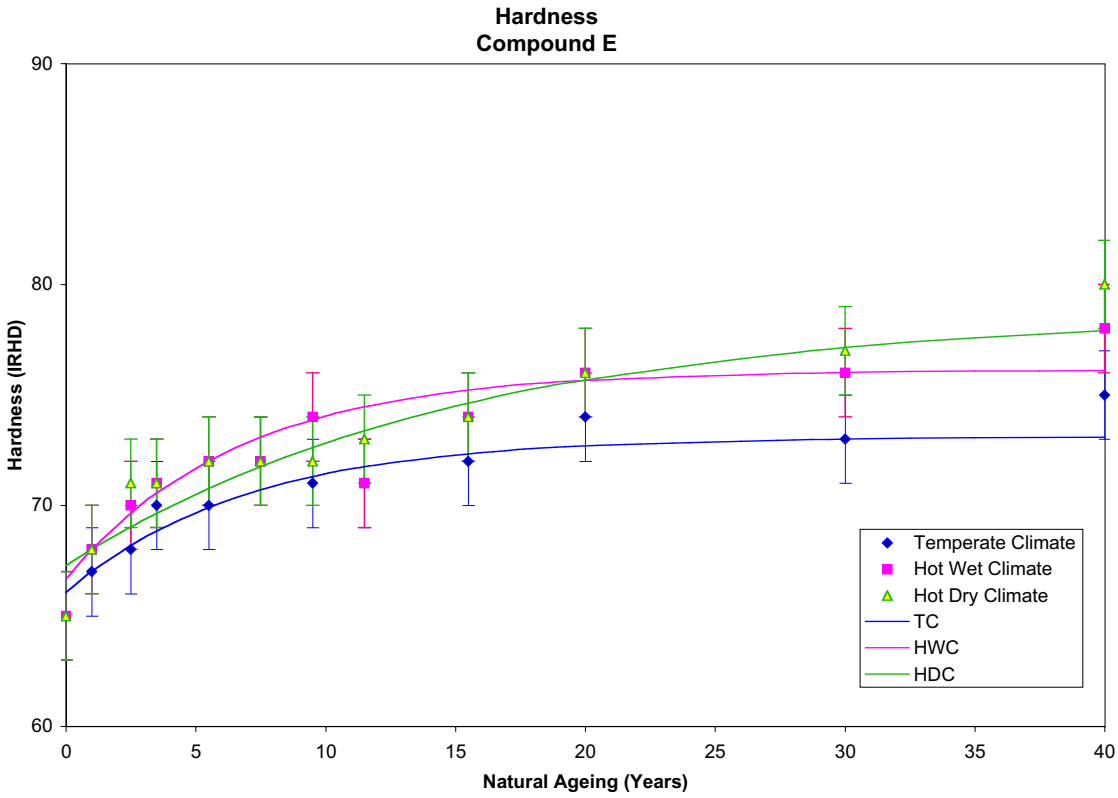

Long Term Compression Set
Compound D
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
Compression Set (%)
Natural Ageing (Years)
0
50
100
150
0
5
10
15
20
25
30
35
40

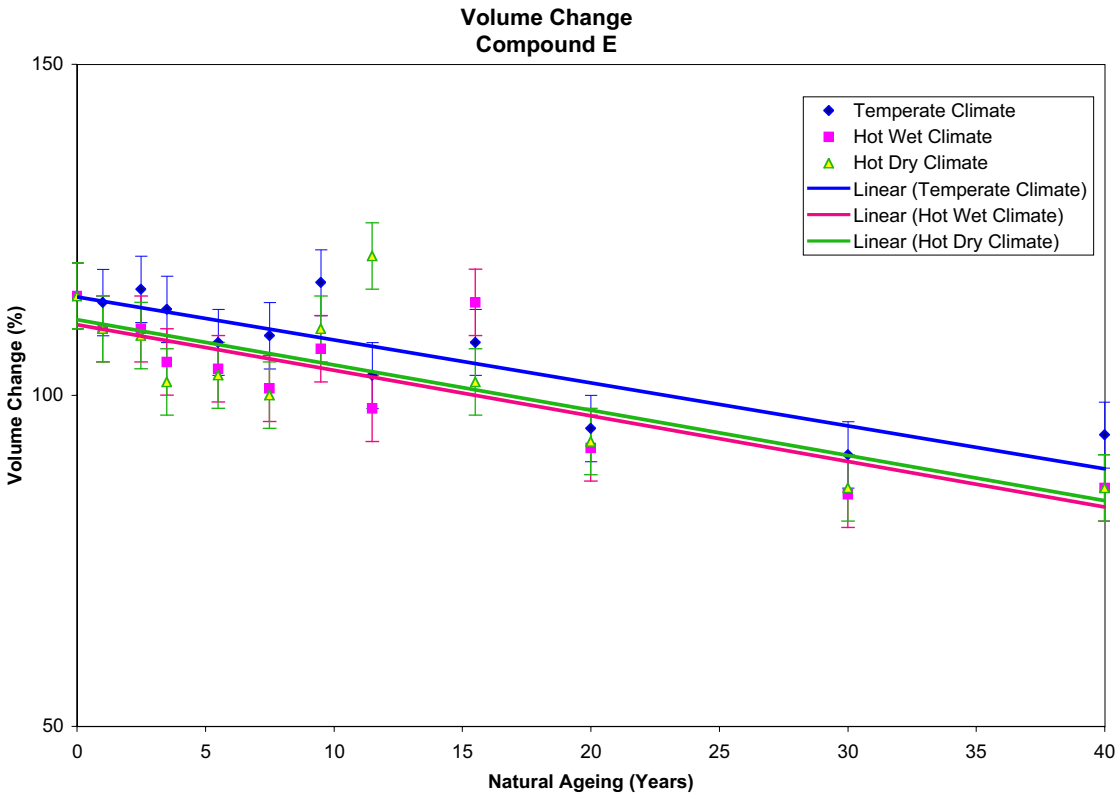


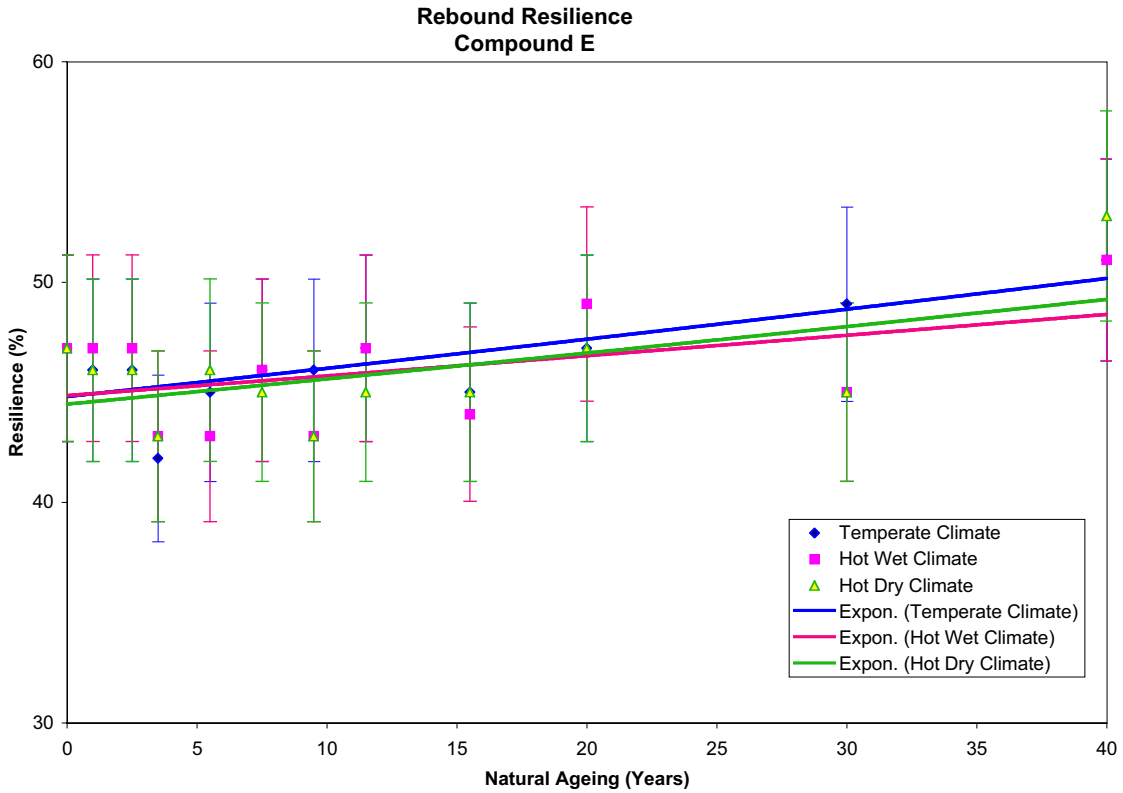


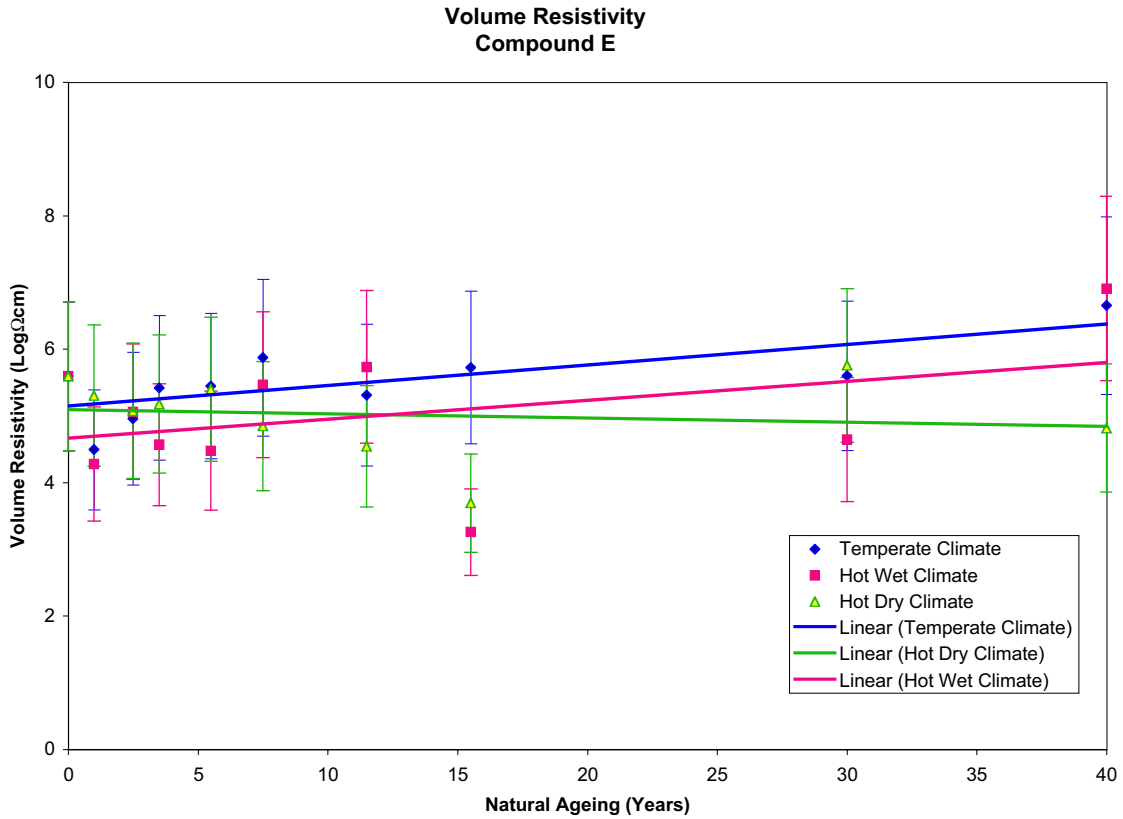
Extrapolated unaged and 40 years natural ageing data: Compound E (styrene butadiene rubber - general purpose)

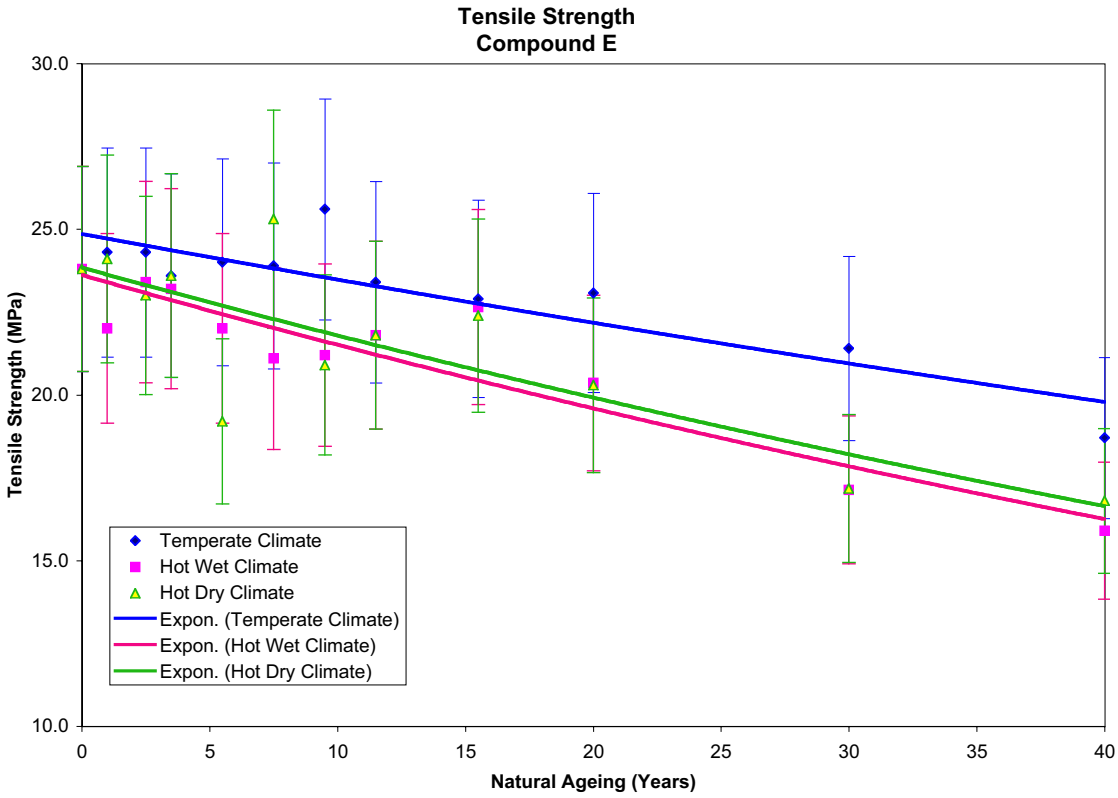
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	66.1	74.3	8.2	12	66.7	77.0	10	15	66.9	79.1	12	18
Volume Change (%)	115	89.2	-26	-22	111	83.3	-28	-25	112	84.2	-28	-25
Rebound Resilience (%)	44.9	50.3	5.4	12	44.9	48.6	3.7	8.2	44.5	49.3	4.8	11
Volume Resistivity (LogΩcm)	5.17	6.42	1.3	24	4.71	5.83	1.1	24	5.08	4.87	-0.21	-4.1
Tensile Properties												
Tensile Strength (MPa)	24.9	19.8	-5.1	-20	23.7	16.3	-7.4	-31	23.8	16.7	-7.1	-30
Elongation at Break (%)	454	242	-213	-47	410	152	-258	-63	417	144	-273	-66
Modulus at 100% (MPa)	3.13	6.50	3.4	108	4.06	9.44	5.4	133	3.75	10.2	6.5	172
Modulus at 300% (MPa)	16.8	21.5	4.7	28	17.7	30.7	13	73	18.2	32.5	14	79
Compression Set												
Short Term (%)	7.00	7.13	0.13	1.9	6.63	8.38	1.8	26	7.13	7.50	0.37	5.2
Long Term (%)	0.0	81.9			0.0	97.3			0.0	97.6		
Low Temperature Properties												
T2 Value (K)	262	258	-4.3	-1.6	261	253	-7.8	-3.0	263	254	-9.3	-3.5
T10 Value (K)	245	242	-2.8	-1.1	240	243	3.6	1.5	243	245	1.7	0.70

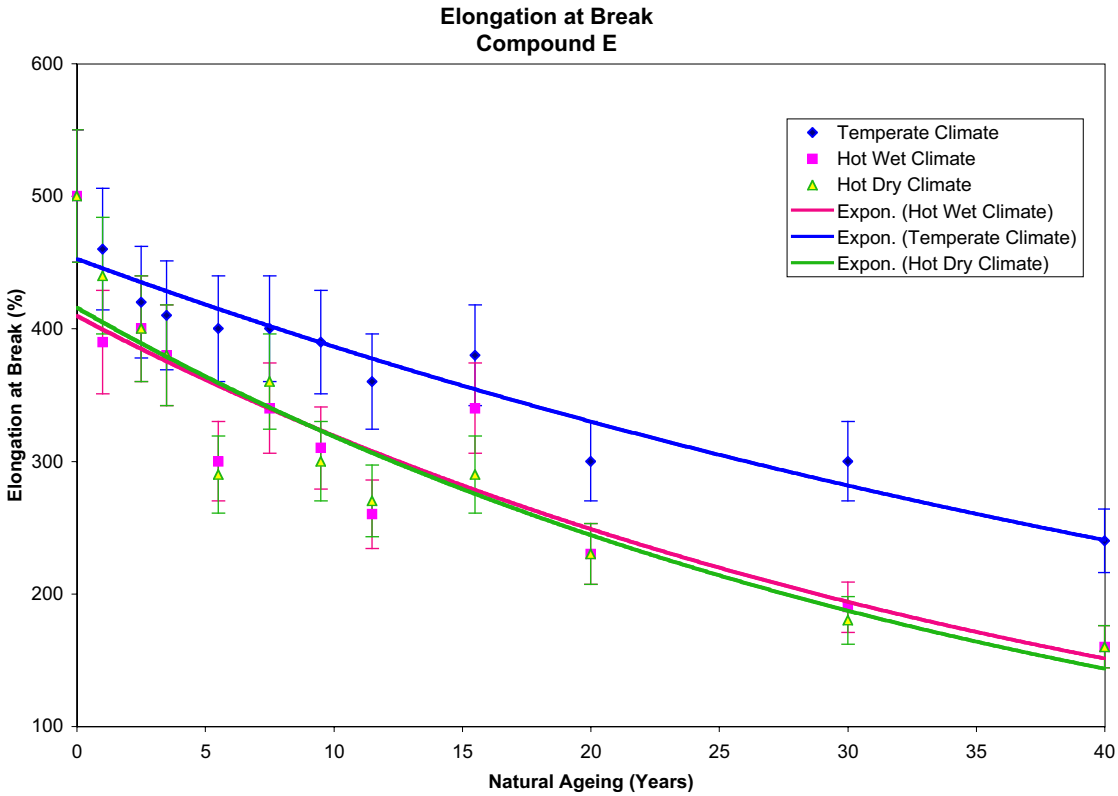

Hardness
Compound E
Hardness (IRHD)
90
80
70
60
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

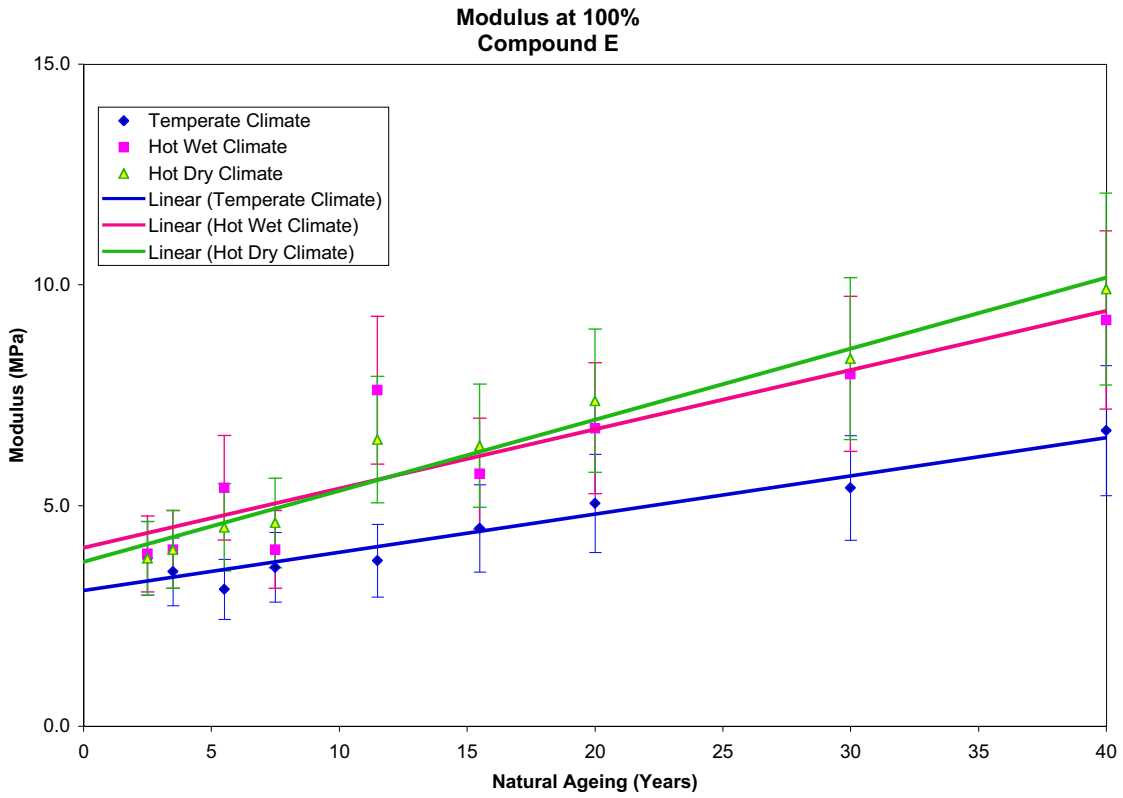

Volume Change
Compound E
Volume Change (%)
150
100
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

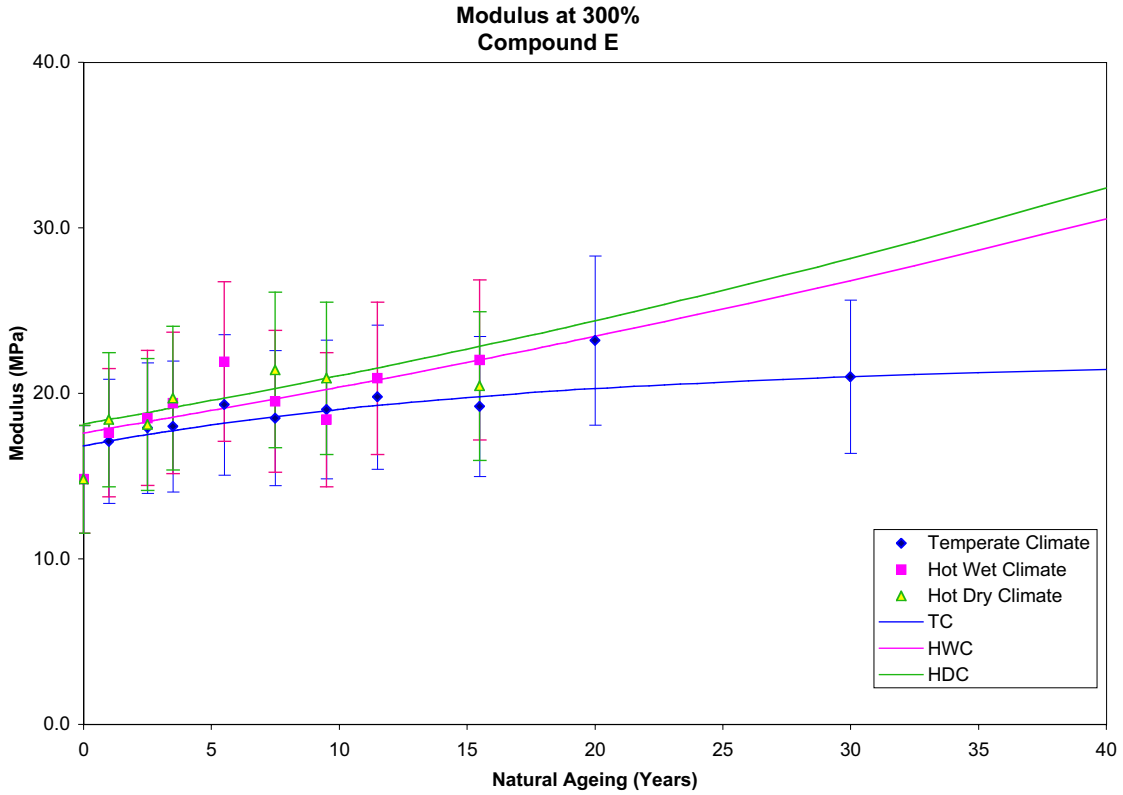


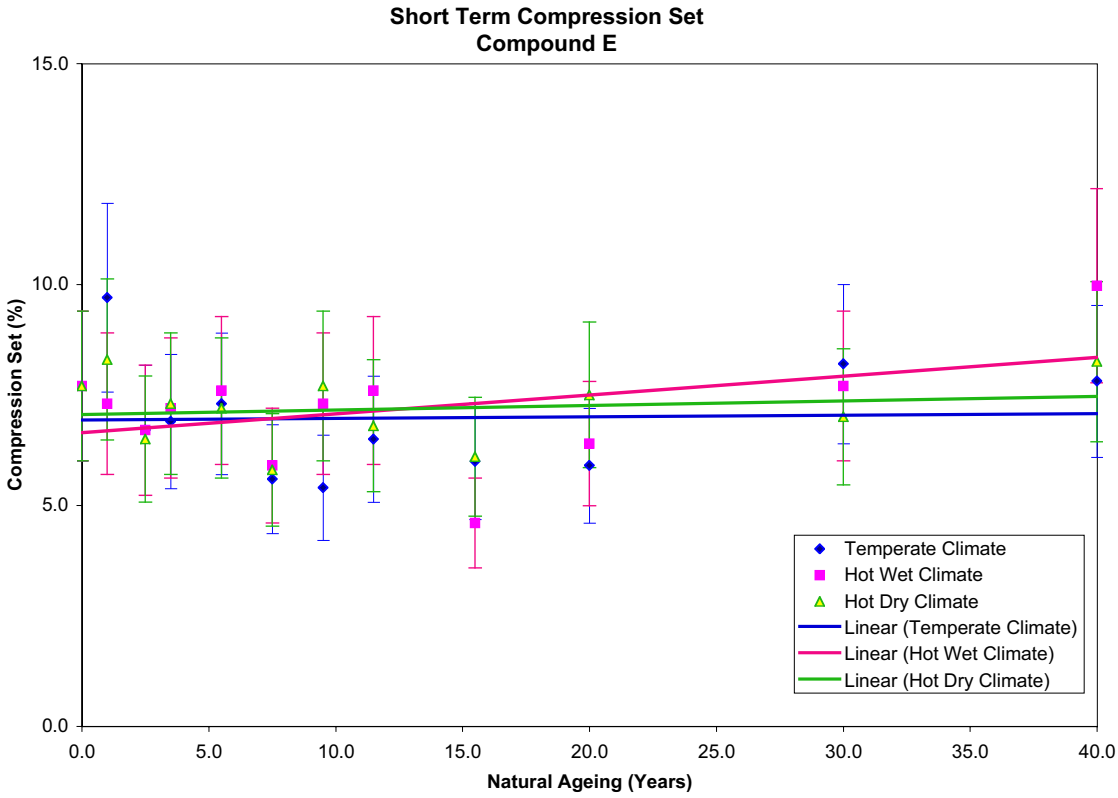


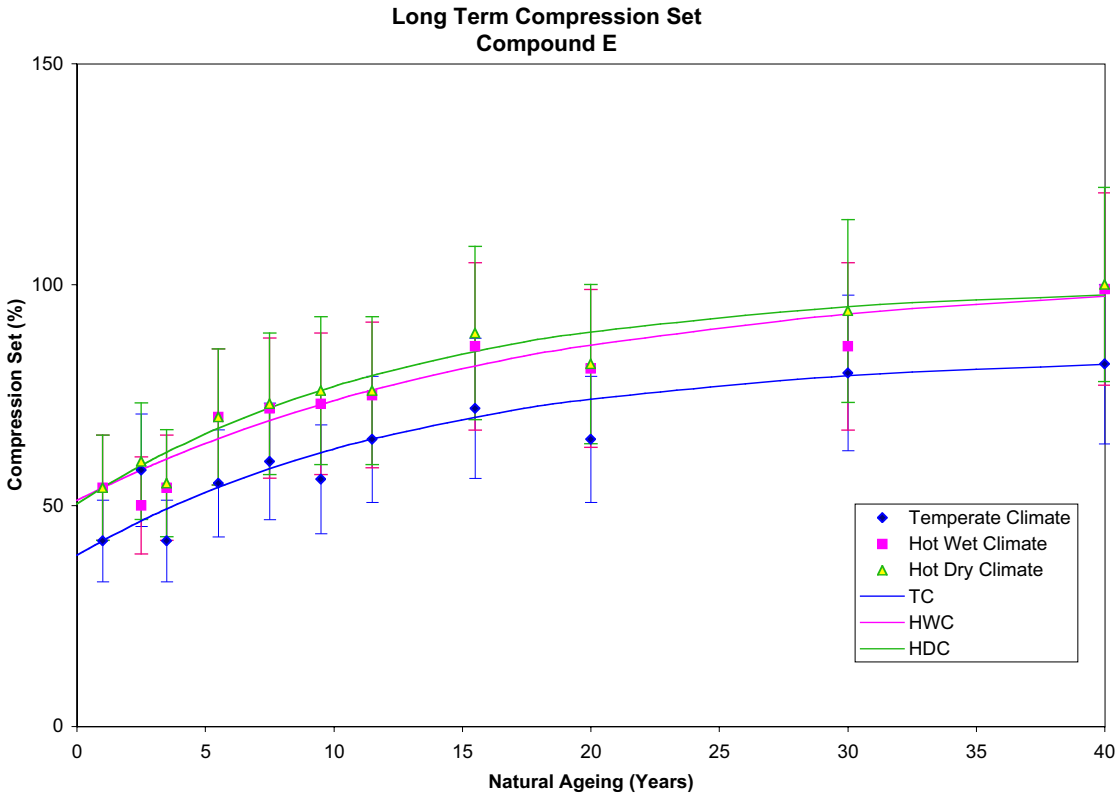

Tensile Strength
Compound E
Tensile Strength (MPa)
30.0
25.0
20.0
15.0
10.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

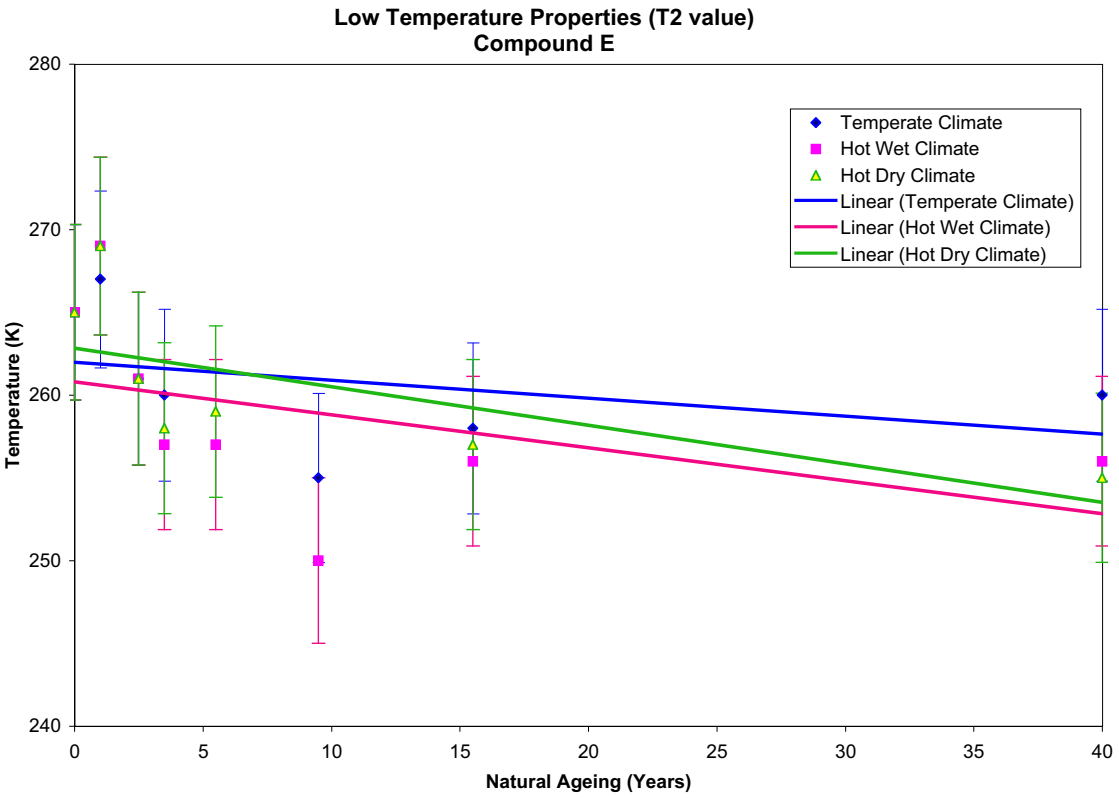

Elongation at Break
Compound E
Elongation at Break (%)
600
500
400
300
200
100
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

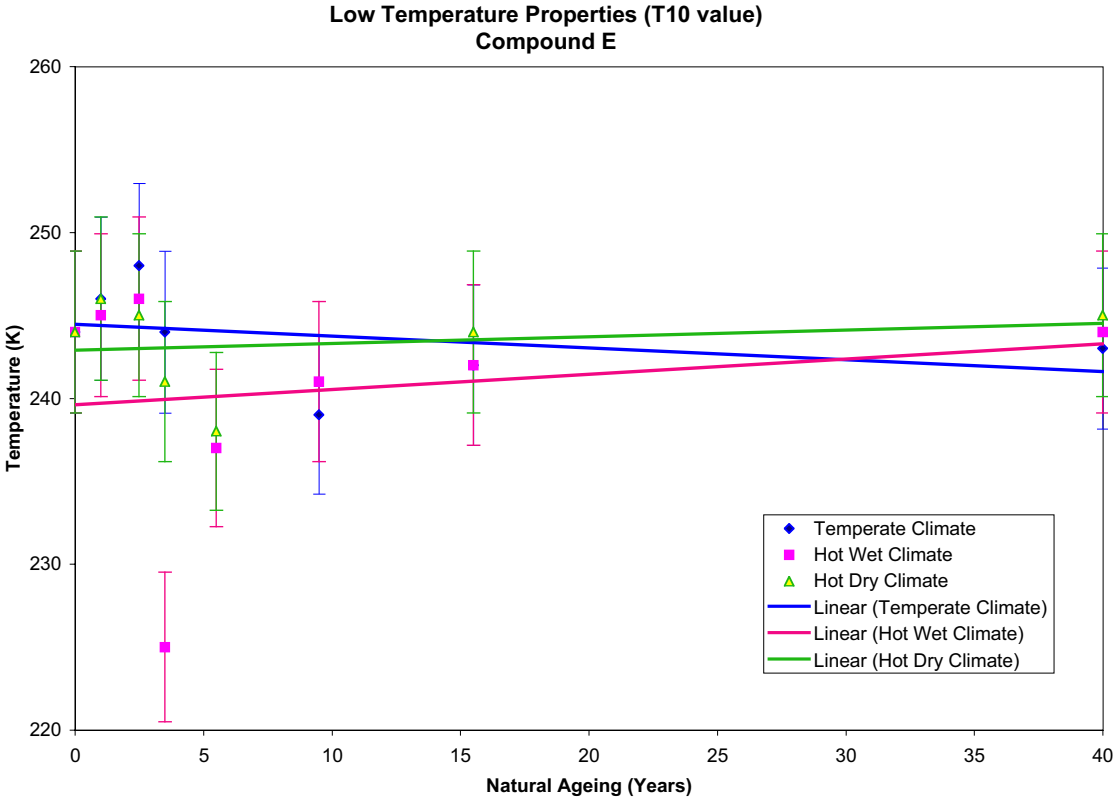





Short Term Compression Set
Compound E
Compression Set (%)
Natural Ageing (Years)
15.0
10.0
5.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

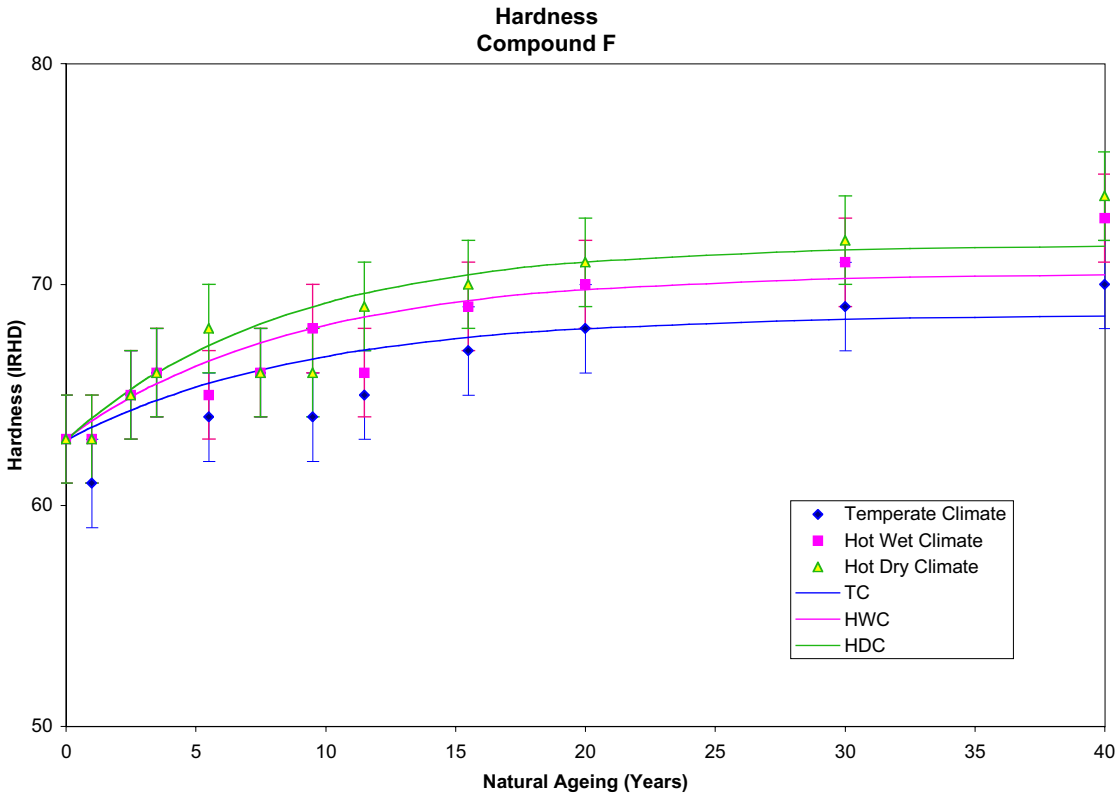

Long Term Compression Set
Compound E
Compression Set (%)
Natural Ageing (Years)
150
100
50
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

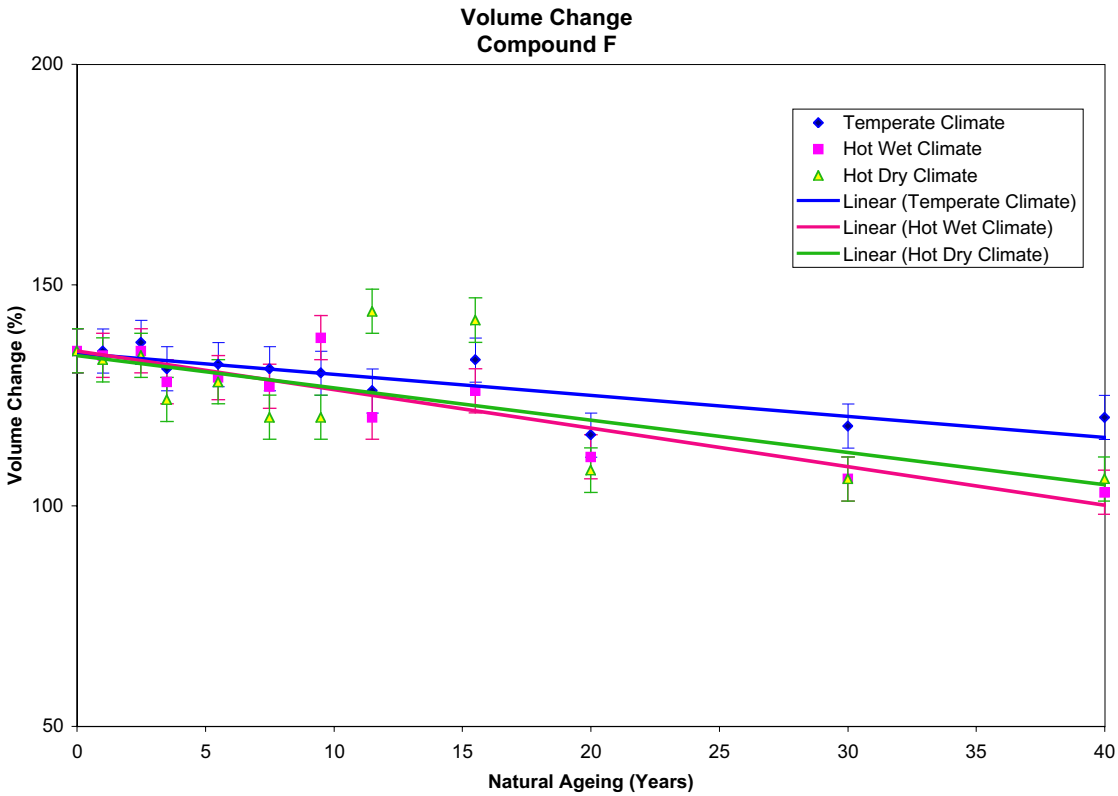


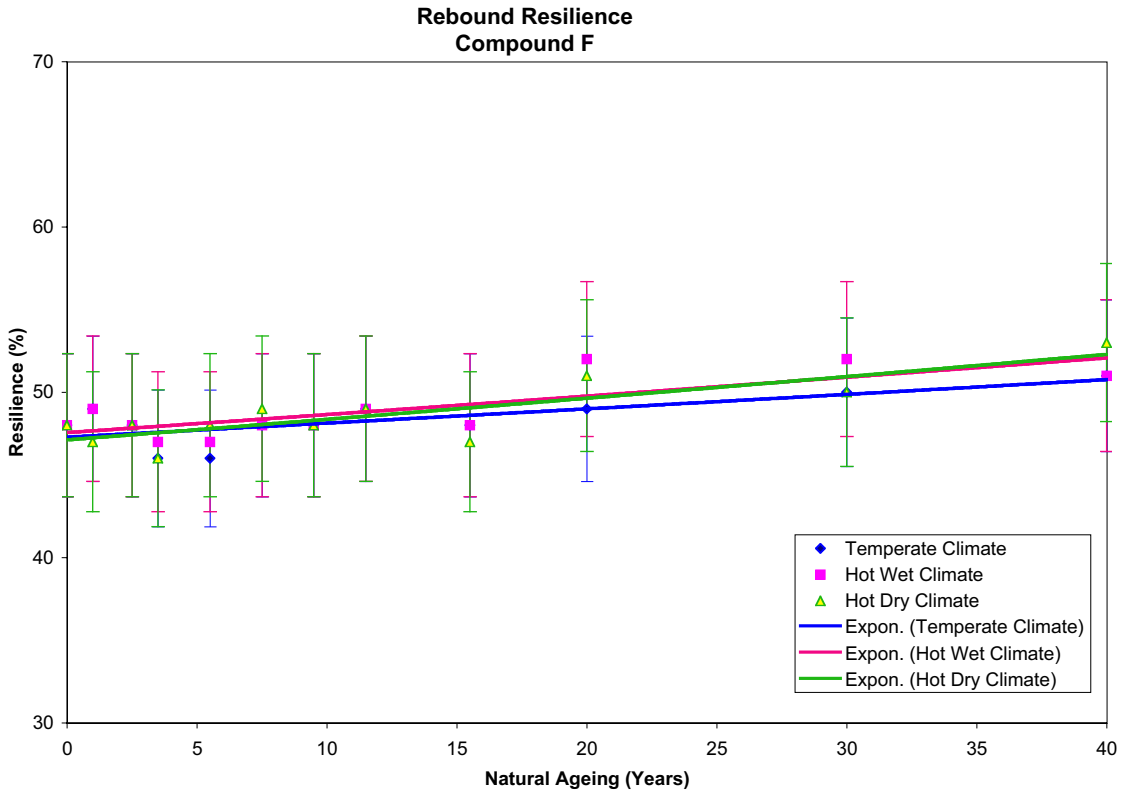


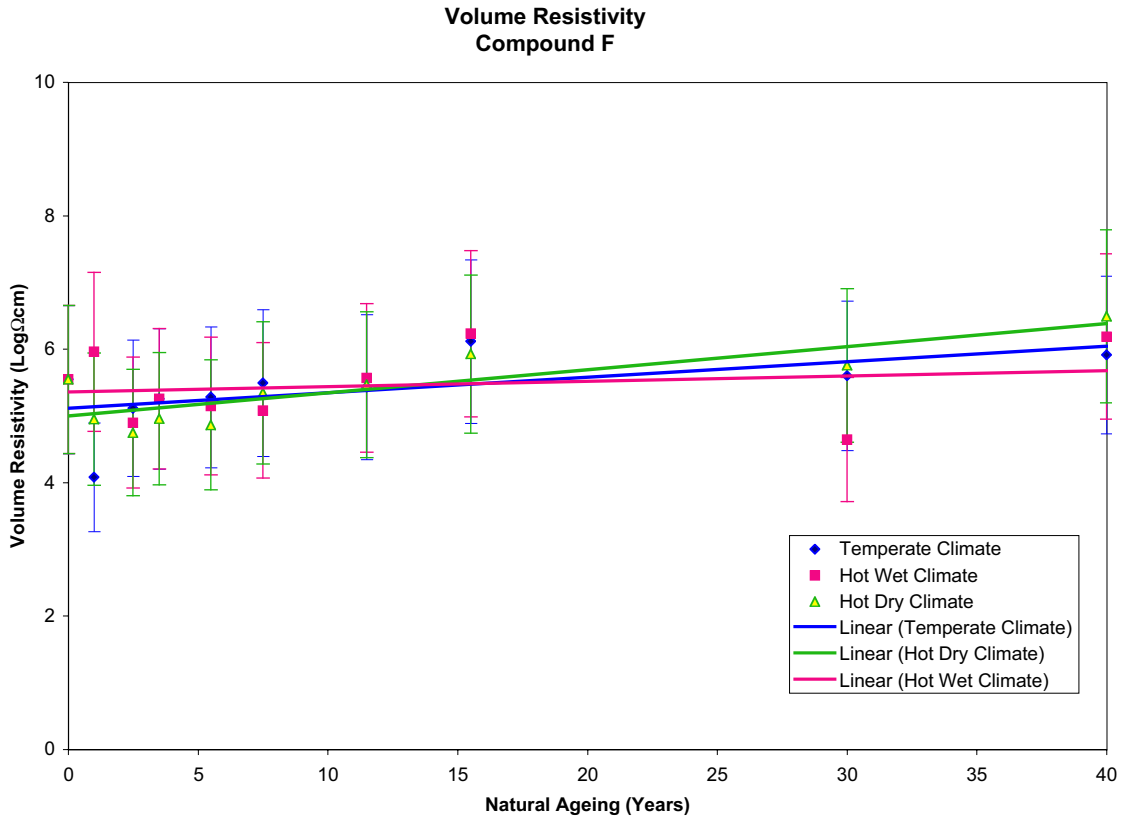
Extrapolated unaged and 40 years natural ageing data: Compound F (styrene butadiene rubber - good ageing)

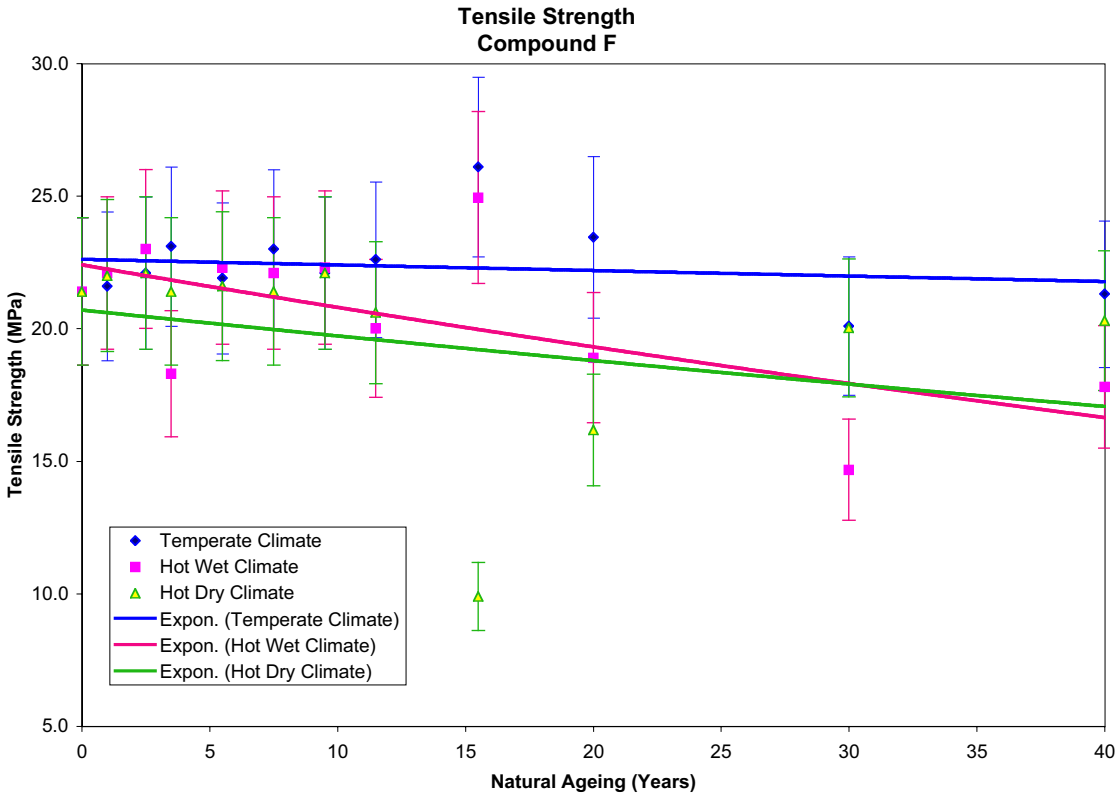
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	62.9	70.1	7.2	11	63.0	72.5	9.5	15	62.9	73.3	10	17
Volume Change (%)	134	116	-19	-14	134	100	-34	-26	134	105	-29	-22
Rebound Resilience (%)	47.3	50.8	3.5	7.4	47.7	52.3	4.6	10	47.2	52.3	5.1	11
Volume Resistivity (LogΩcm)	5.12	6.08	0.96	19	5.37	5.67	0.30	5.6	5.00	6.42	1.4	28
Tensile Properties												
Tensile Strength (MPa)	22.7	21.9	-0.80	-3.5	22.5	16.7	-5.8	-26	20.7	17.1	-3.6	-17
Elongation at Break (%)	527	408	-119	-23	527	250	-277	-53	494	265	-229	-46
Modulus at 100% (MPa)	2.25	3.53	1.3	57	2.25	5.08	2.8	126	2.15	5.00	2.9	133
Modulus at 300% (MPa)	11.3	15.1	3.8	34	11.3	19.8	8.5	75	11.5	17.6	6.1	53
Compression Set												
Short Term (%)	8.75	6.81	-1.9	-22	9.00	6.00	-3.0	-33	8.38	6.25	-2.1	-25
Long Term (%)	0.0	60.6			0.0	74.4			0.0	76.2		
Low Temperature Properties												
T2 Value (K)	255	258	3.3	1.3	253	250	-3.0	-1.2	256	250	-5.2	-2.0
T10 Value (K)	237	235	-1.7	-0.7	235	235	0.80	0.3	236	235	-0.80	-0.3

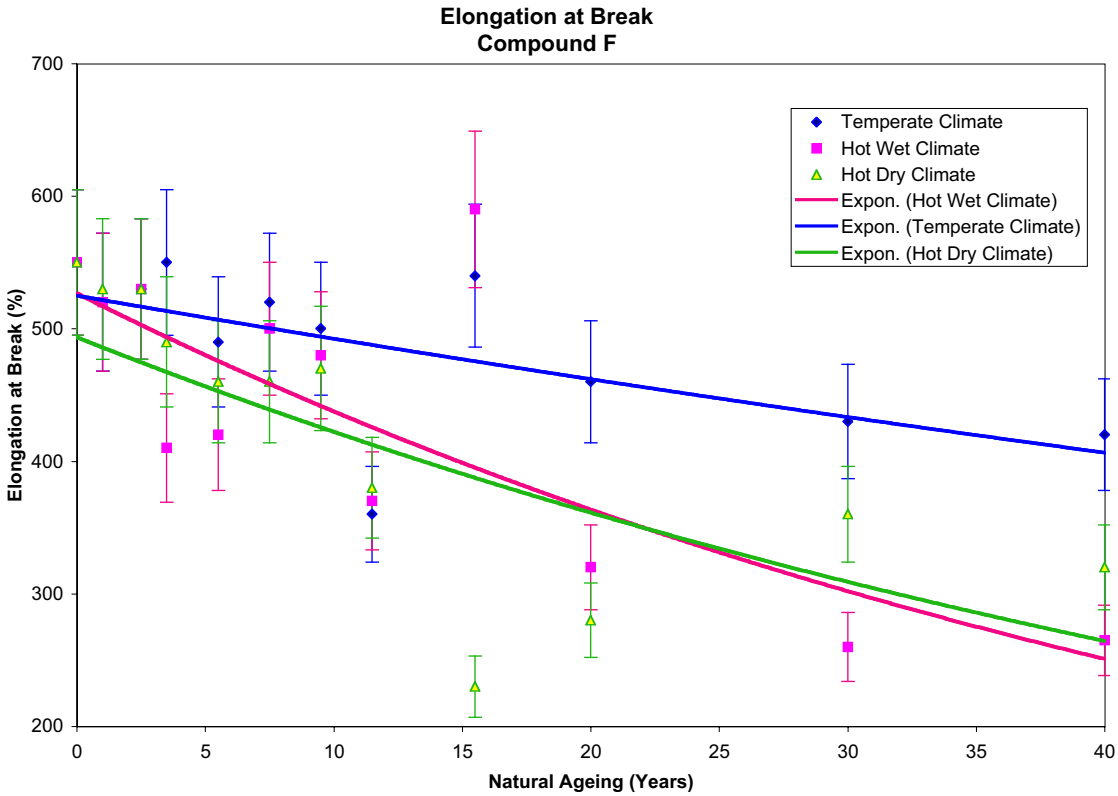

Hardness
Compound F
Hardness (IRHD)
80
70
60
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

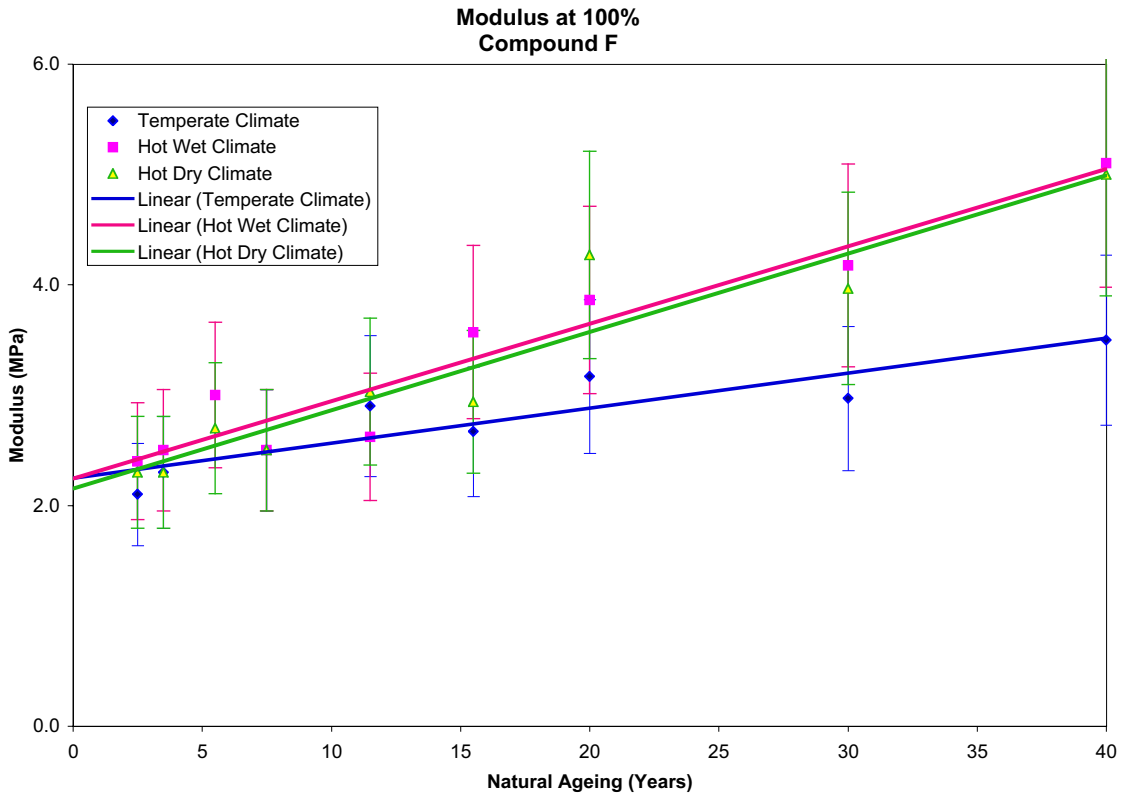

Volume Change
Compound F
Volume Change (%)
200
150
100
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

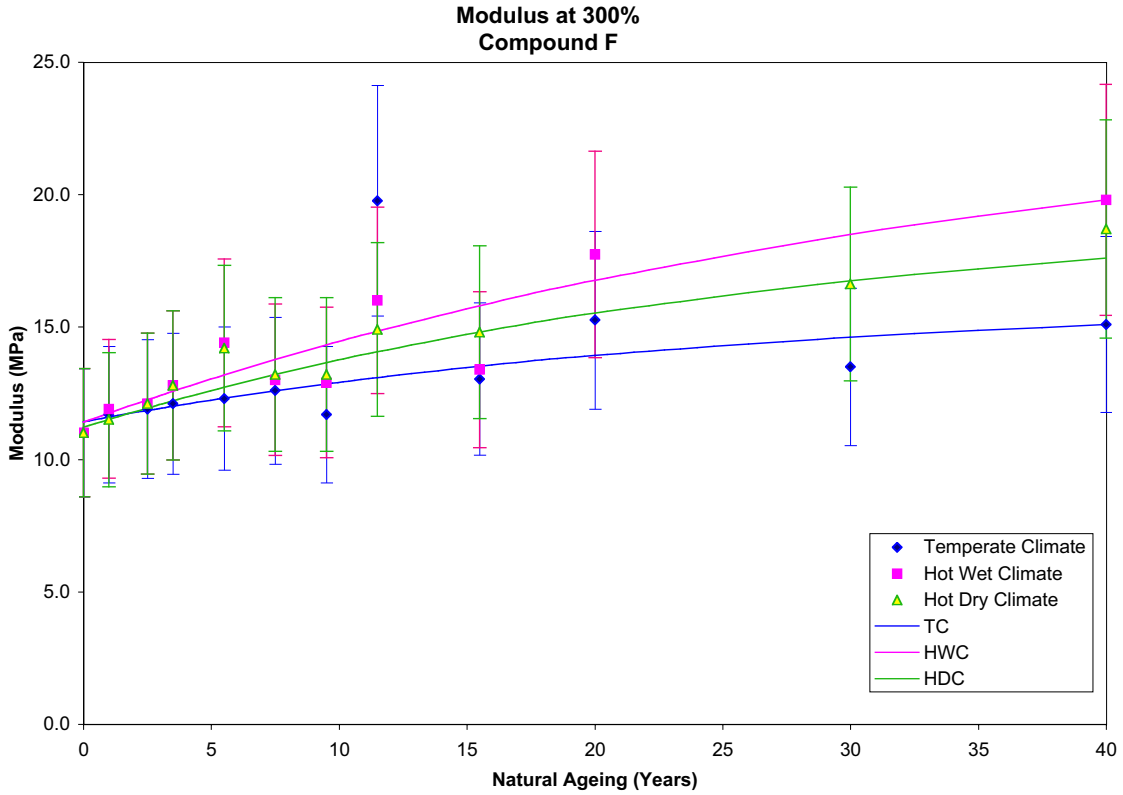


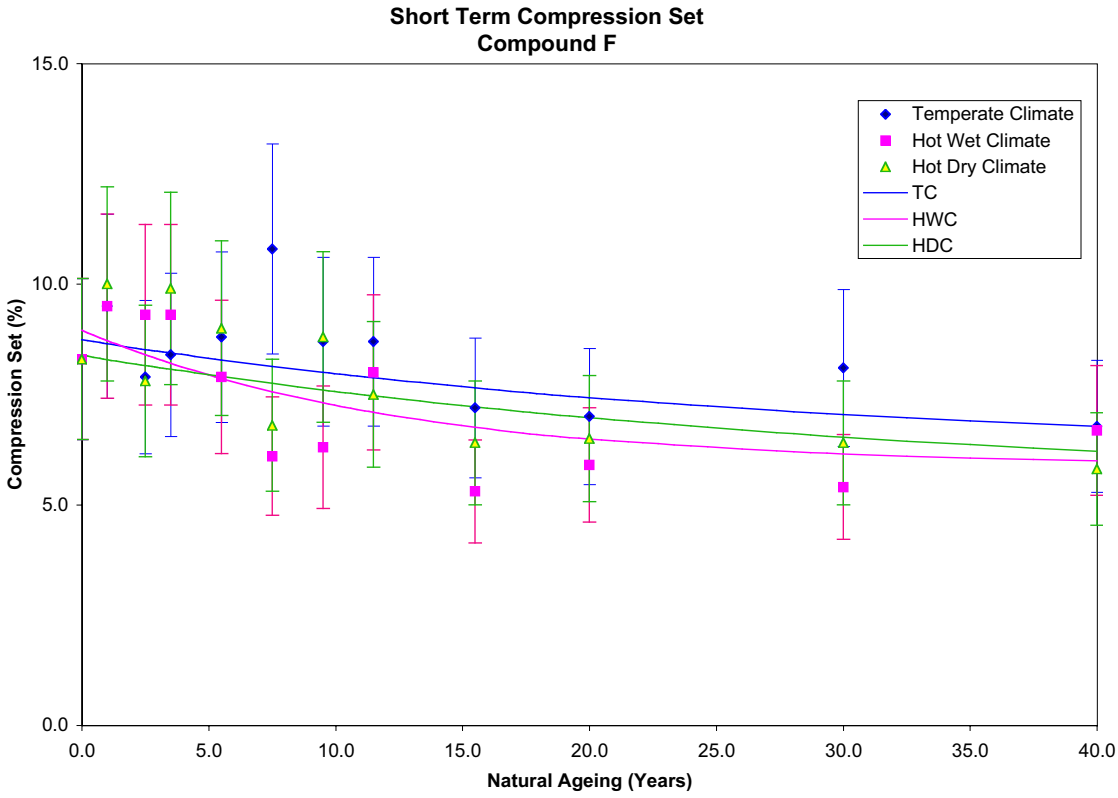


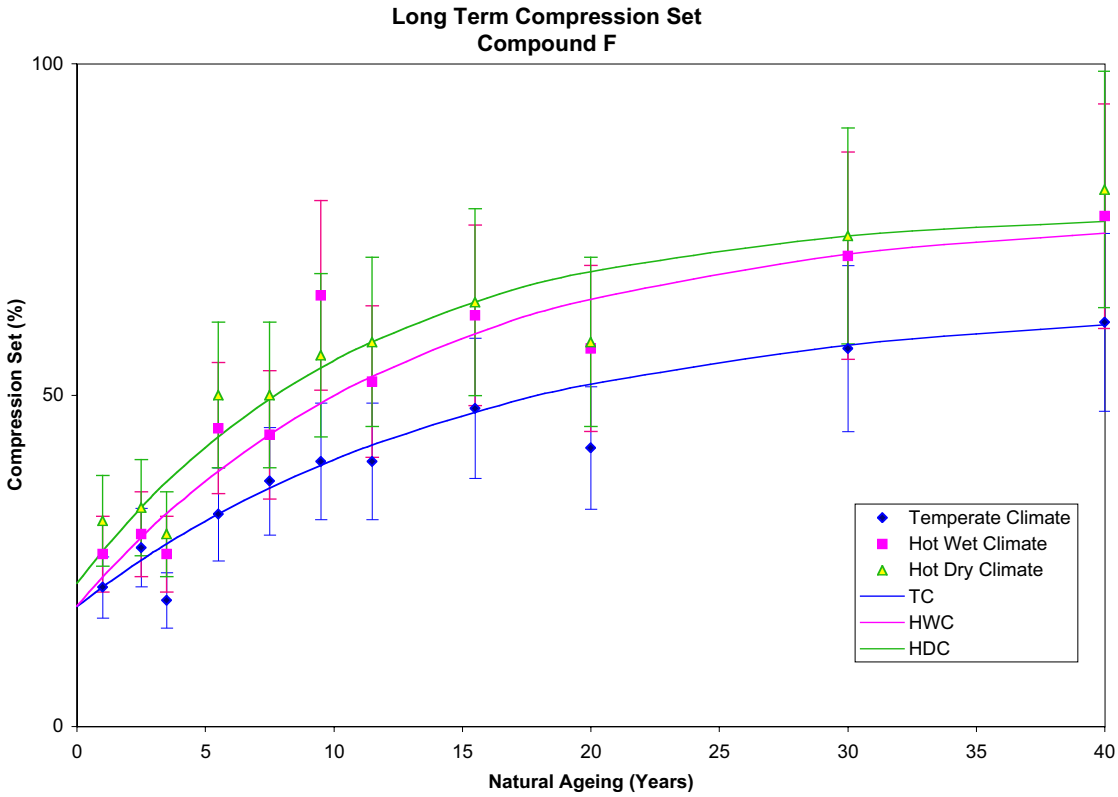

Tensile Strength
Compound F
Tensile Strength (MPa)
30.0
25.0
20.0
15.0
10.0
5.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

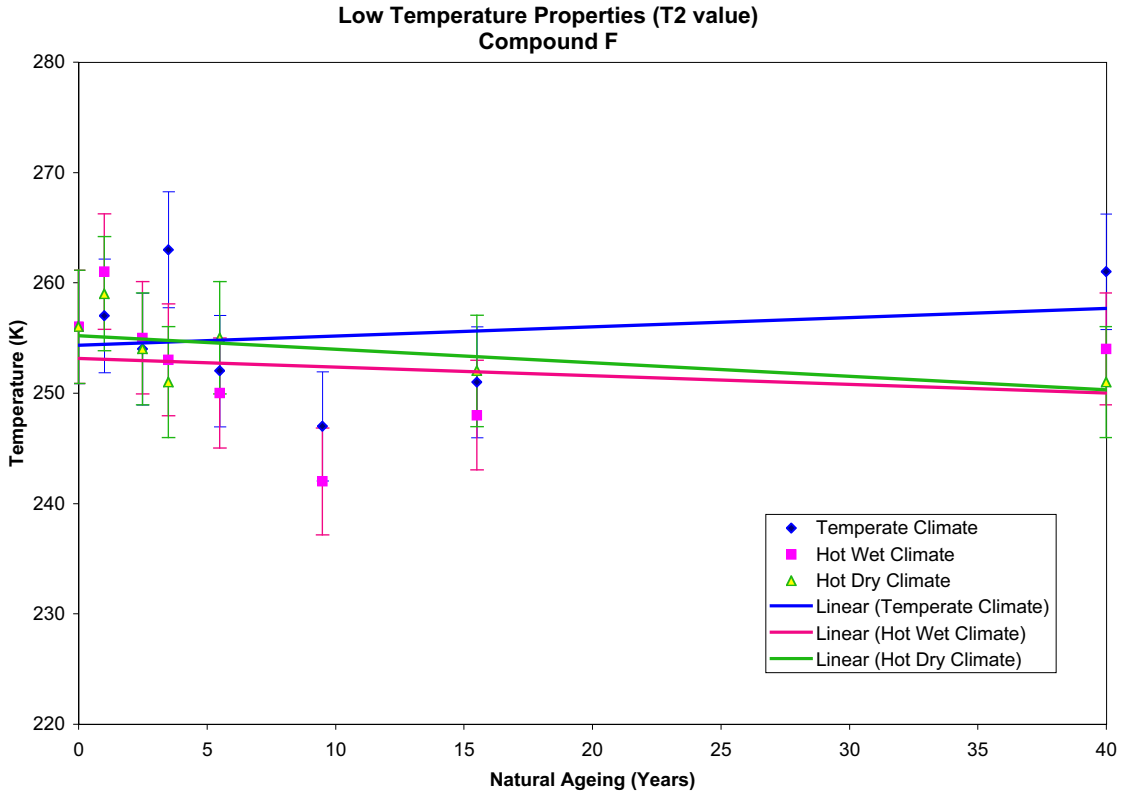

Elongation at Break
Compound F
Elongation at Break (%)
700
600
500
400
300
200
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

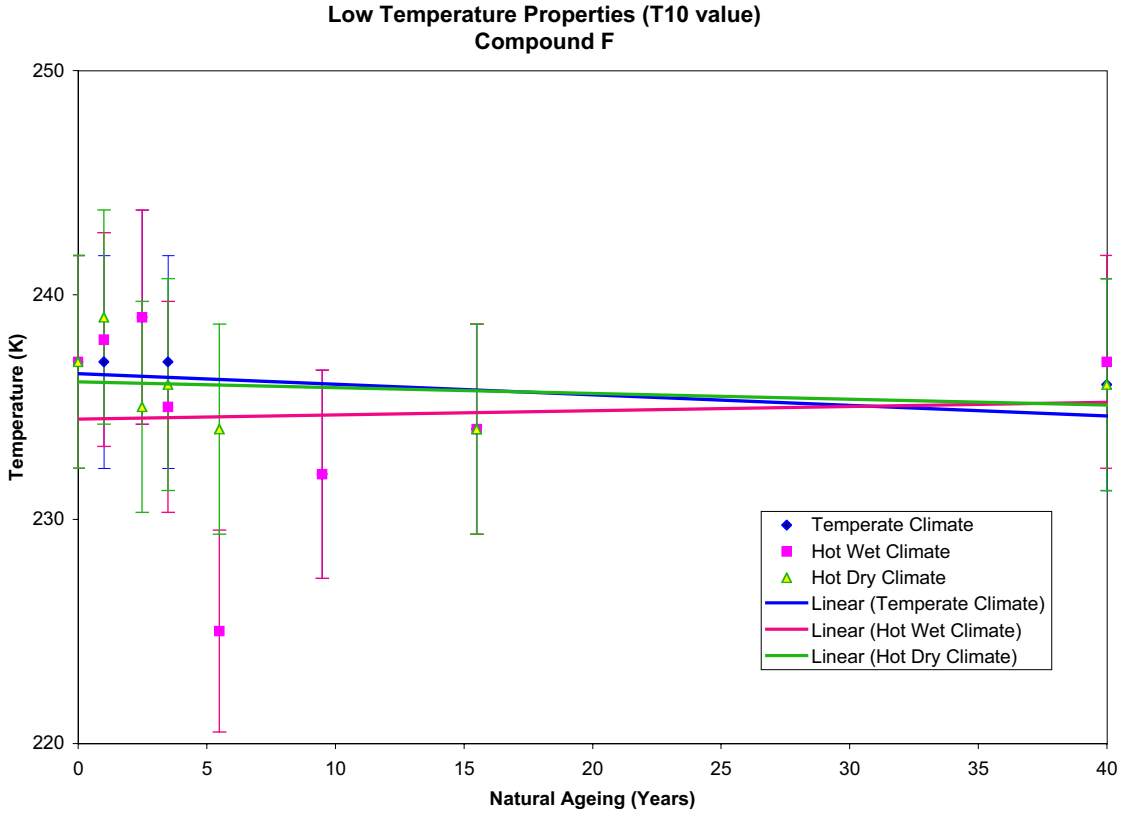





Short Term Compression Set
Compound F
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
15.0
10.0
5.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

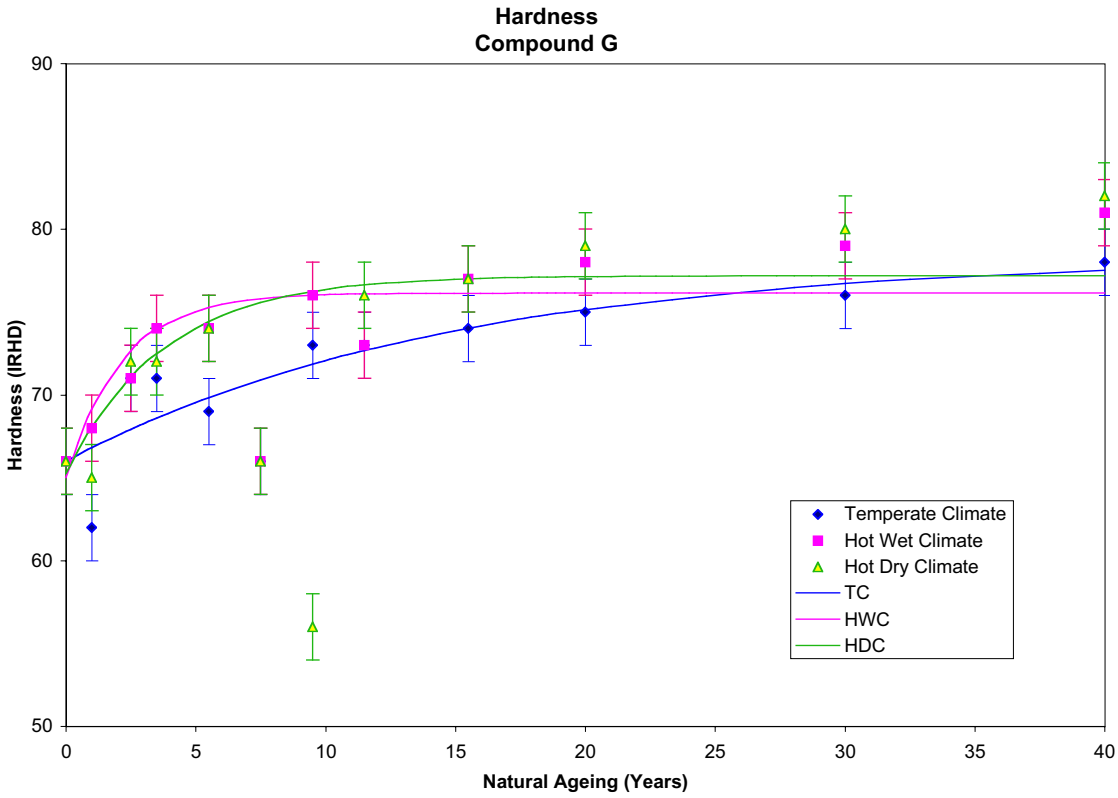

Long Term Compression Set
Compound F
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
100
50
0
0
5
10
15
20
25
30
35
40

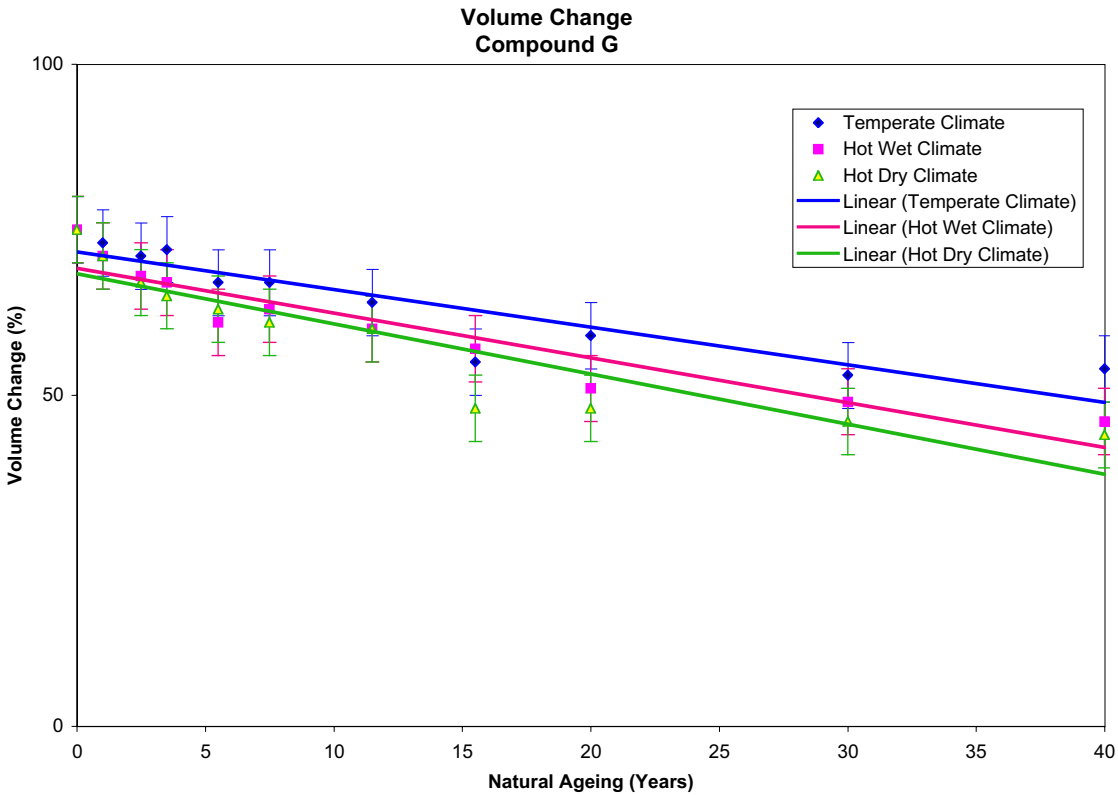


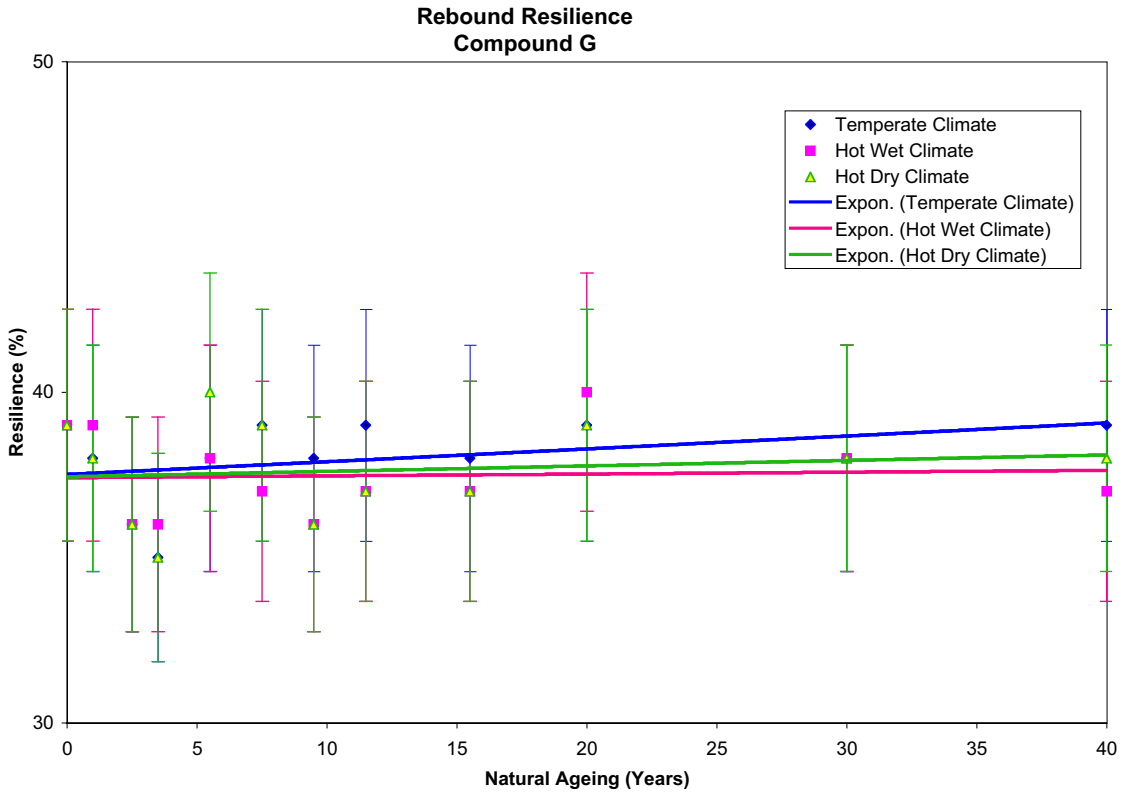


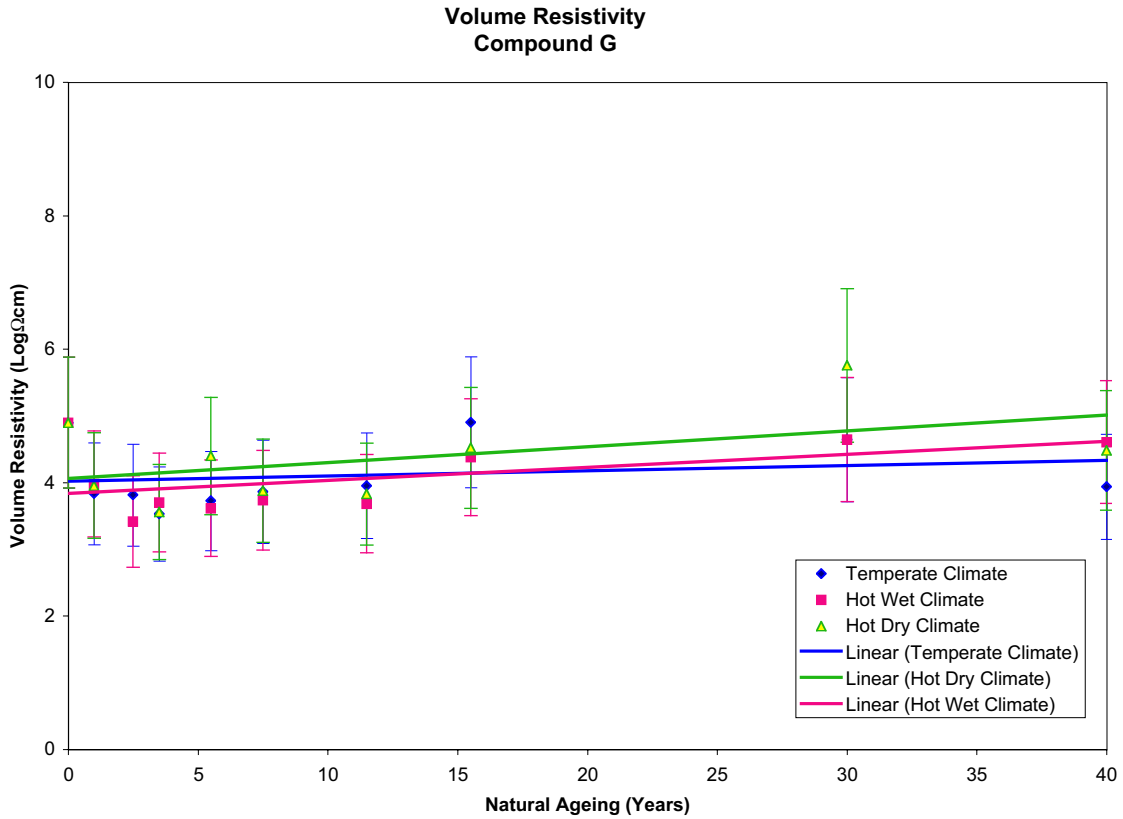
Extrapolated unaged and 40 years natural ageing data: Compound G (styrene butadiene rubber (oil extended) - general purpose)

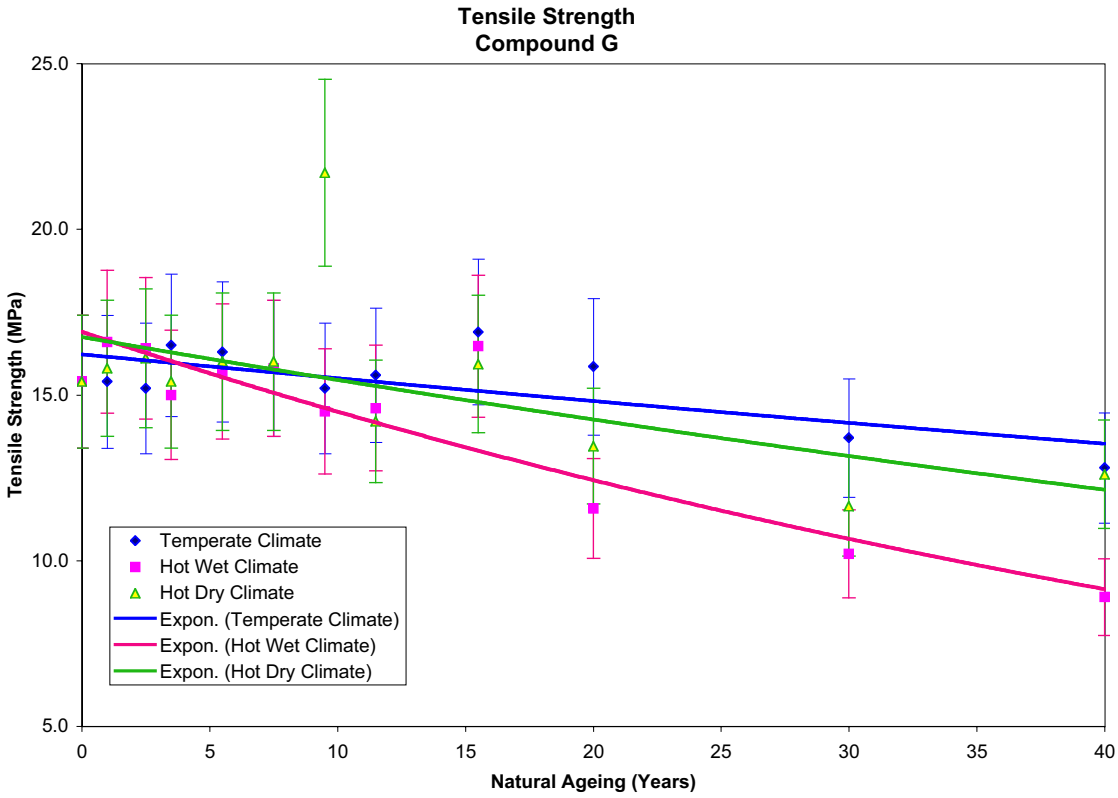
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	66.0	77.7	12	18	65.0	80.7	16	24	65.2	81.8	17	25
Volume Change (%)	71.7	49.2	-23	-31	69.2	42.5	-27	-39	68.3	38.3	-30	-44
Rebound Resilience (%)	37.5	39.1	1.6	4.3	37.5	37.7	0.20	0.53	37.5	38.2	0.70	1.9
Volume Resistivity (LogΩcm)	4.00	4.33	0.33	8.3	3.83	4.63	0.80	21	4.08	5.04	1.0	24
Tensile Properties												
Tensile Strength (MPa)	16.2	13.5	-2.7	-17	17.0	9.17	-7.8	-46	16.8	12.2	-4.6	-27
Elongation at Break (%)	340	178	-162	-48	340	96.7	-243	-72	317	107	-210	-66
Modulus at 100% (MPa)	3.38	7.00	3.6	107	4.75	7.19	2.4	51	3.63	10.9	7.3	200
Modulus at 300% (MPa)	15.2	10.5	-4.7	-31	16.0	1.17	-15	-93	15.5	1.50	-14	-90
Compression Set												
Short Term (%)	9.67	10.8	1.1	12	9.50	13.6	4.1	43	9.50	13.7	4.2	44
Long Term (%)	0.0	92.9			0.0	99.7			0.0	89.9		
Low Temperature Properties												
T2 Value (K)	262	262	-0.30	-0.1	259	260	0.70	0.3	260	259	-1.0	-0.4
T10 Value (K)	242	243	0.90	0.4	242	247	5.1	2.1	244	245	0.70	0.3

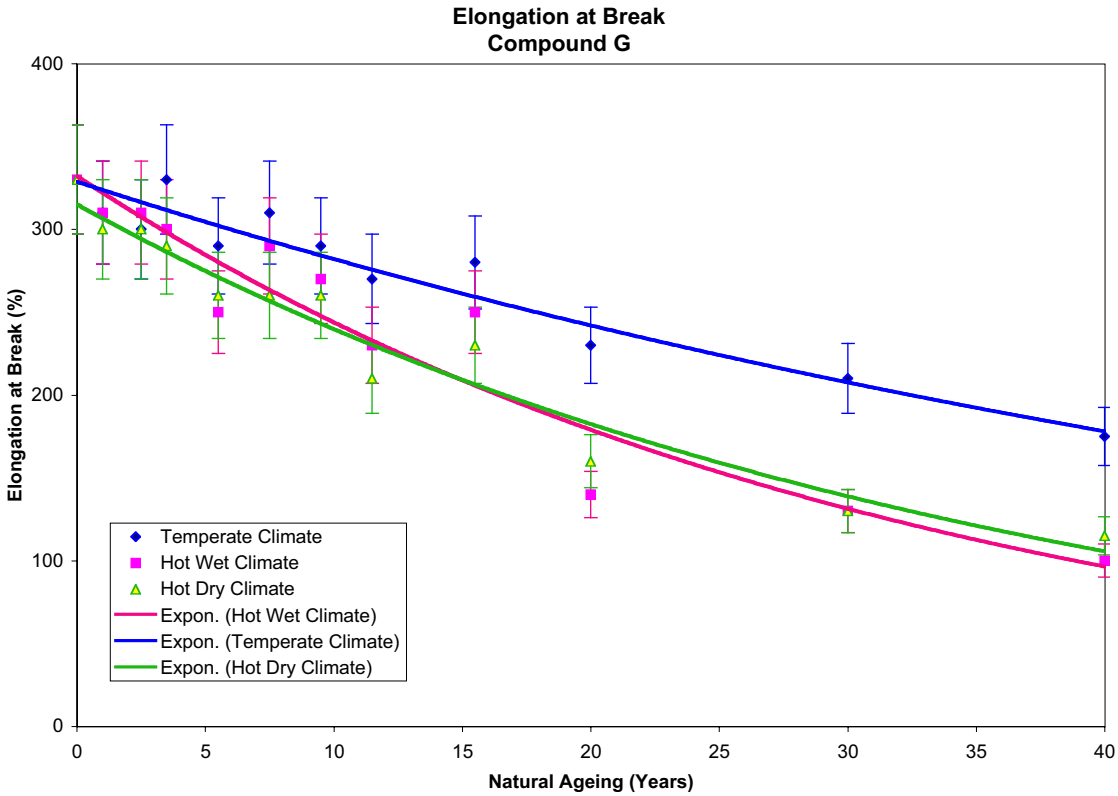

Hardness
Compound G
Hardness (IRHD)
Natural Ageing (Years)
90
80
70
60
50
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

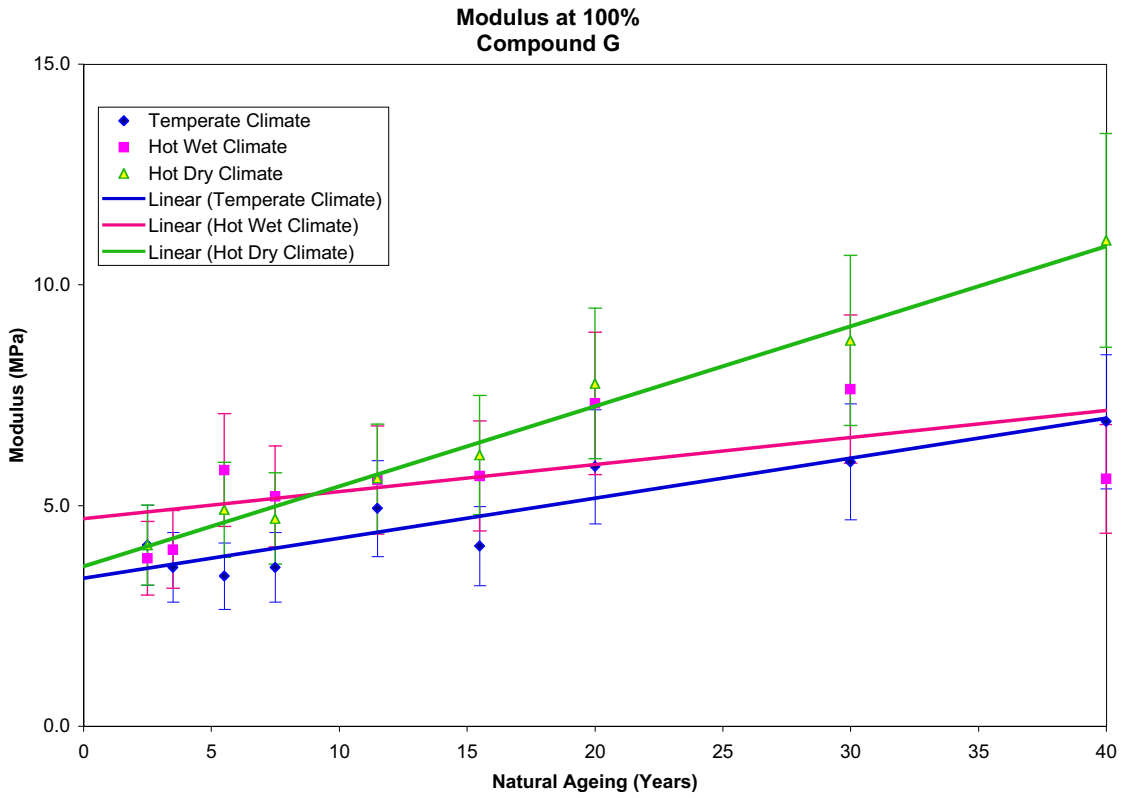

Volume Change
Compound G
Volume Change (%)
Natural Ageing (Years)
100
50
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

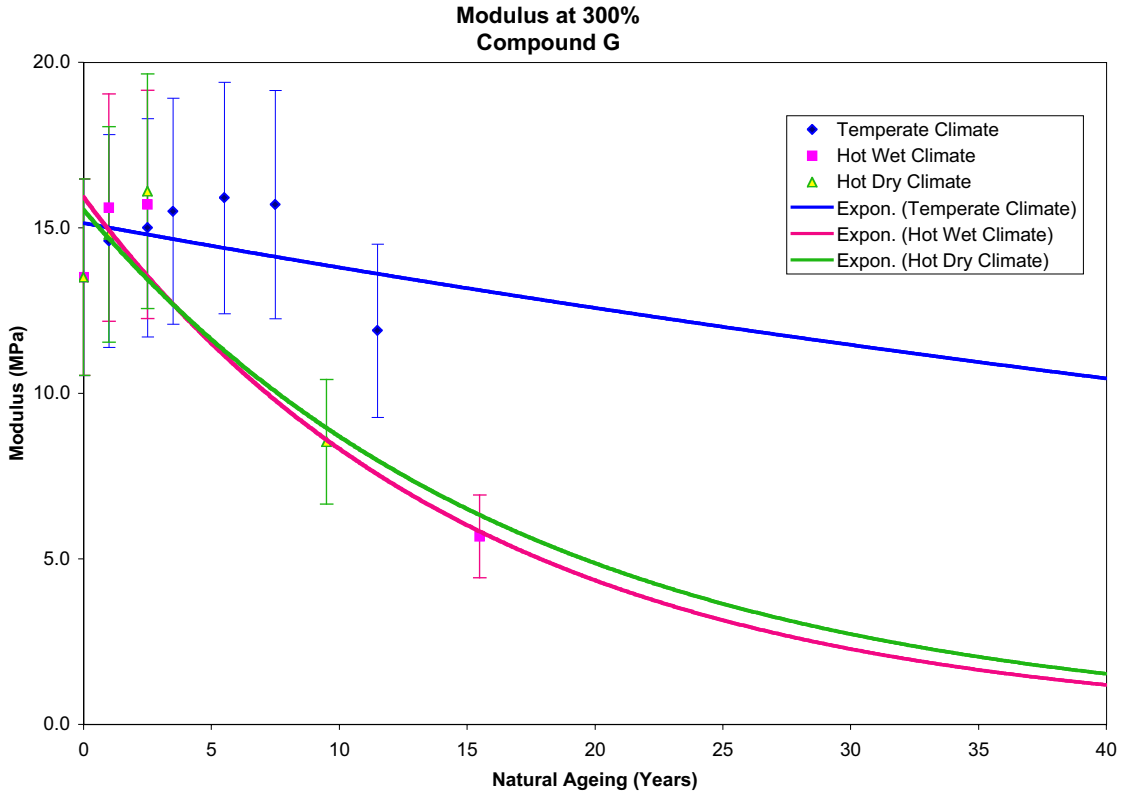


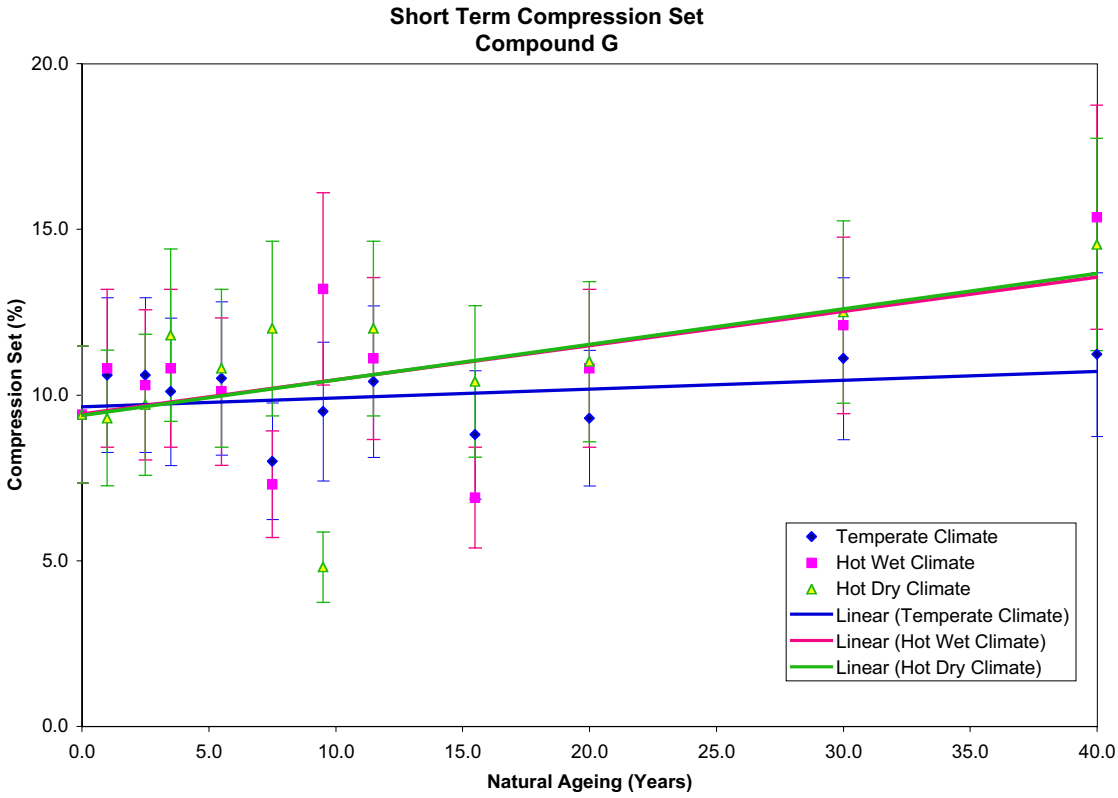


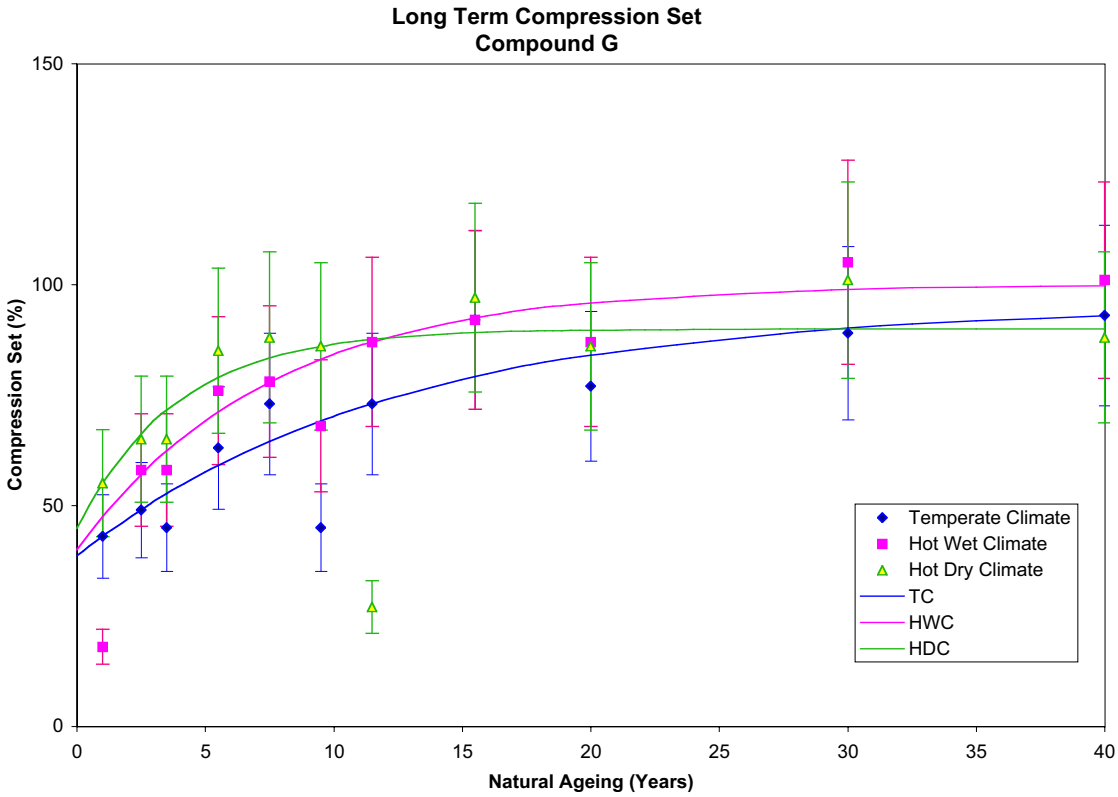

Tensile Strength
Compound G
Tensile Strength (MPa)
25.0
20.0
15.0
10.0
5.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

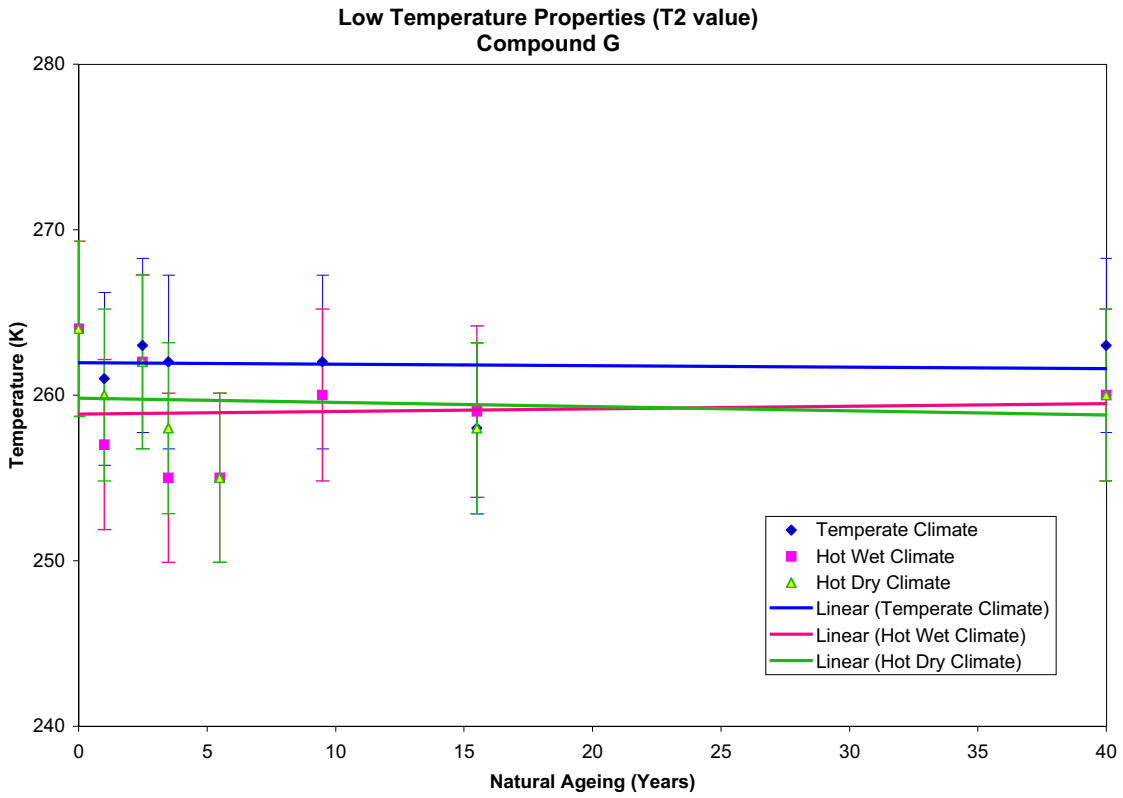

Elongation at Break
Compound G
Elongation at Break (%)
400
300
200
100
0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

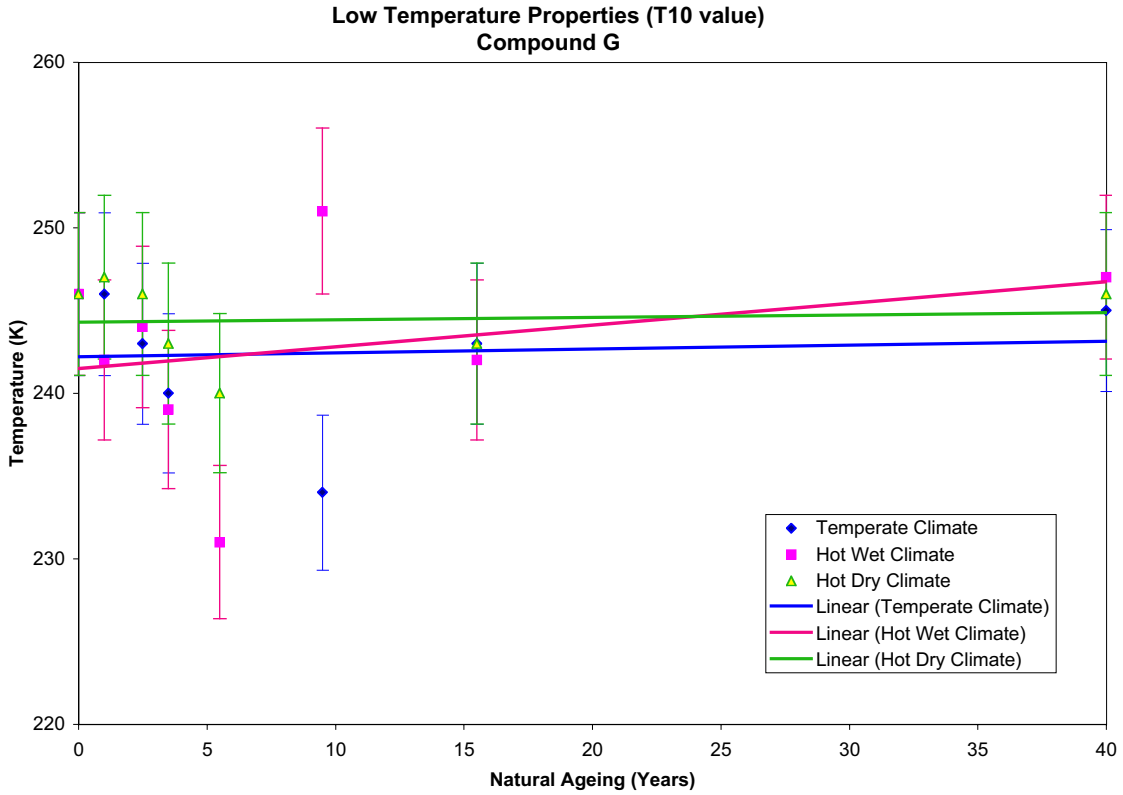





Short Term Compression Set
Compound G
Compression Set (%)
Natural Ageing (Years)
20.0
15.0
10.0
5.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

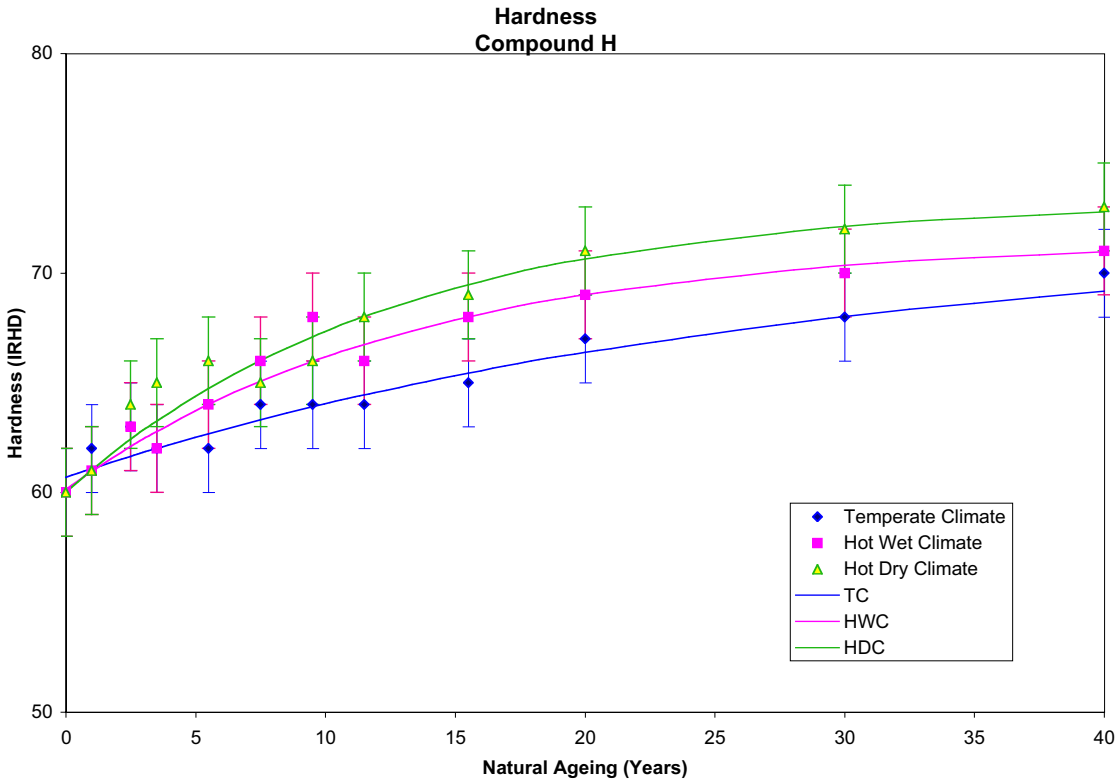

Long Term Compression Set
Compound G
Compression Set (%)
Natural Ageing (Years)
150
100
50
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

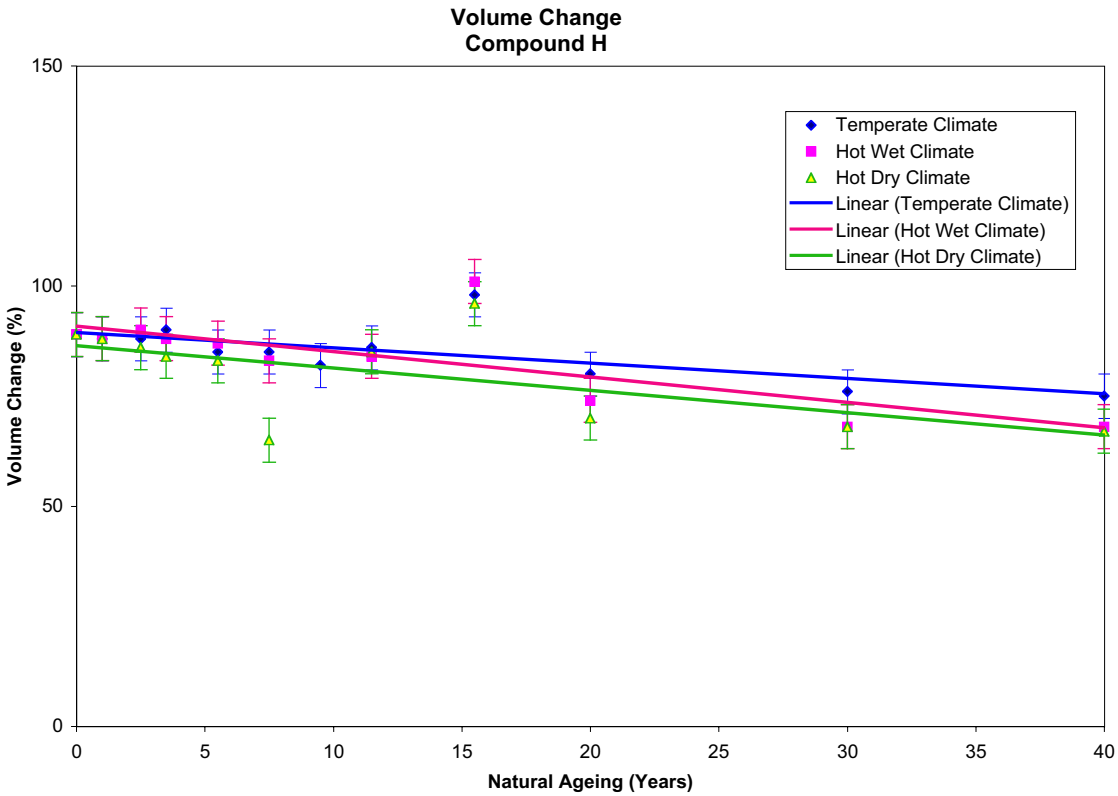


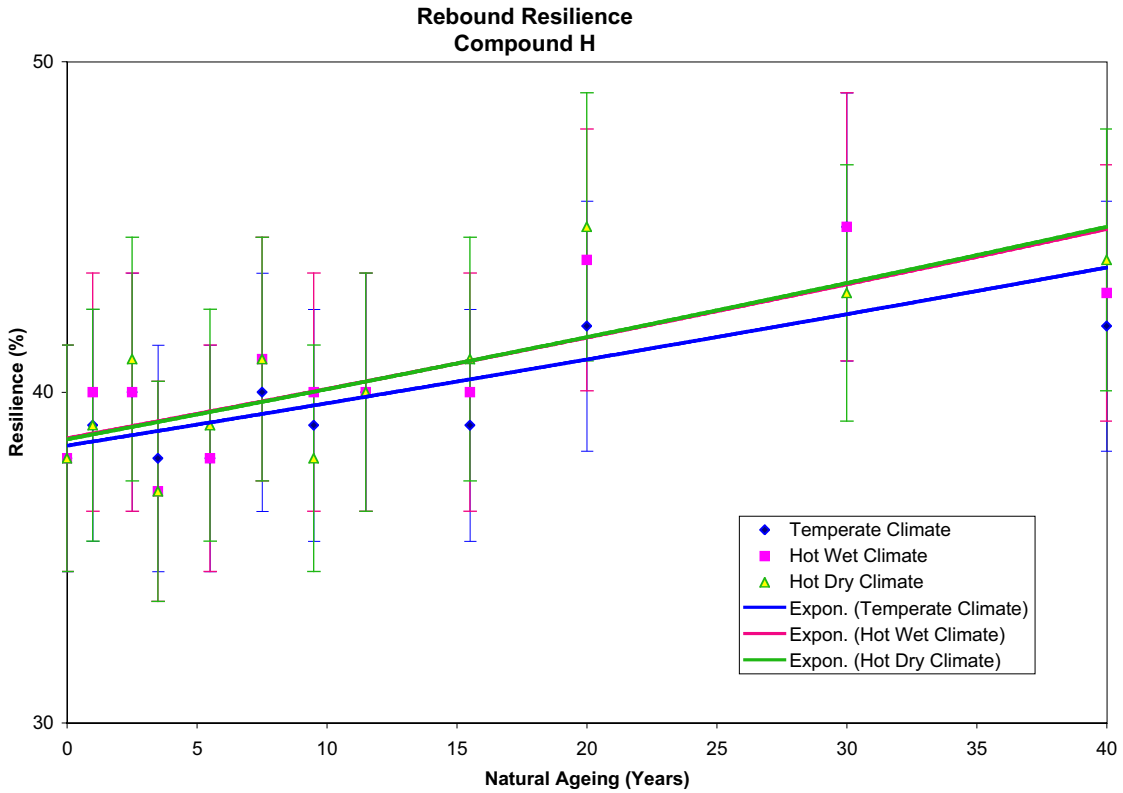


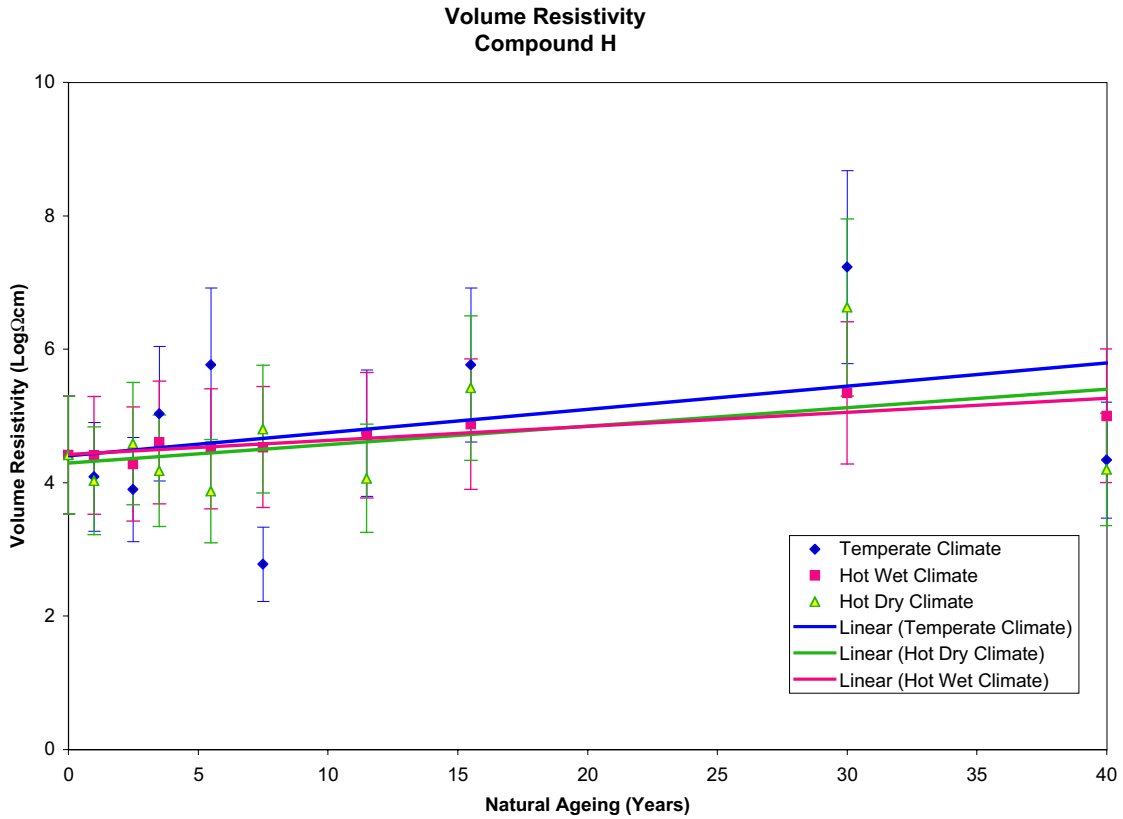
Extrapolated unaged and 40 years natural ageing data: Compound H (styrene butadiene rubber (oil extended) - good ageing)

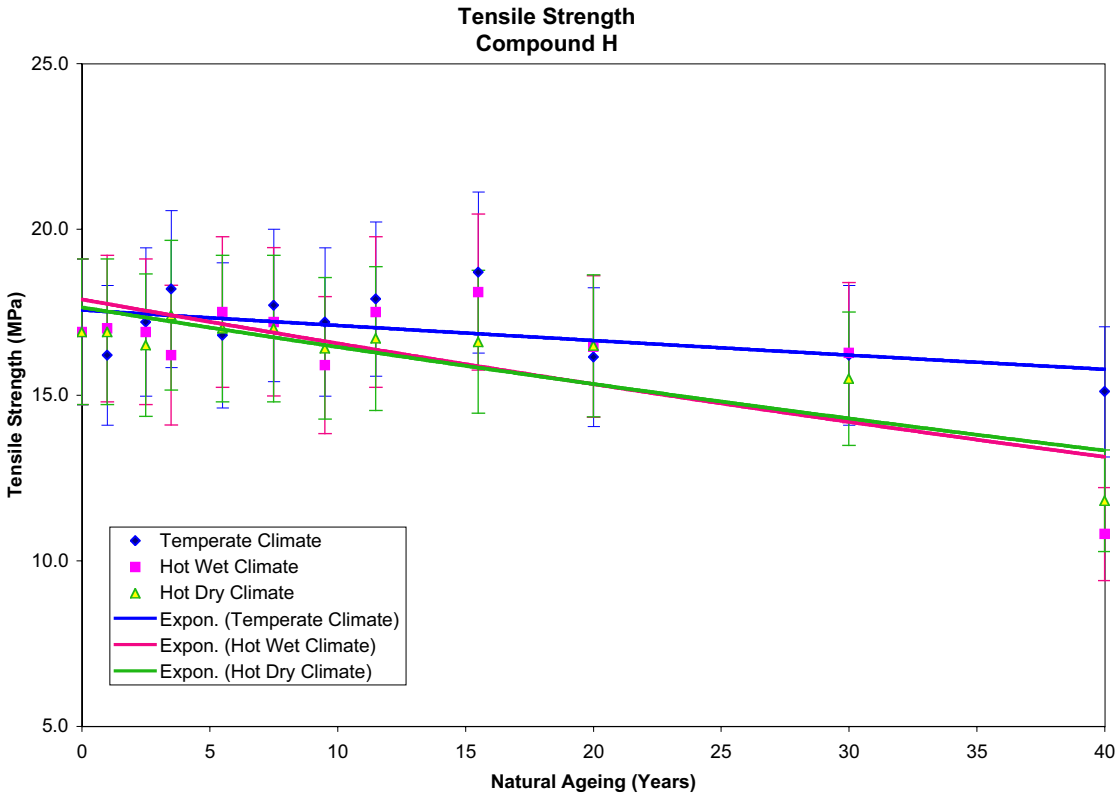
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	60.7	69.2	8.5	14	60.1	71.0	11	18	60.0	72.8	13	21
Volume Change (%)	89.4	75.9	-14	-15	91.3	68.1	-23	-25	86.3	66.3	-20	-23
Rebound Resilience (%)	38.4	43.8	5.4	14	38.7	45.0	6.3	16	38.7	45.0	6.3	16
Volume Resistivity (LogΩcm)	4.42	5.83	1.4	32	4.42	5.25	0.83	19	4.33	5.42	1.1	25
Tensile Properties												
Tensile Strength (MPa)	17.7	15.8	-1.9	-11	17.9	13.2	-4.7	-26	17.7	13.3	-4.4	-25
Elongation at Break (%)	522	397	-125	-24	527	247	-280	-53	522	270	-252	-48
Modulus at 100% (MPa)	1.55	3.00	1.5	94	1.95	3.83	1.9	96	1.55	4.73	3.2	205
Modulus at 300% (MPa)	9.33	11.8	2.5	26	9.50	15.7	6.2	65	9.83	16.1	6.3	64
Compression Set												
Short Term (%)	10.0	9.00	-1.0	-10	9.83	7.83	-2.0	-20	10.3	8.17	-2.1	-21
Long Term (%)	0.0	74.3			0.0	82.5			0.0	87.1		
Low Temperature Properties												
T2 Value (K)	255	253	-1.5	-0.6	253	256	3.0	1.2	255	256	0.70	0.3
T10 Value (K)	241	238	-2.7	-1.1	238	238	0.0	0.0	242	239	-2.4	-1.0

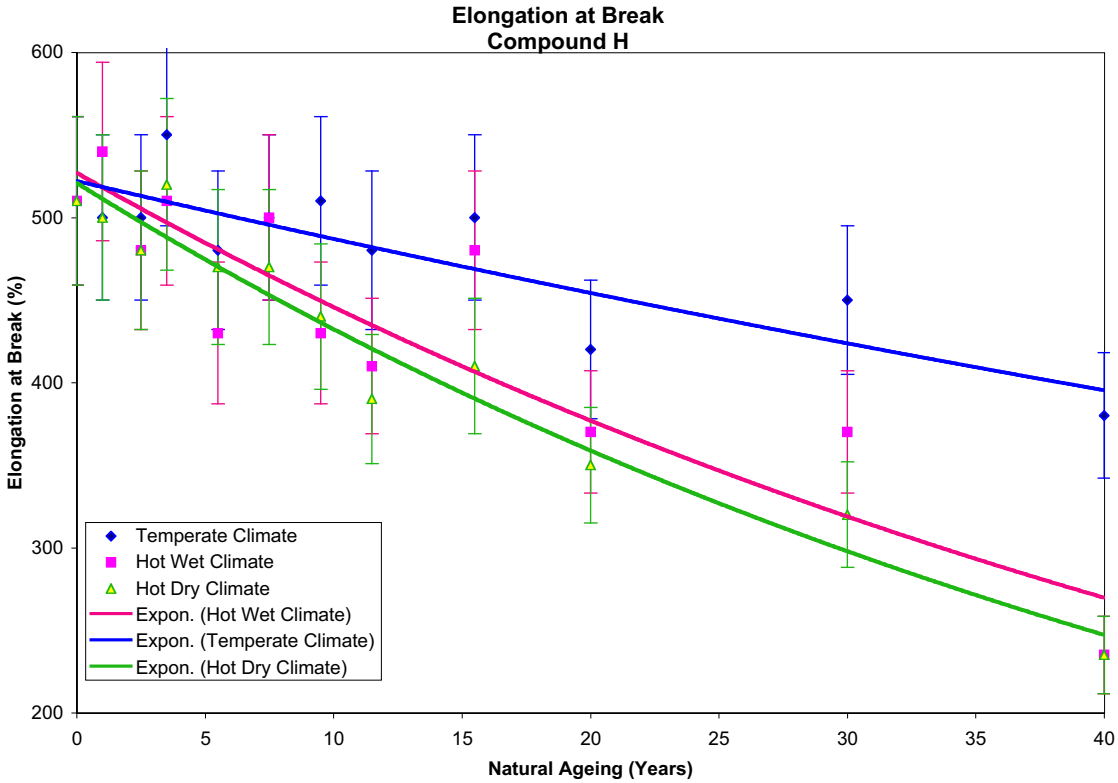

Hardness
Compound H
Hardness (IRHD)
80
70
60
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

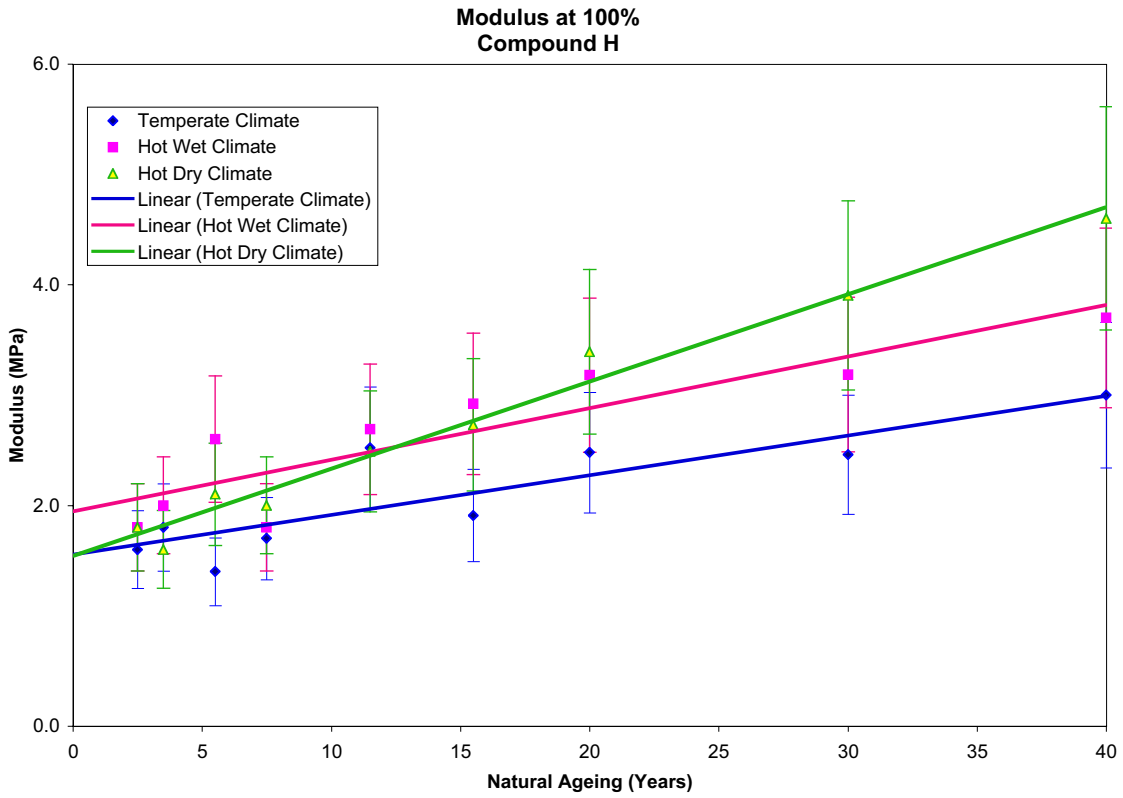

Volume Change
Compound H
Volume Change (%)
150
100
50
0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

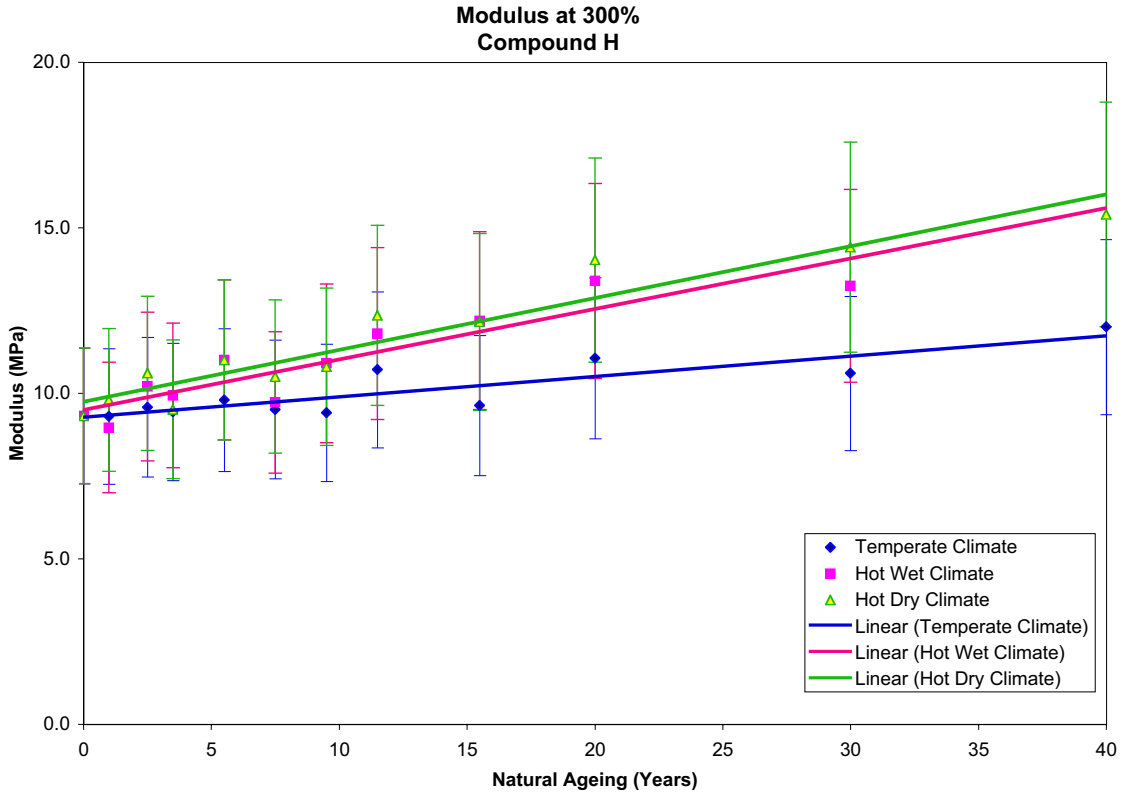


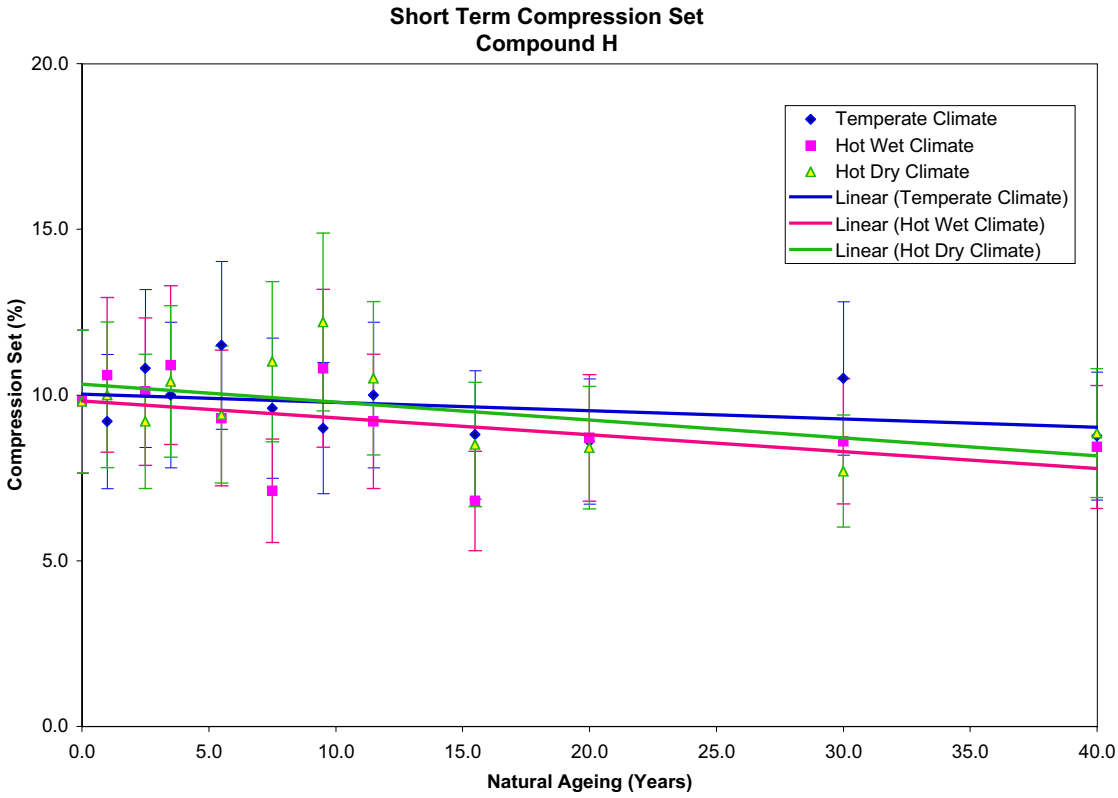


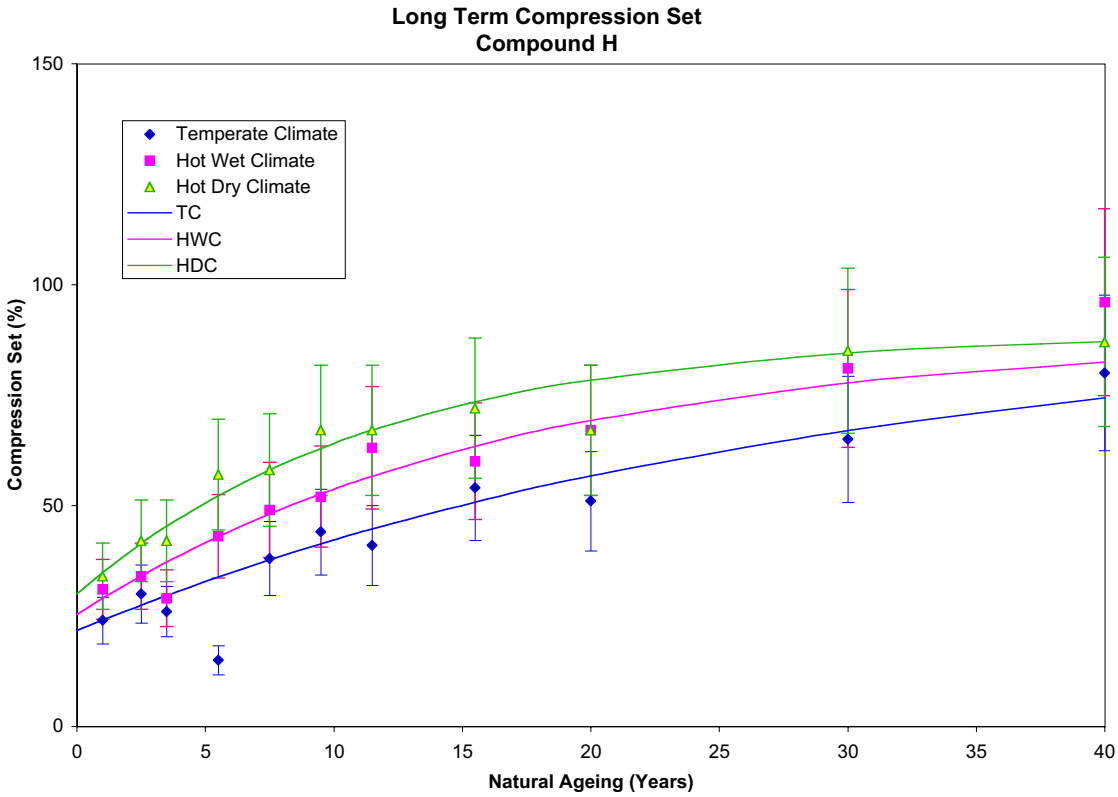

Tensile Strength
Compound H
Tensile Strength (MPa)
25.0
20.0
15.0
10.0
5.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

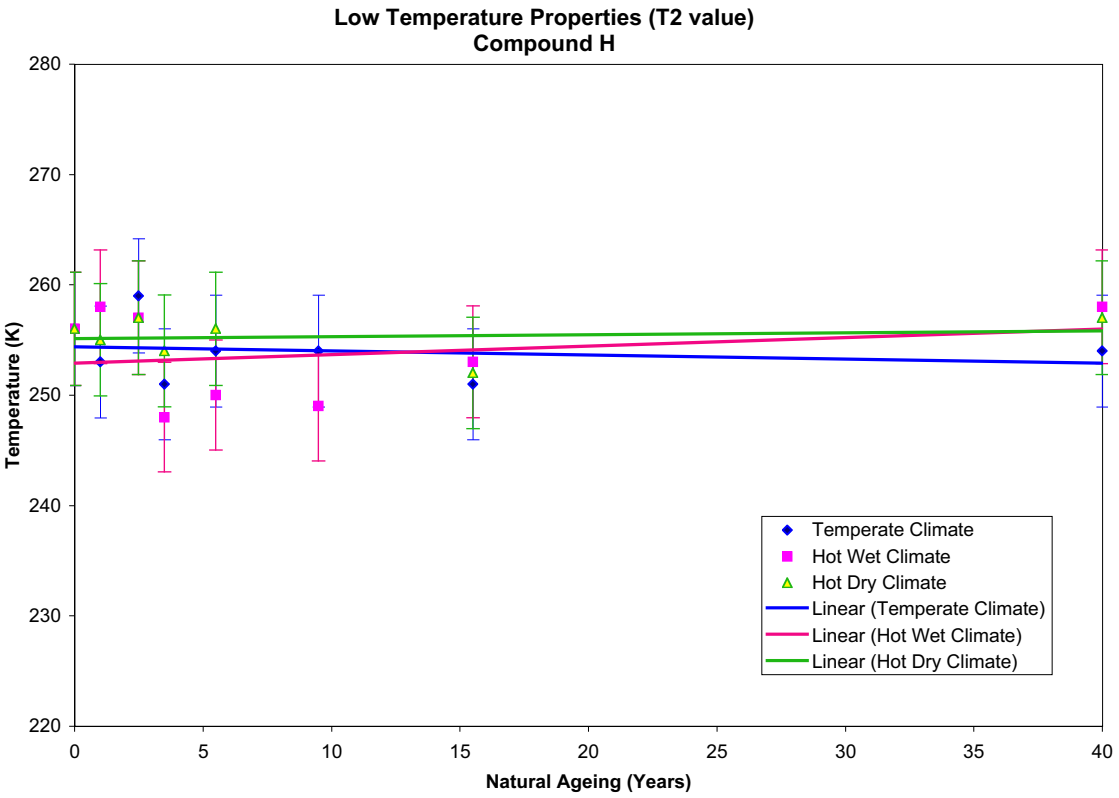

Elongation at Break
Compound H
Elongation at Break (%)
600
500
400
300
200
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

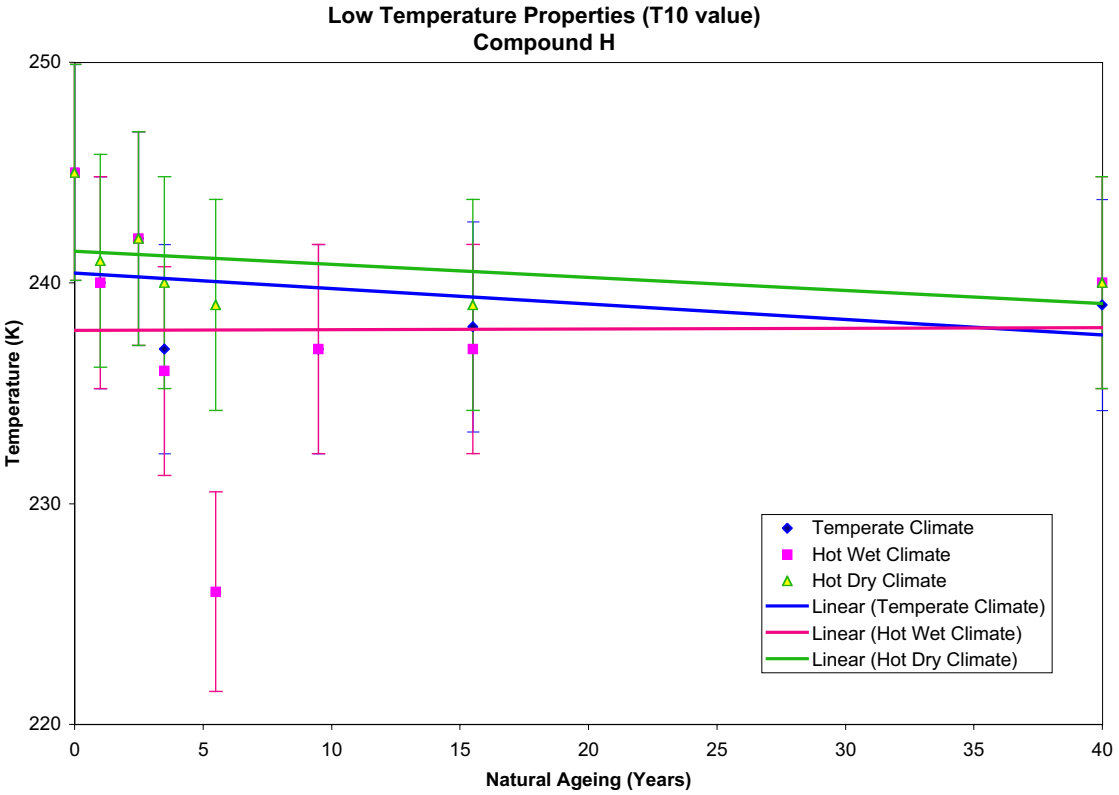





Short Term Compression Set
Compound H
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)
Compression Set (%)
Natural Ageing (Years)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

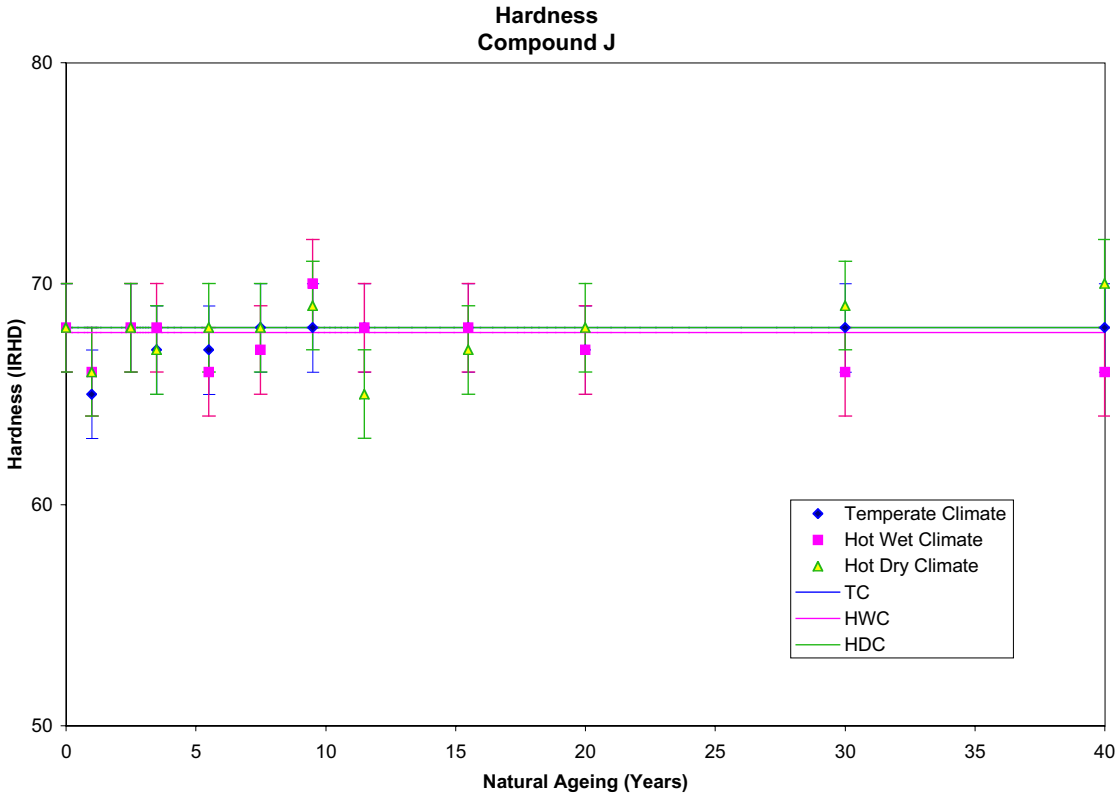

Long Term Compression Set
Compound H
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
Compression Set (%)
Natural Ageing (Years)
0
50
100
150
0
5
10
15
20
25
30
35
40

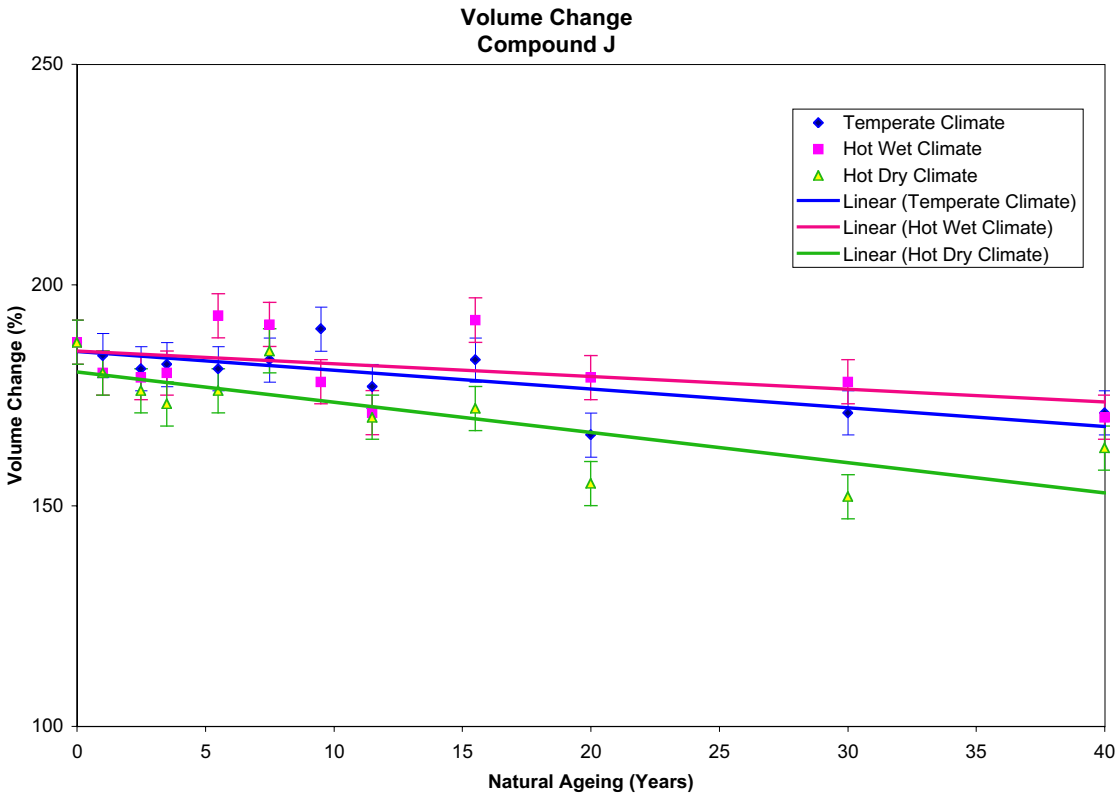


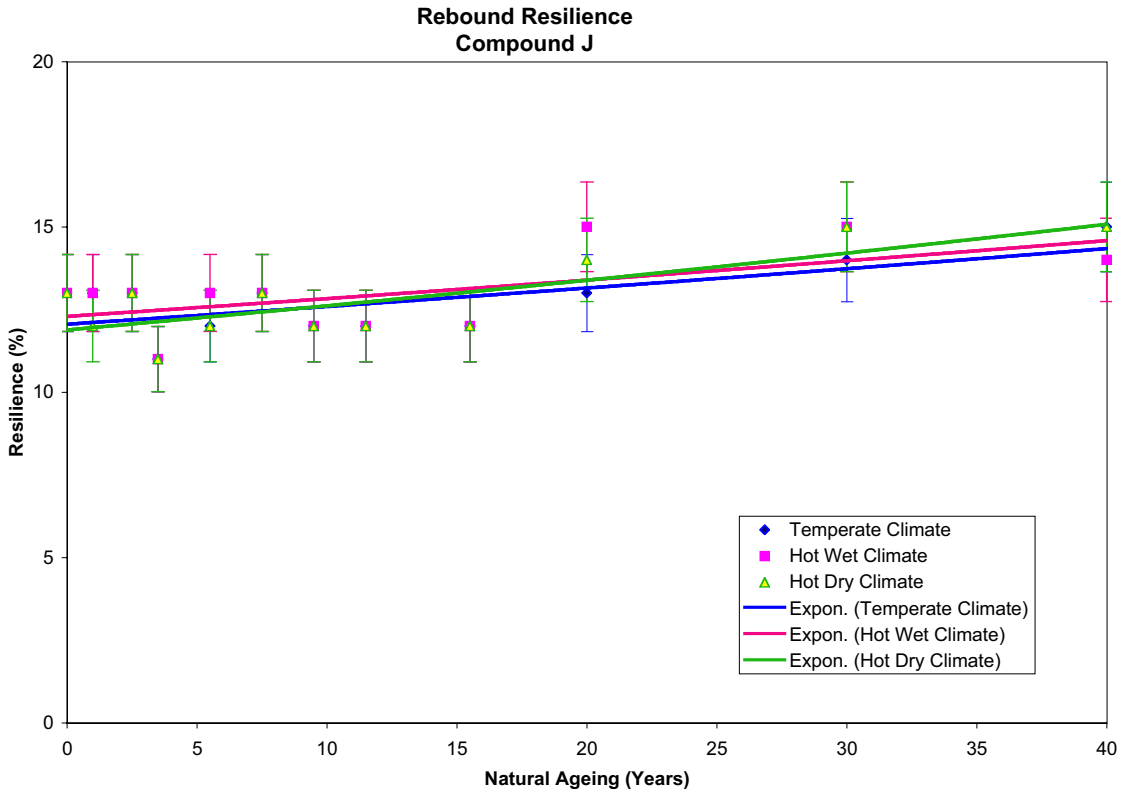


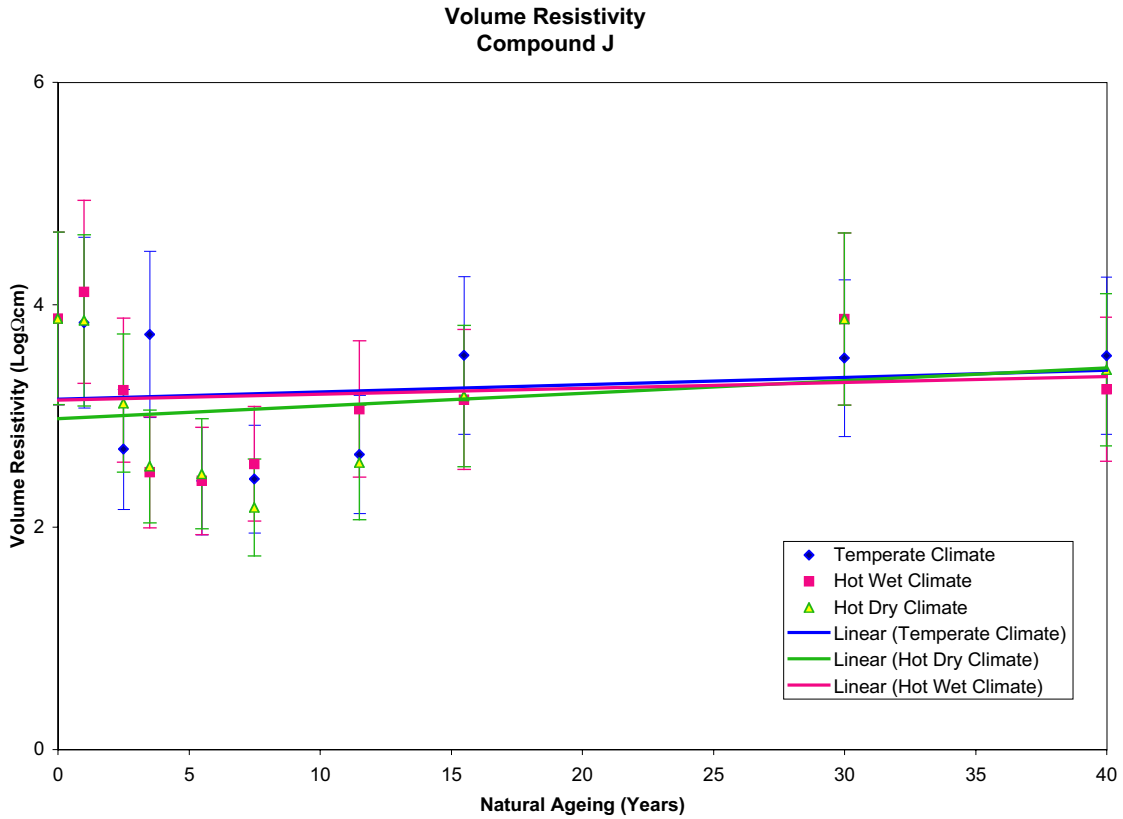
Extrapolated unaged and 40 years natural ageing data: Compound J (butyl rubber - general purpose)

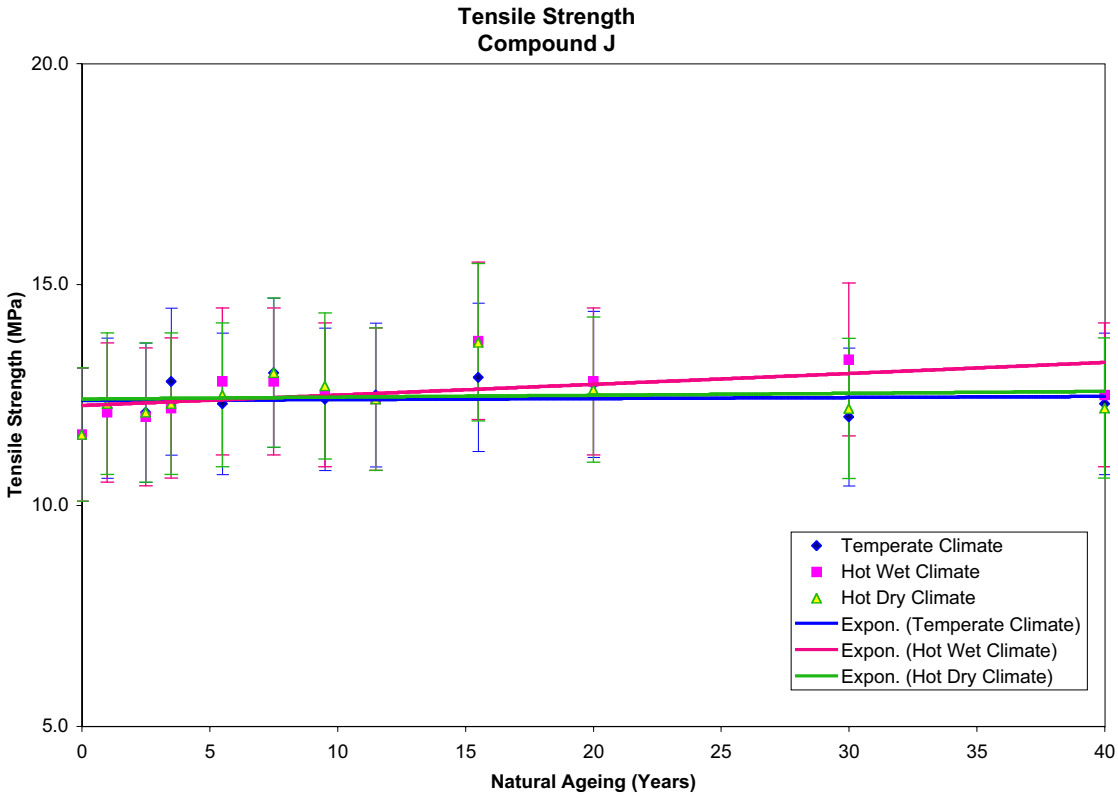
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	68.0	68.0	0.0	0.0	67.8	67.8	0.0	0.0	68.0	68.0	0.0	0.0
Volume Change (%)	179	169	-10	-5.6	179	174	-5.0	-2.8	181	153	-28	-15
Rebound Resilience (%)	12.1	14.3	2.2	18	12.3	14.6	2.3	19	11.9	15.1	3.2	27
Volume Resistivity (LogΩcm)	3.15	3.43	0.28	8.9	3.15	3.35	0.20	6.3	3.00	3.45	0.45	15
Tensile Properties												
Tensile Strength (MPa)	12.5	12.5	0.0	0.0	12.4	13.3	0.90	7.3	12.5	12.6	0.10	0.80
Elongation at Break (%)	478	433	-45	-9.4	483	440	-43	-8.8	478	385	-93	-19
Modulus at 100% (MPa)	2.50	2.85	0.35	14	2.50	2.85	0.35	14	2.50	3.25	0.75	30
Modulus at 300% (MPa)	8.60	9.31	0.71	8.3	8.50	9.63	1.1	13	8.69	10.9	2.2	25
Compression Set												
Short Term (%)	7.75	5.33	-2.4	-31	8.33	5.58	-2.8	-33	7.00	4.7	-2.3	-33
Long Term (%)	0.0	75.0			0.0	76.0			0.0	90.0		
Low Temperature Properties												
T2 Value (K)	255	244	-11	-4.4	251	249	-2.5	-1.0	251	243	-7.7	-3.1
T10 Value (K)	233	226	-6.9	-3.0	231	226	-4.7	-2.0	230	226	-4.2	-1.8

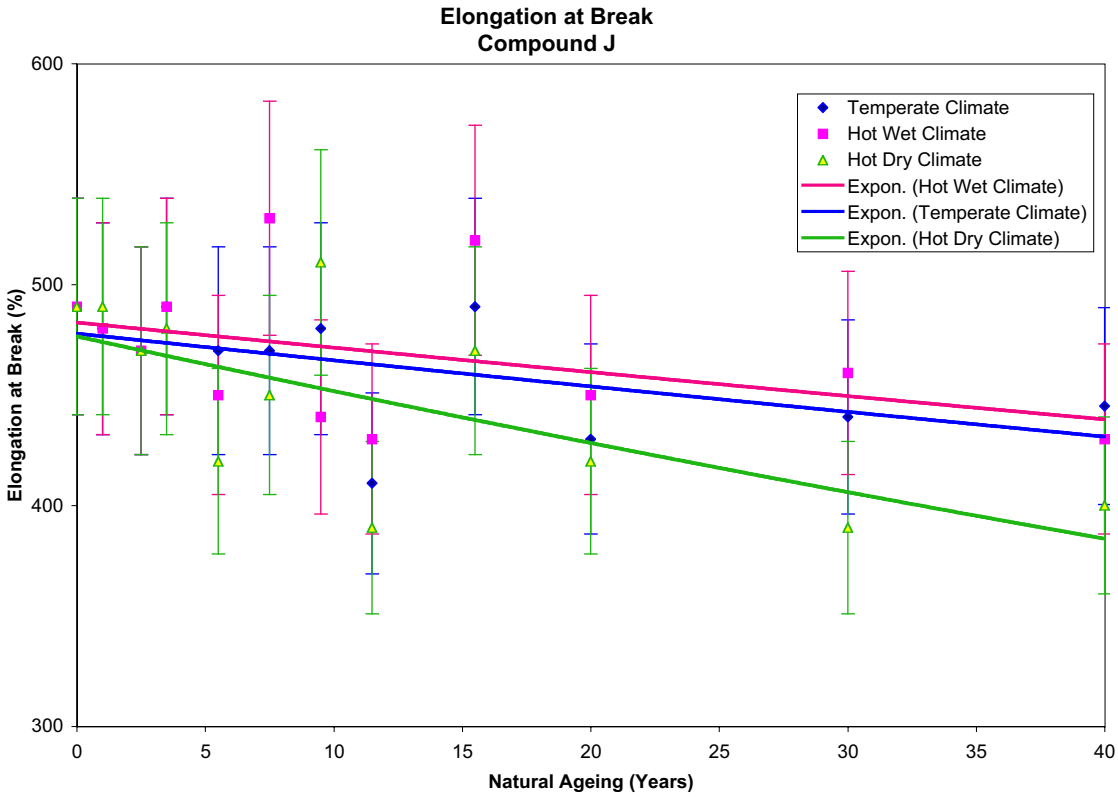

Hardness
Compound J
Hardness (IRHD)
80
70
60
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

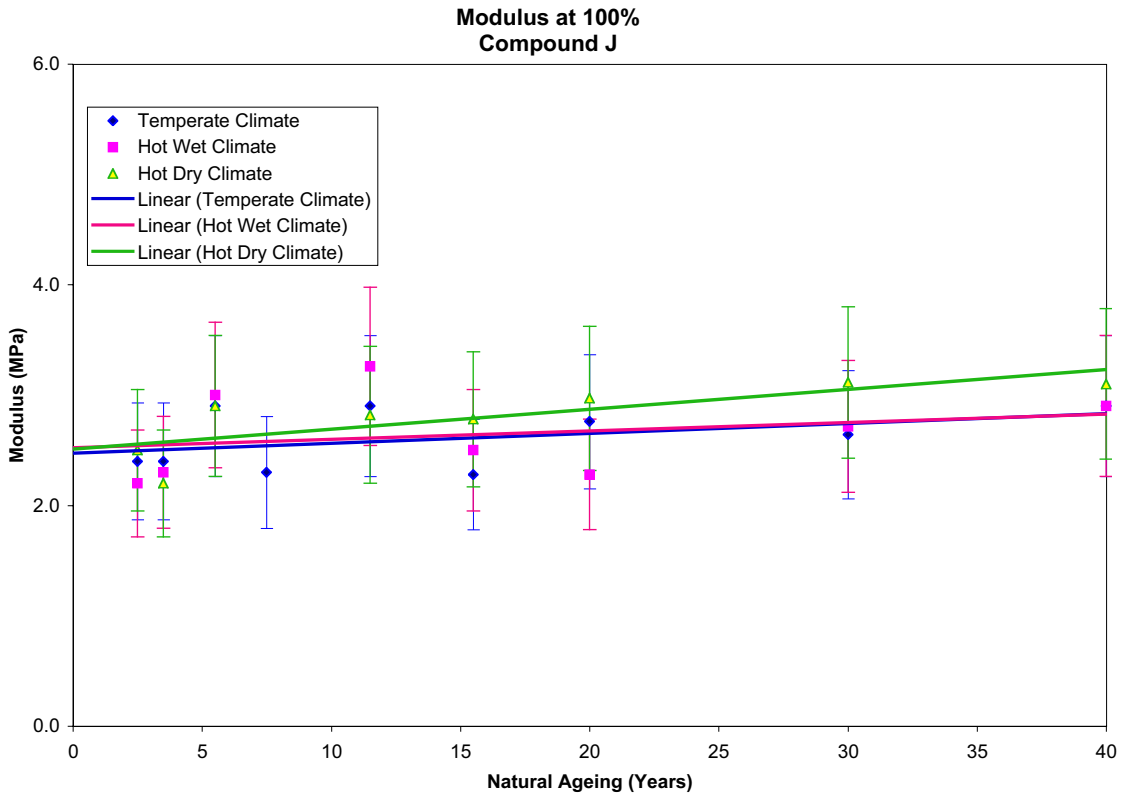

Volume Change
Compound J
Volume Change (%)
250
200
150
100
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

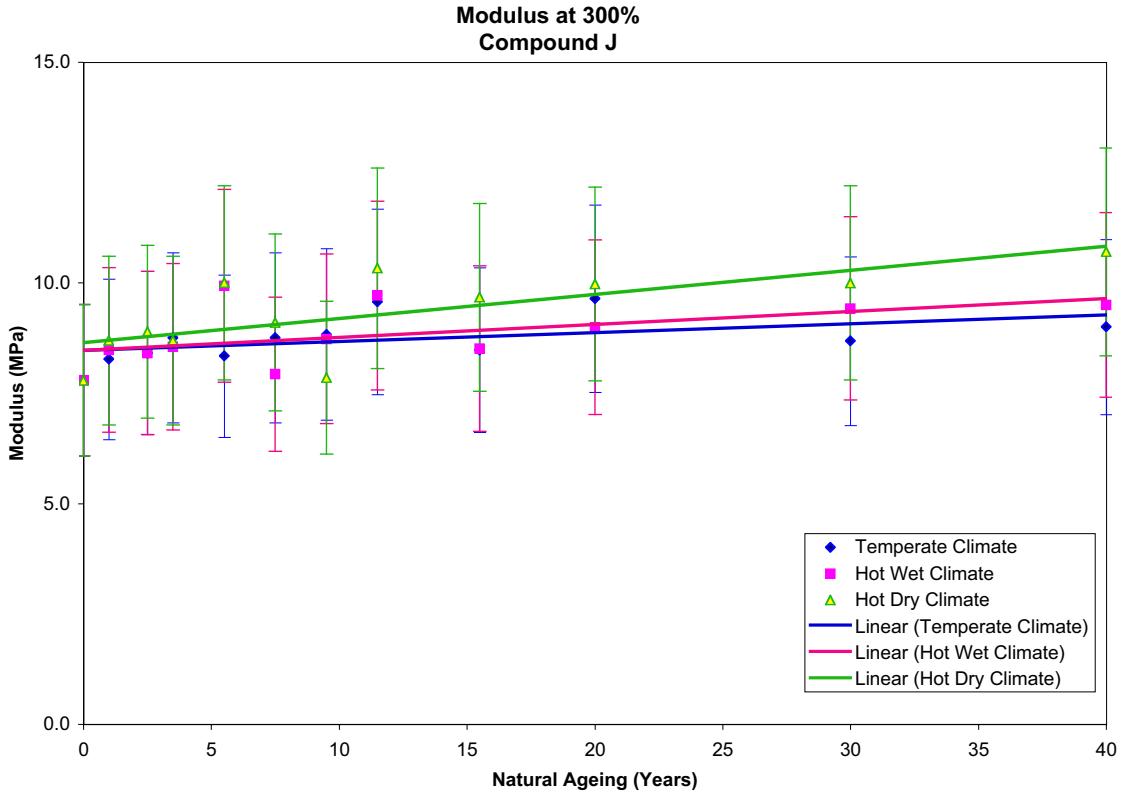


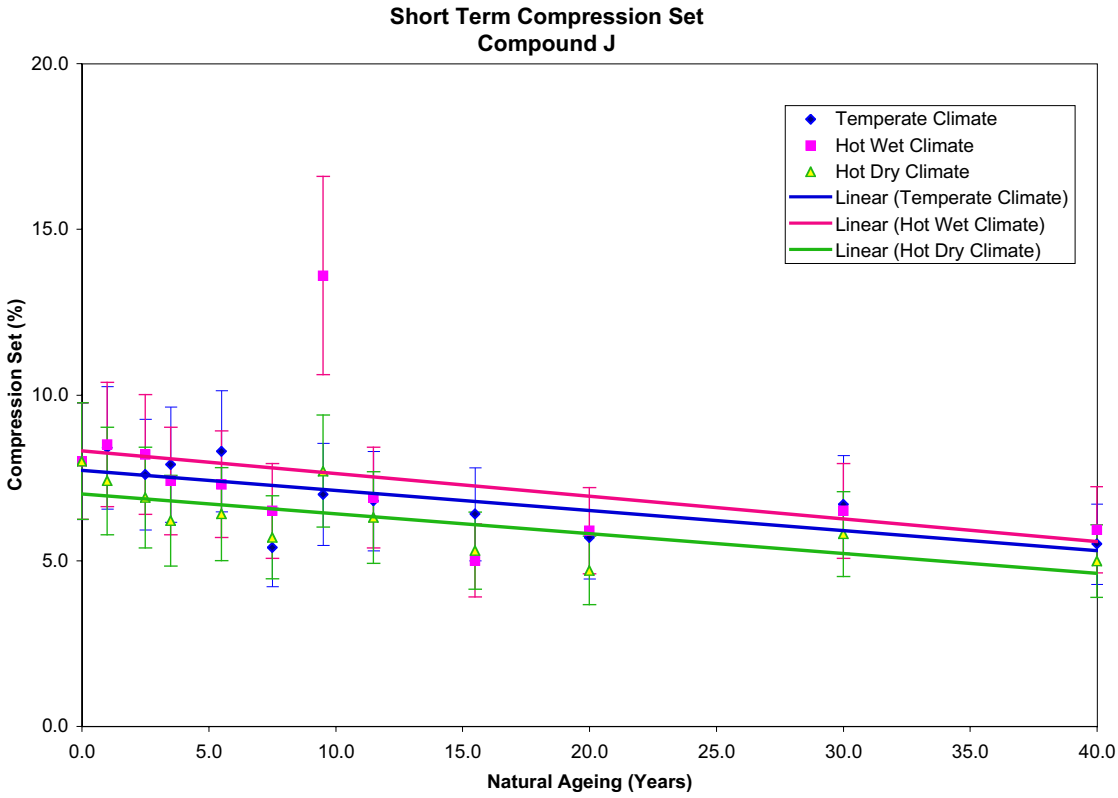


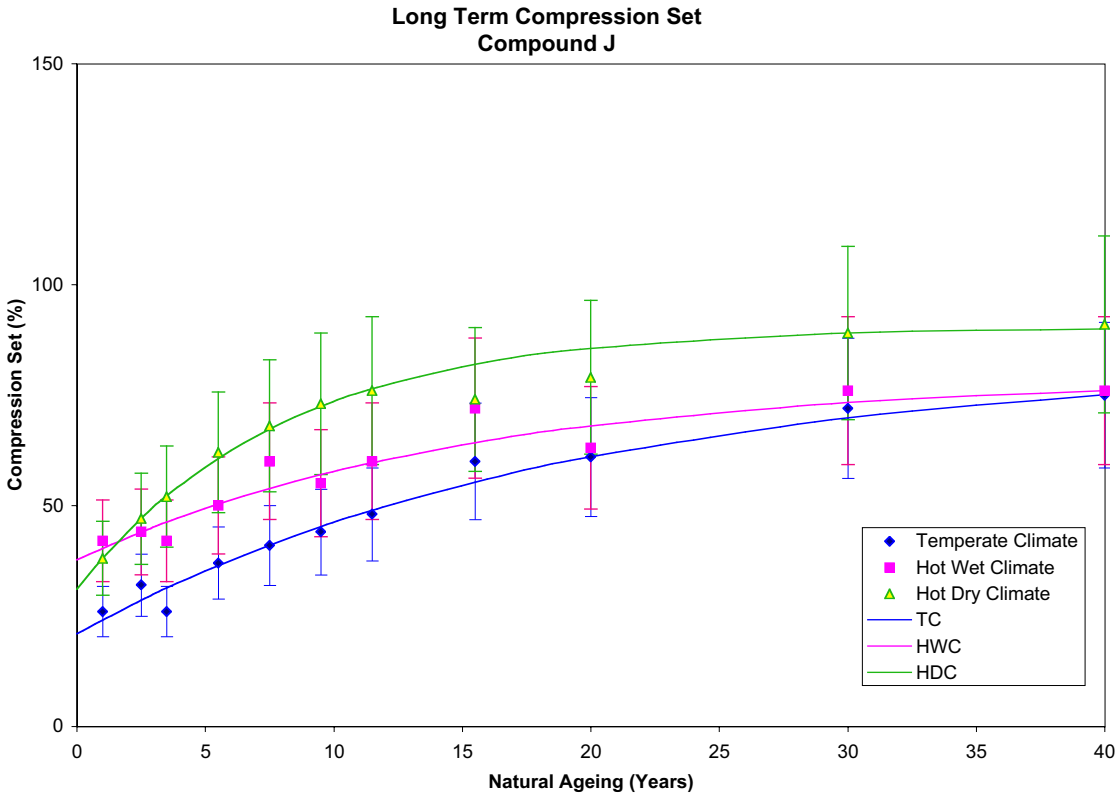

Tensile Strength
Compound J
Tensile Strength (MPa)
20.0
15.0
10.0
5.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

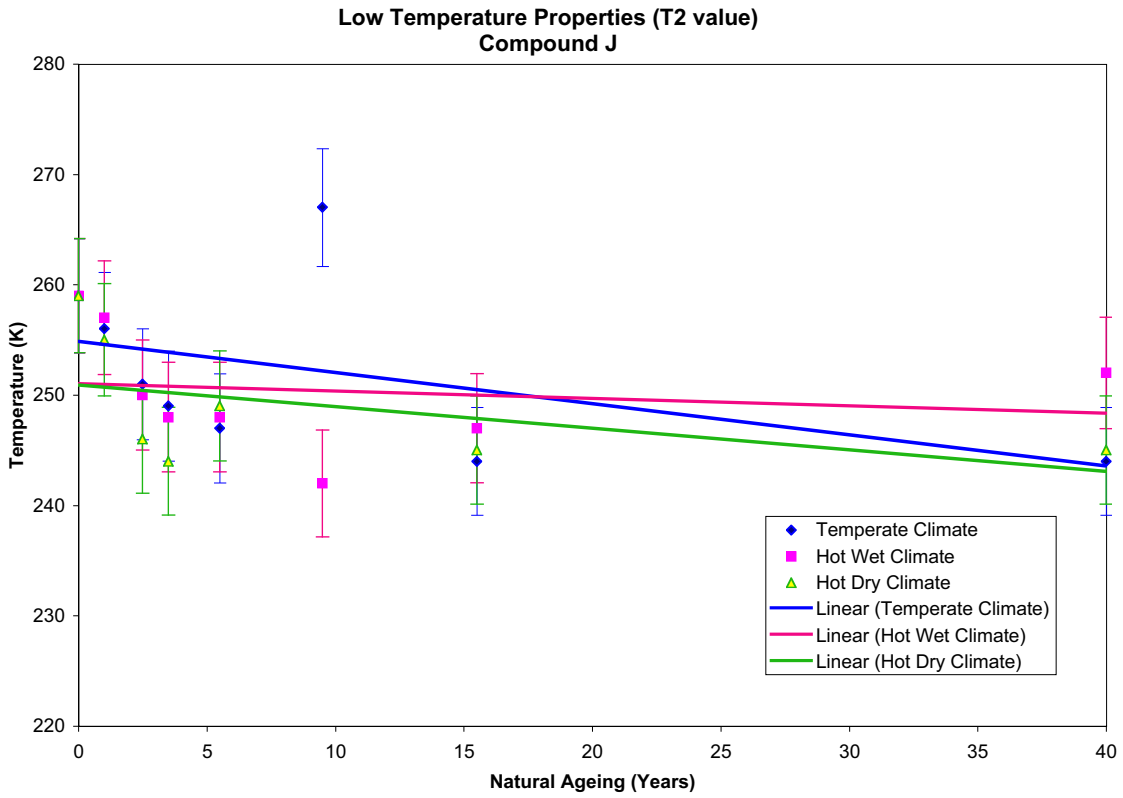

Elongation at Break
Compound J
Elongation at Break (%)
600
500
400
300
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

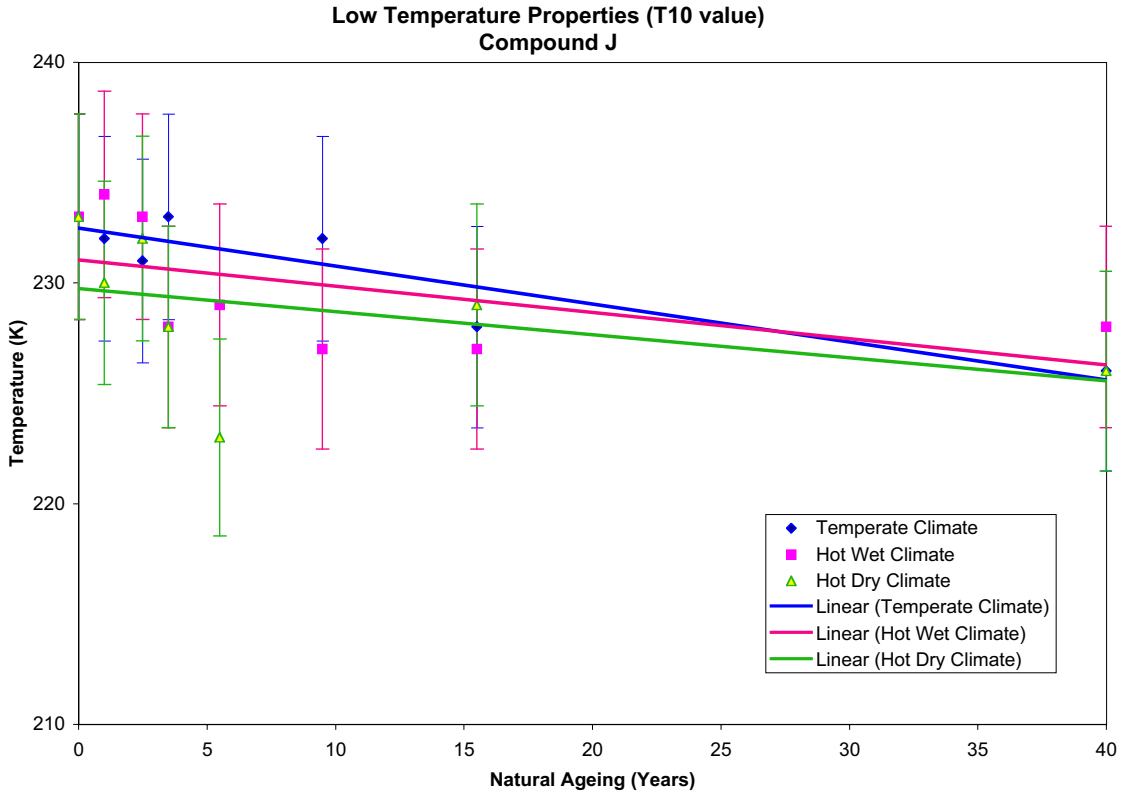





Short Term Compression Set
Compound J
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

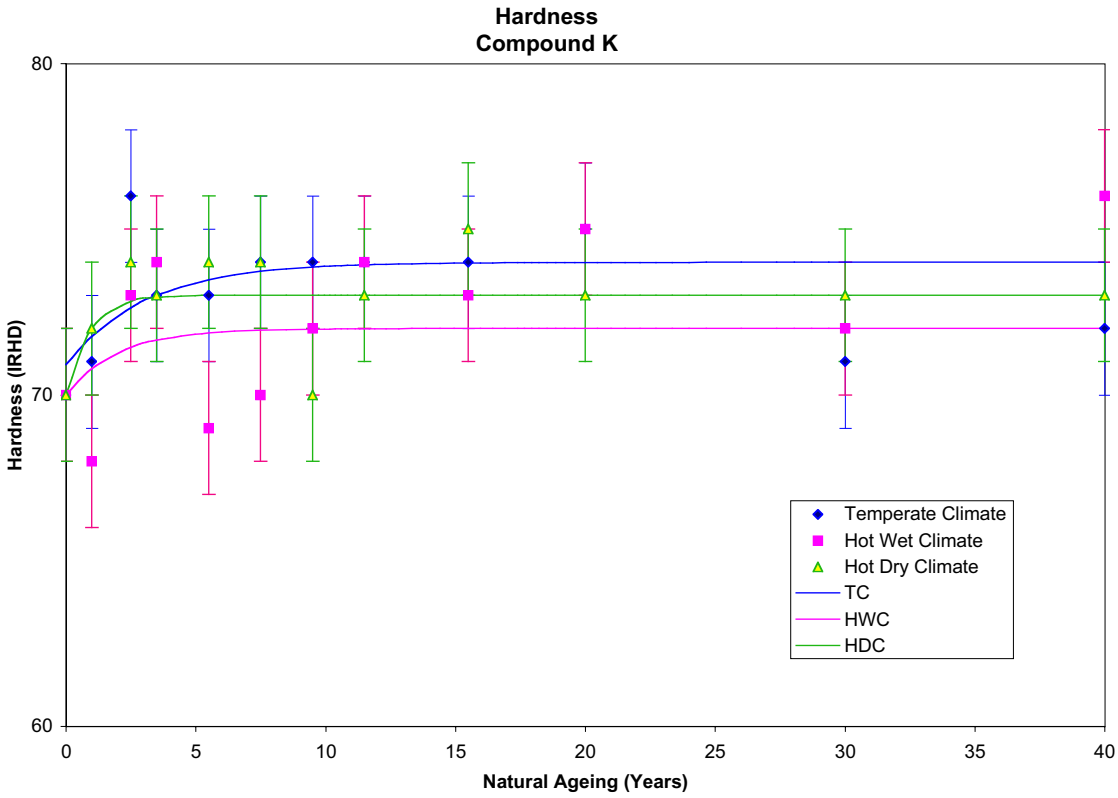

Long Term Compression Set
Compound J
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
0
50
100
150
0
5
10
15
20
25
30
35
40

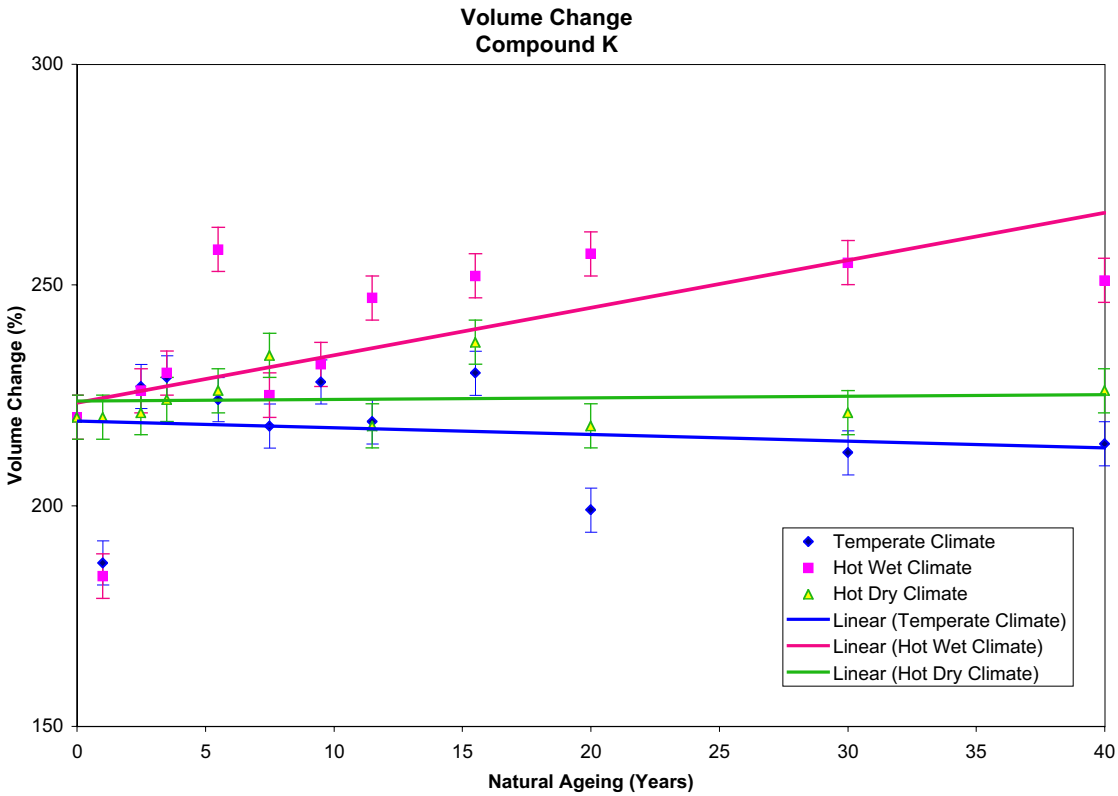


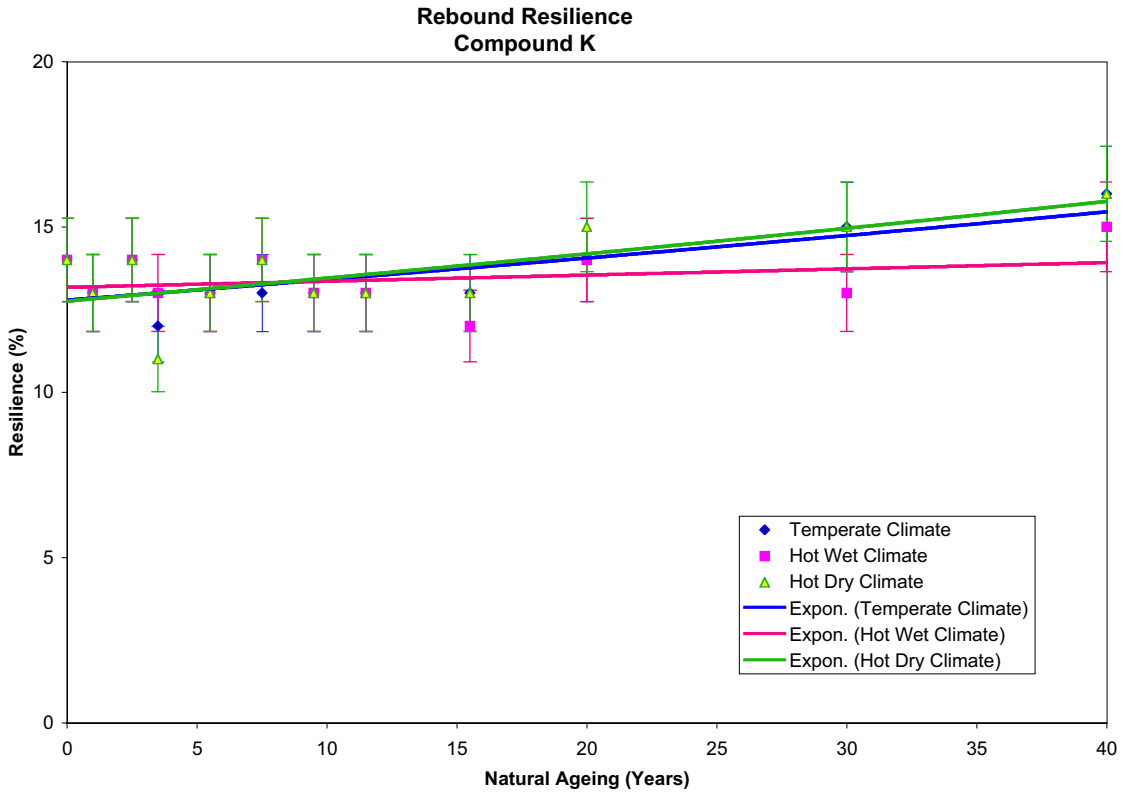


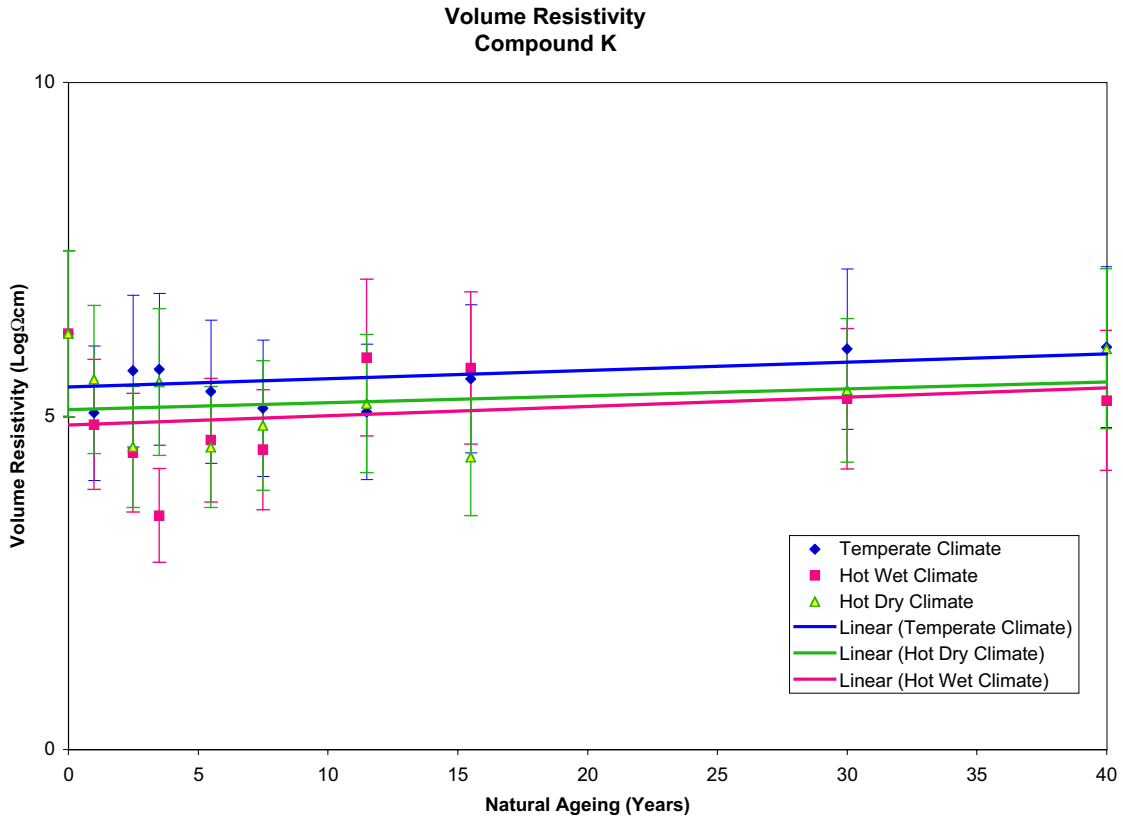
Extrapolated unaged and 40 years natural ageing data: Compound K (butyl rubber - good ageing)

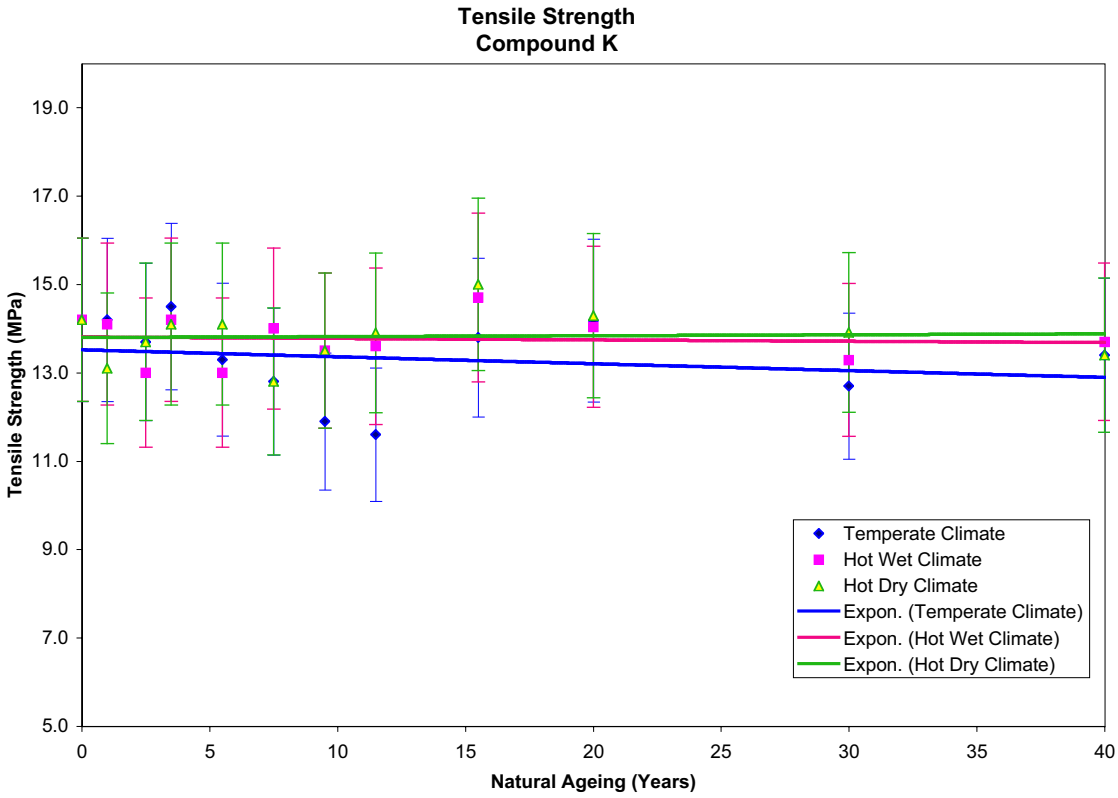
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	70.9	74.0	3.1	4.4	69.9	74.7	4.8	6.9	70.0	73.0	3.0	4.3
Volume Change (%)	219	213	-6.3	-2.9	224	266	43	19	224	225	1.5	0.67
Rebound Resilience (%)	12.8	15.5	2.7	21	13.2	14.0	0.80	6.1	12.8	15.8	3.0	23
Volume Resistivity (LogΩcm)	5.46	5.96	0.50	9.2	4.90	5.42	0.52	11	5.13	5.50	0.37	7.2
Tensile Properties												
Tensile Strength (MPa)	13.6	12.9	-0.70	-5.1	13.8	13.8	0.0	0.0	13.8	13.9	0.10	0.72
Elongation at Break (%)	428	367	-62	-14	453	383	-70	-15	420	430	10	2.4
Modulus at 100% (MPa)	2.03	2.95	0.92	45	2.48	3.15	0.67	27	2.95	2.35	-0.60	-20
Modulus at 300% (MPa)	10.6	11.3	0.70	6.6	10.7	11.6	0.90	8.4	10.8	10.8	0.0	0.0
Compression Set												
Short Term (%)	15.2	11.1	-4.1	-27	16.0	12.2	-3.8	-24	14.1	9.4	-4.7	-33
Long Term (%)	0.0	79.5			0.0	89.6			0.0	91.0		
Low Temperature Properties												
T2 Value (K)	254	247	-7.5	-3.0	249	247	-2.5	-1.0	251	246	-5.5	-2.2
T10 Value (K)	231	226	-5.0	-2.2	227	224	-3.4	-1.5	229	225	-3.1	-1.4

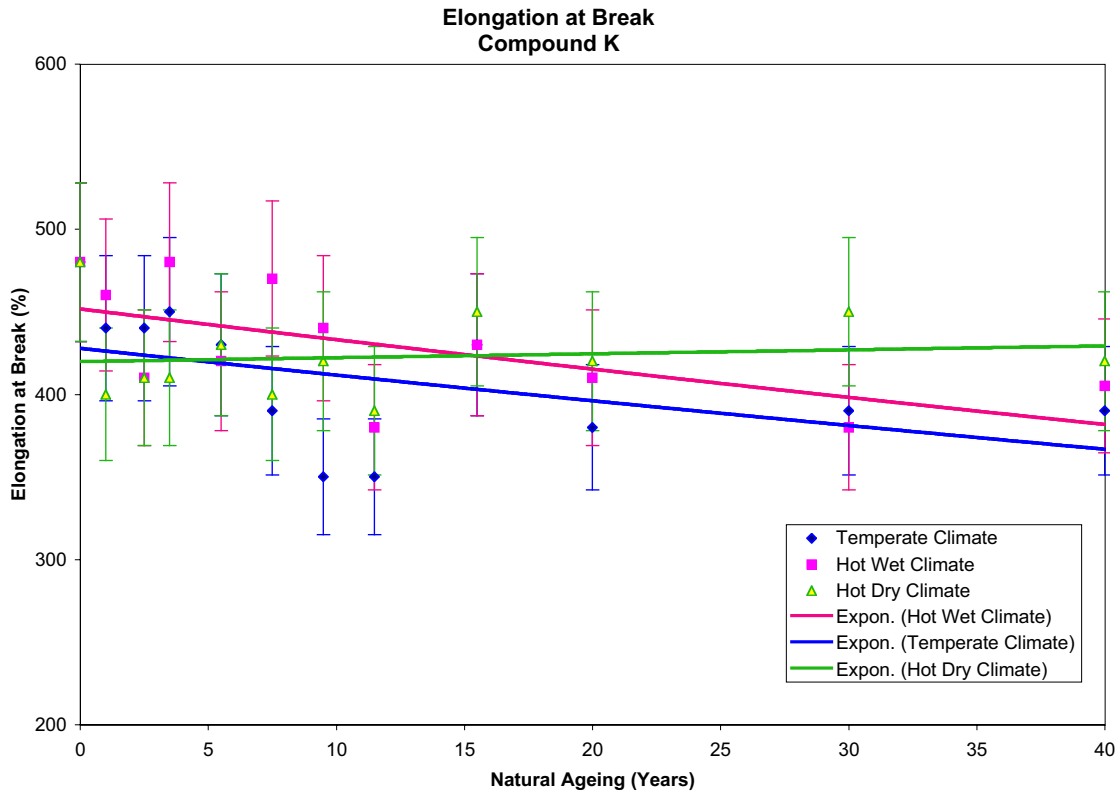

Hardness
Compound K
Hardness (IRHD)
80
70
60
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

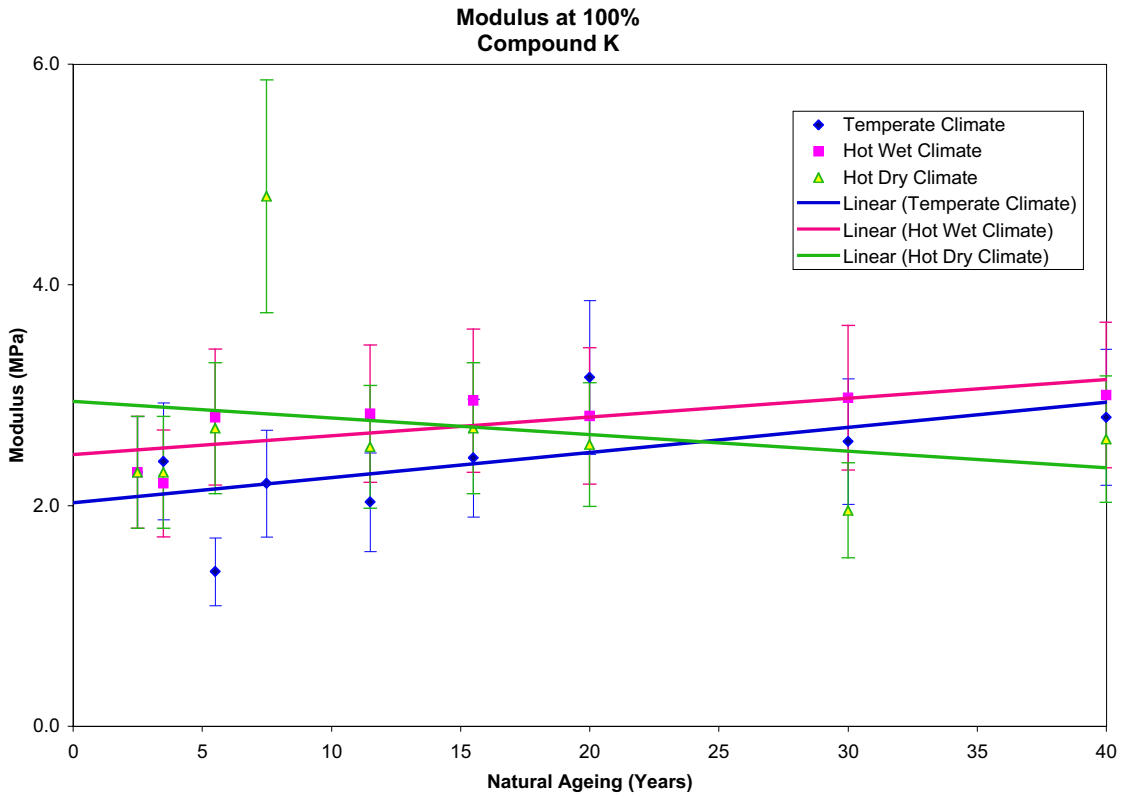

Volume Change
Compound K
Volume Change (%)
300
250
200
150
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

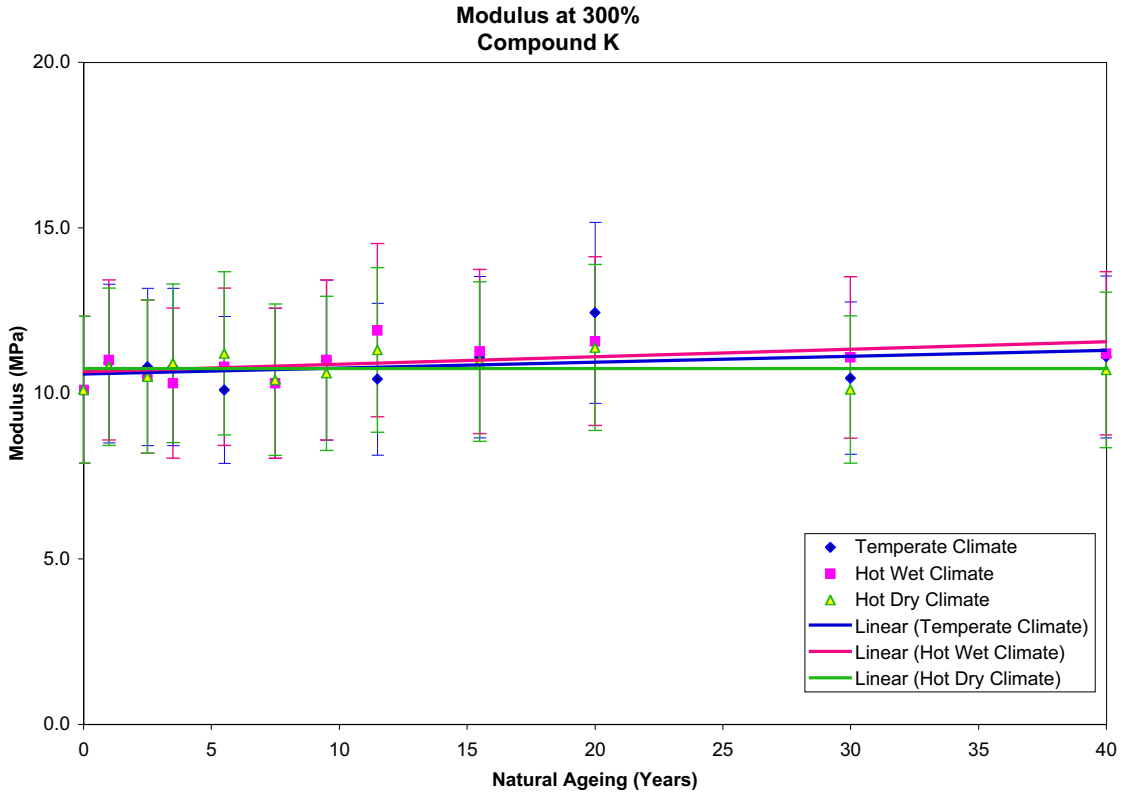


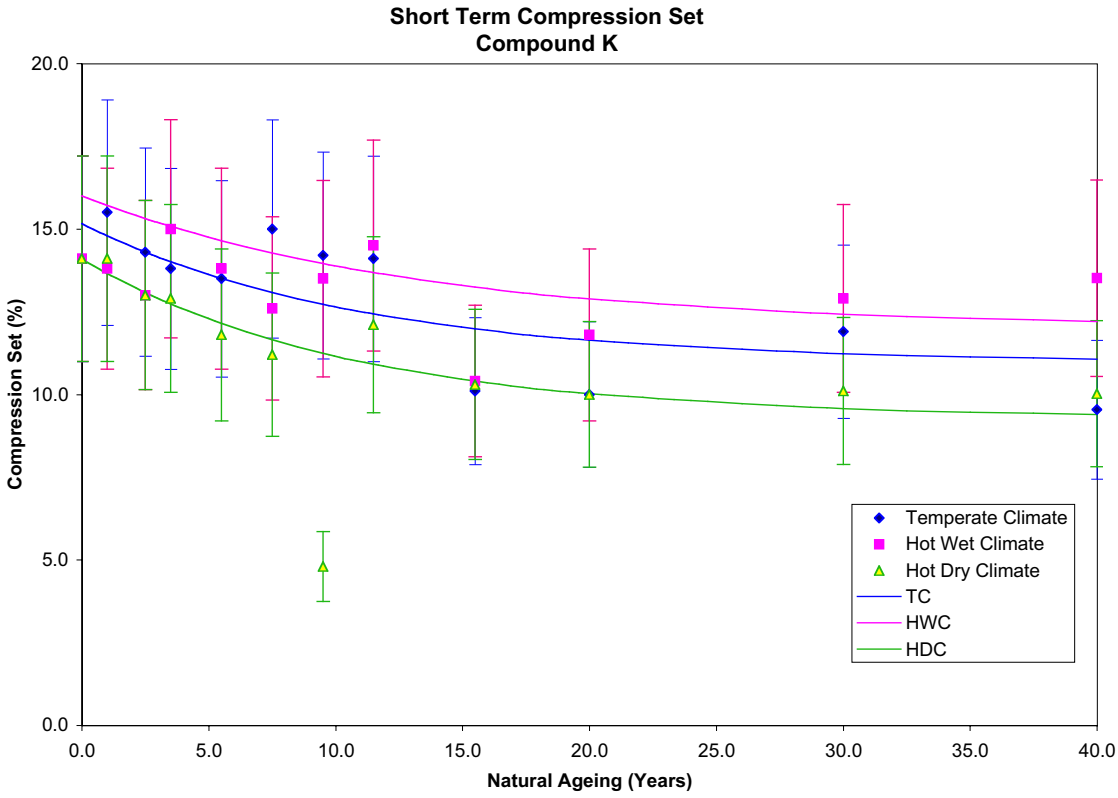


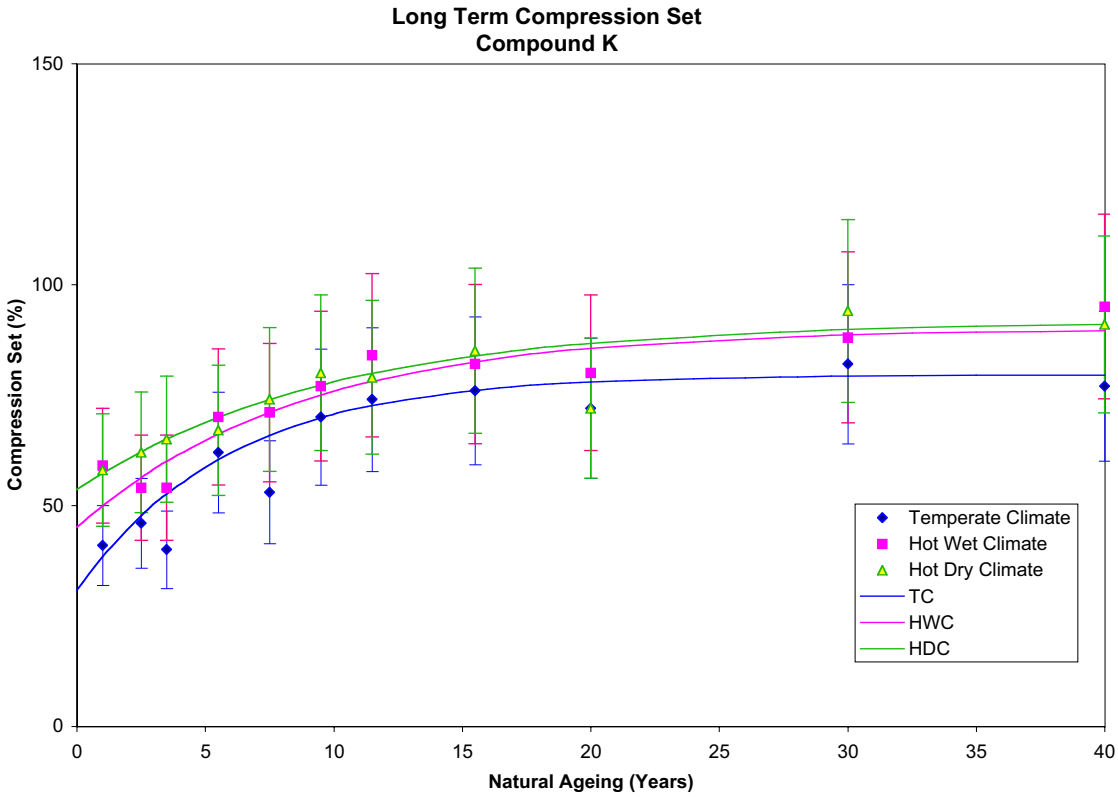

Tensile Strength
Compound K
Tensile Strength (MPa)
19.0
17.0
15.0
13.0
11.0
9.0
7.0
5.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

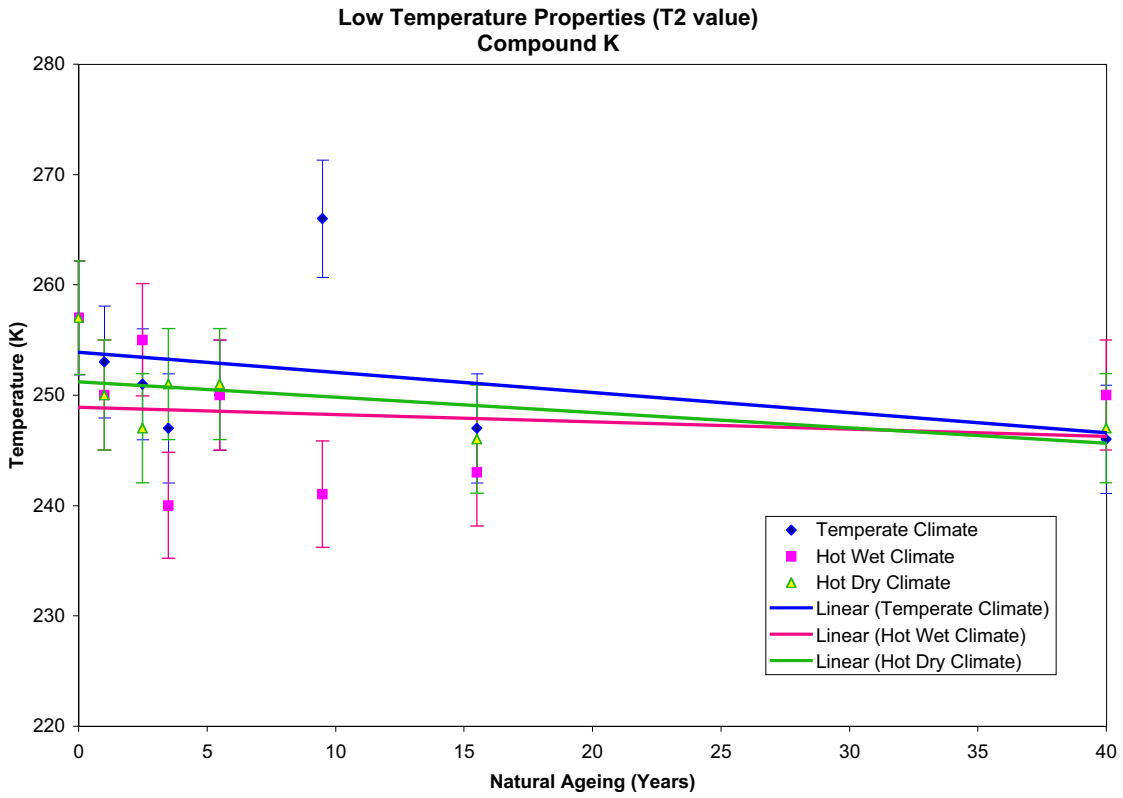

Elongation at Break
Compound K
Elongation at Break (%)
600
500
400
300
200
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

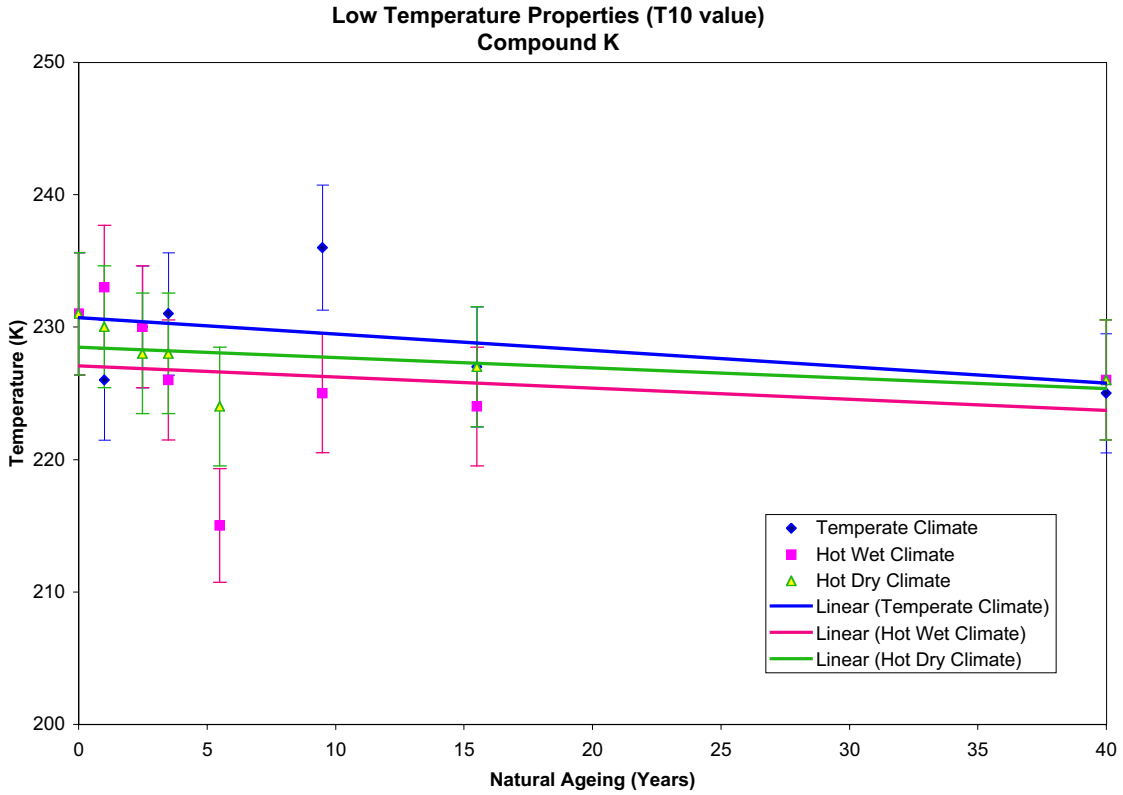





Short Term Compression Set
Compound K
Compression Set (%)
Natural Ageing (Years)
20.0
15.0
10.0
5.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

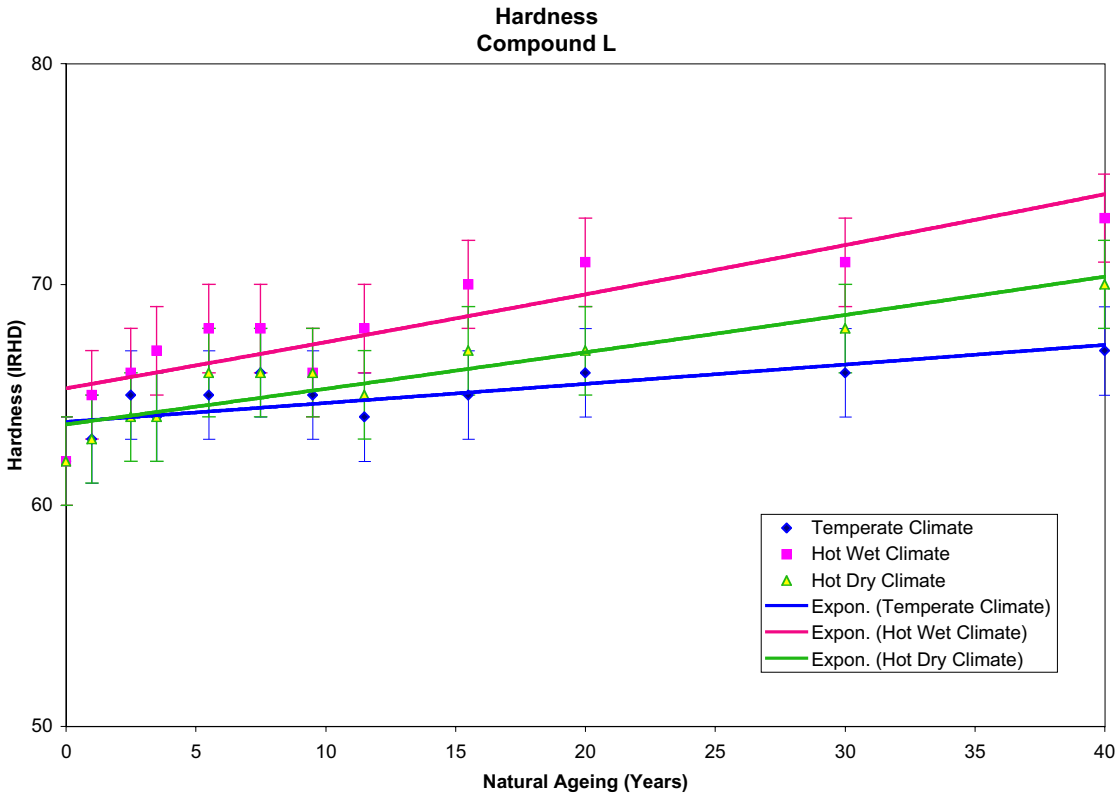

Long Term Compression Set
Compound K
Compression Set (%)
Natural Ageing (Years)
150
100
50
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

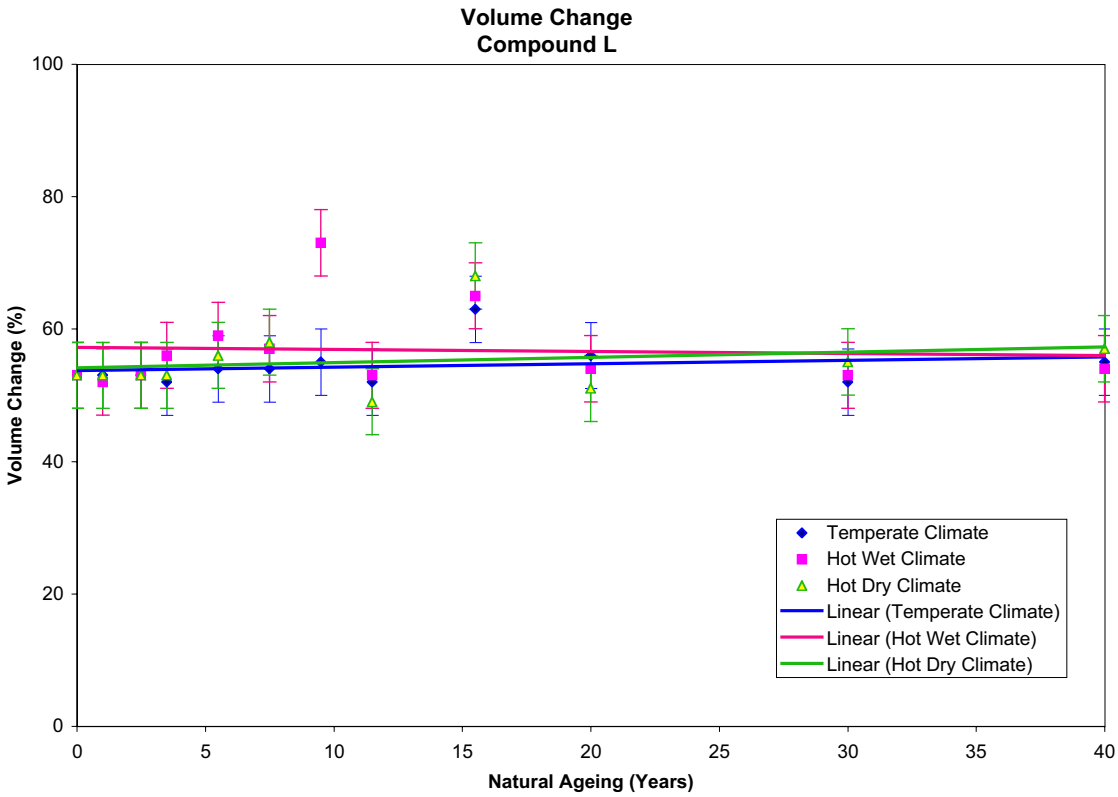


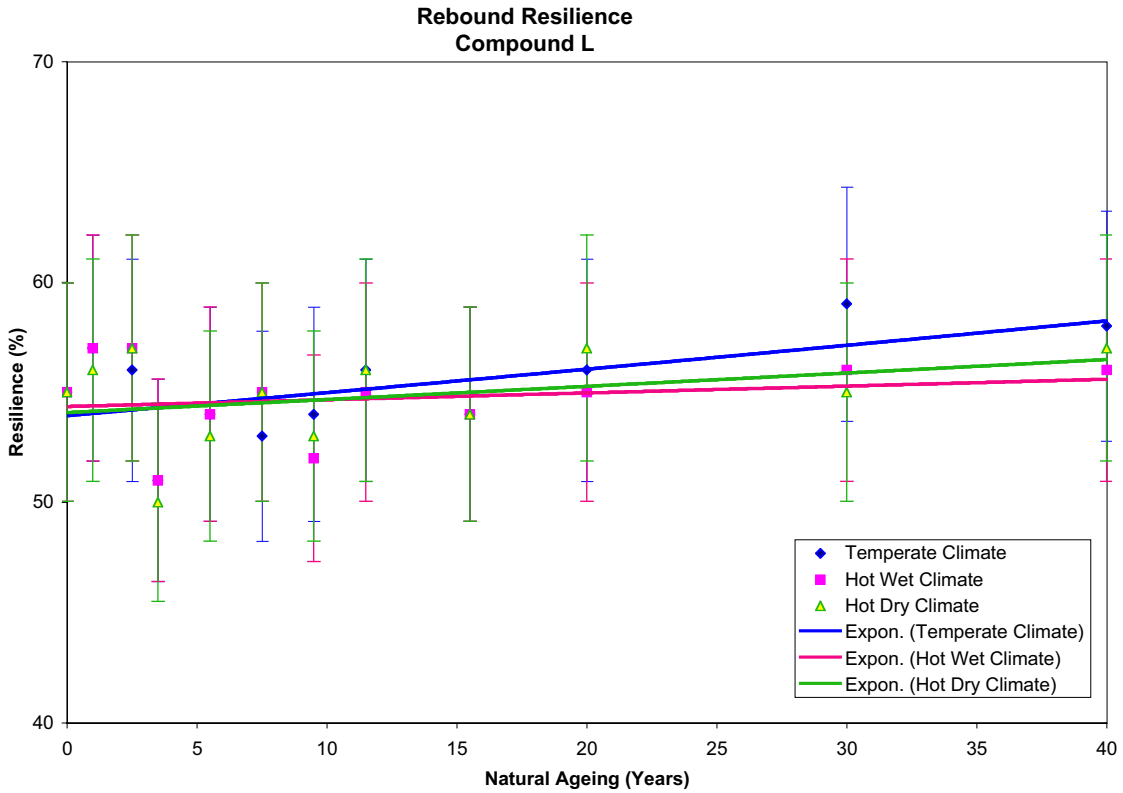


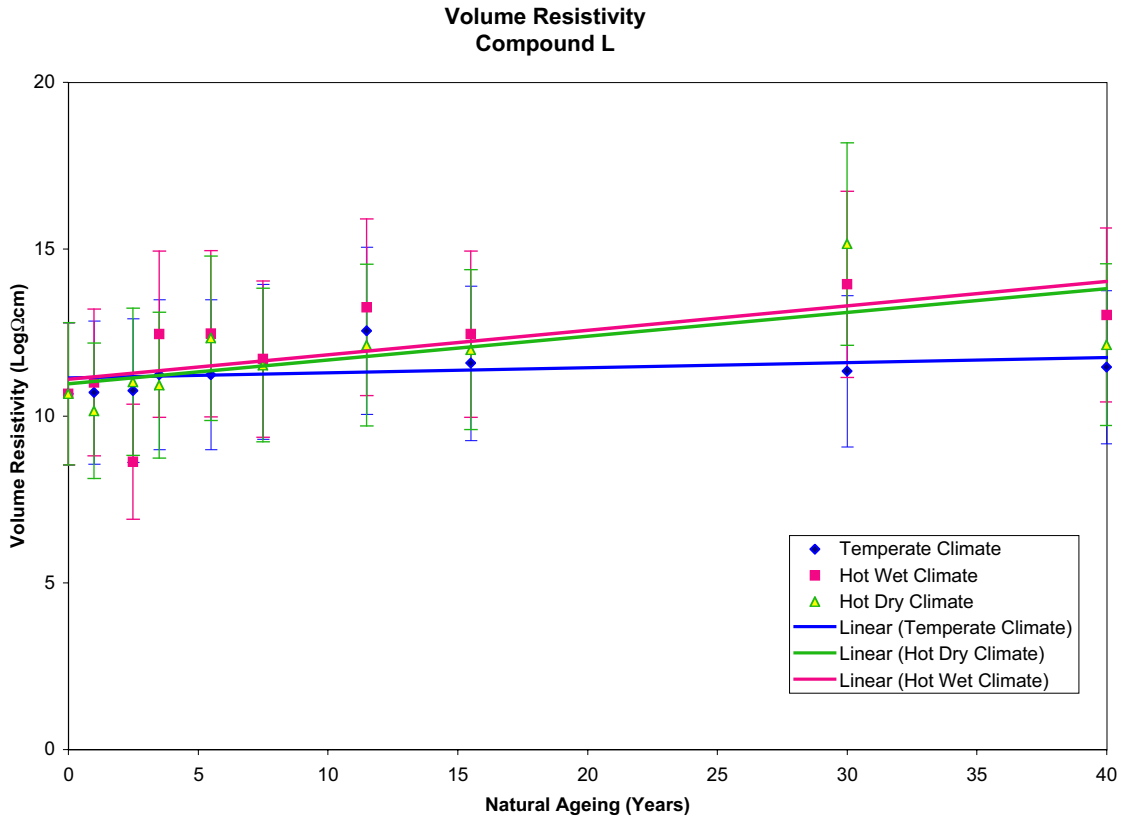
Extrapolated unaged and 40 years natural ageing data: Compound L (polychloroprene - general purpose)

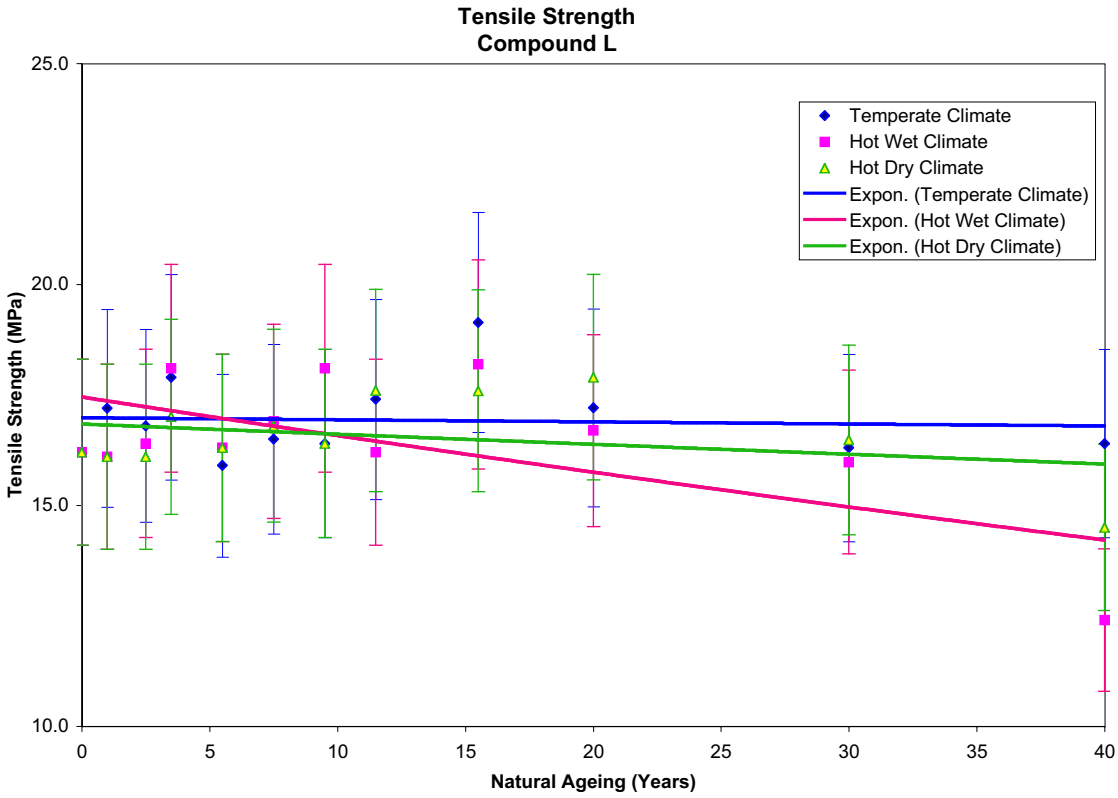
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	63.8	67.4	3.6	5.6	65.4	74.1	8.7	13	63.8	70.4	6.6	10
Volume Change (%)	54.2	55.8	1.6	3.0	57.5	55.8	-1.7	-3.0	54.2	57.5	3.3	6.1
Rebound Resilience (%)	54.1	58.3	4.2	7.8	54.5	55.6	1.1	2.0	54.1	56.5	2.4	4.4
Volume Resistivity (LogΩcm)	11.2	11.8	0.60	5.4	11.2	14.1	2.9	26	11.0	13.8	2.8	25
Tensile Properties												
Tensile Strength (MPa)	17.0	16.8	-0.20	-1.2	17.5	14.3	-3.2	-18	16.9	16.0	-0.90	-5.3
Elongation at Break (%)	300	265	-35	-12	287	250	-37	-13	292	260	-32	-11
Modulus at 100% (MPa)	2.92	4.08	1.2	40	3.33	6.29	3.0	89	3.25	4.96	1.7	53
Modulus at 300% (MPa)	-	-			-	-			-	-		
Compression Set												
Short Term (%)	3.75	5.88	2.1	57	3.69	11.0	7.3	198	3.88	6.69	2.8	72
Long Term (%)	0.0	59.0			0.0	78.0			0.0	68.8		
Low Temperature Properties												
T2 Value (K)	253	248	-4.2	-1.7	249	246	-3.8	-1.5	250	247	-3.5	-1.4
T10 Value (K)	242	240	-2.2	-0.9	239	240	1.1	0.5	241	241	-0.20	-0.08

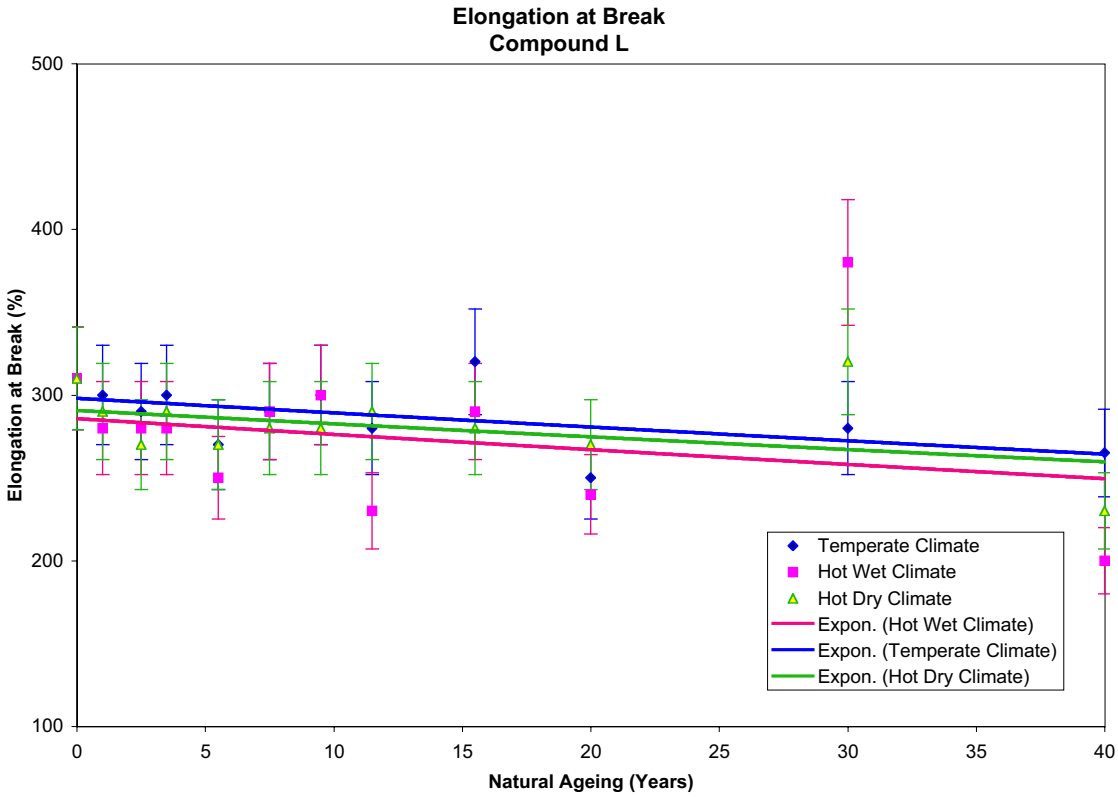

Hardness
Compound L
Hardness (IRHD)
80
70
60
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

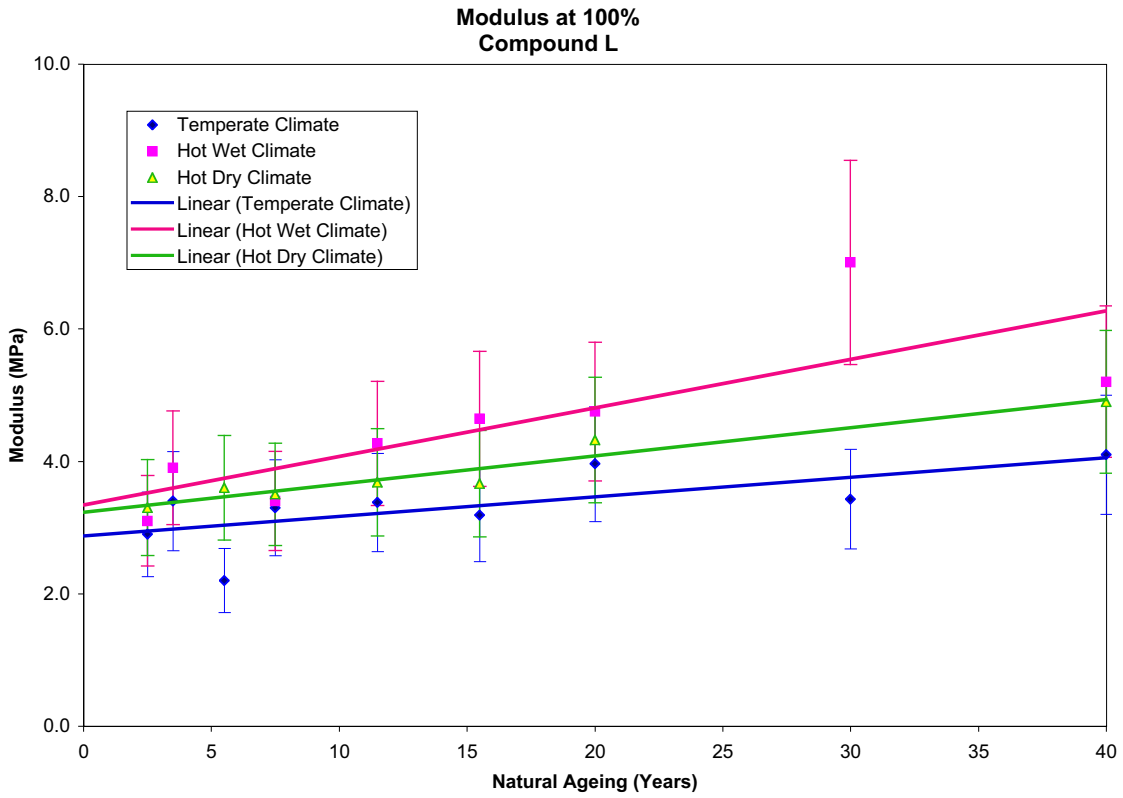

Volume Change
Compound L
Volume Change (%)
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

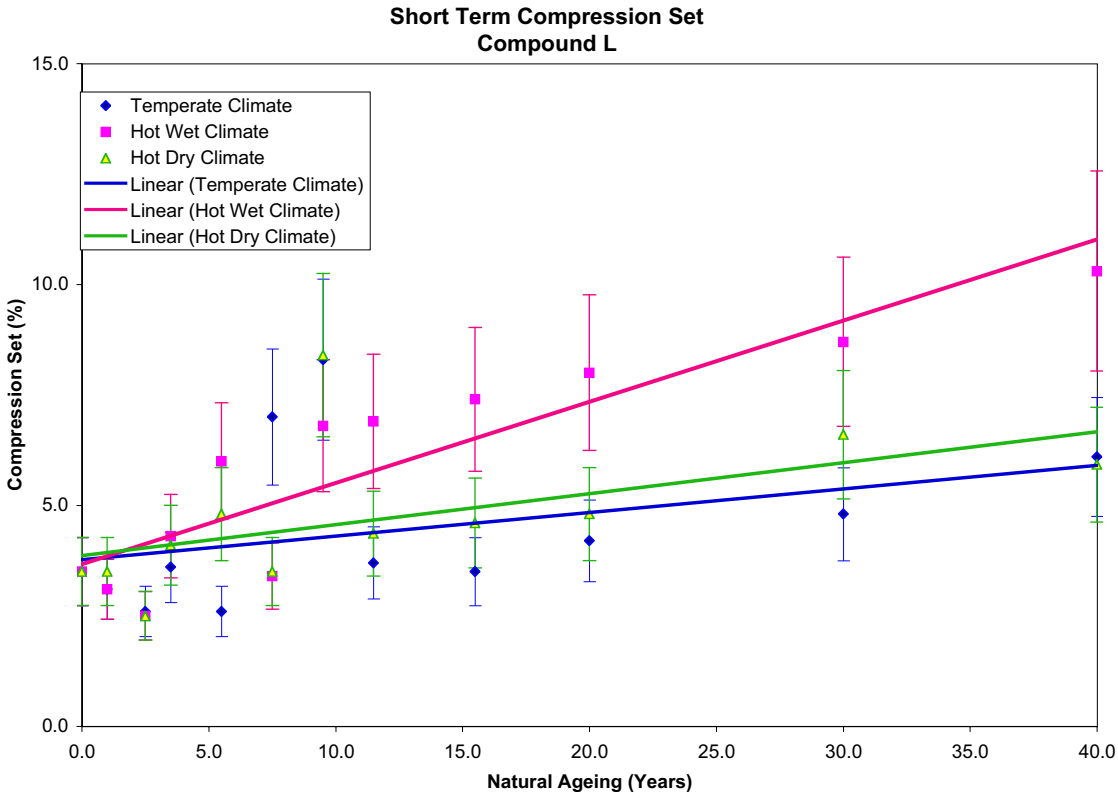


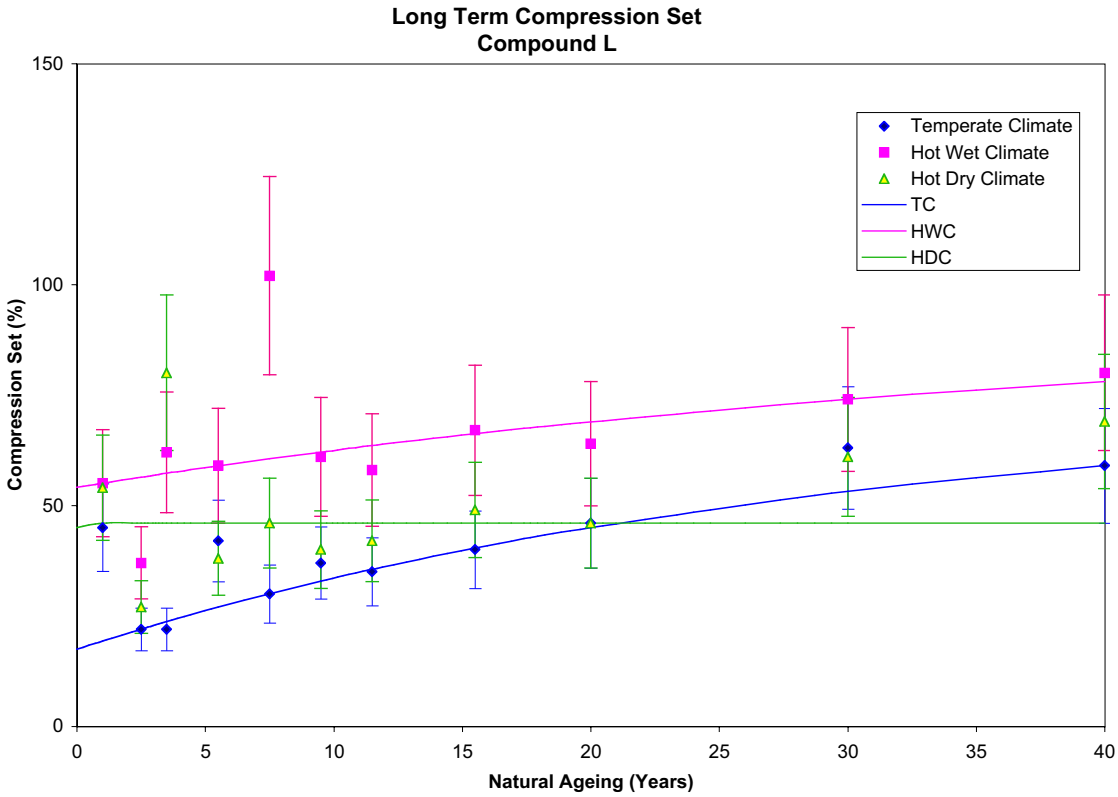


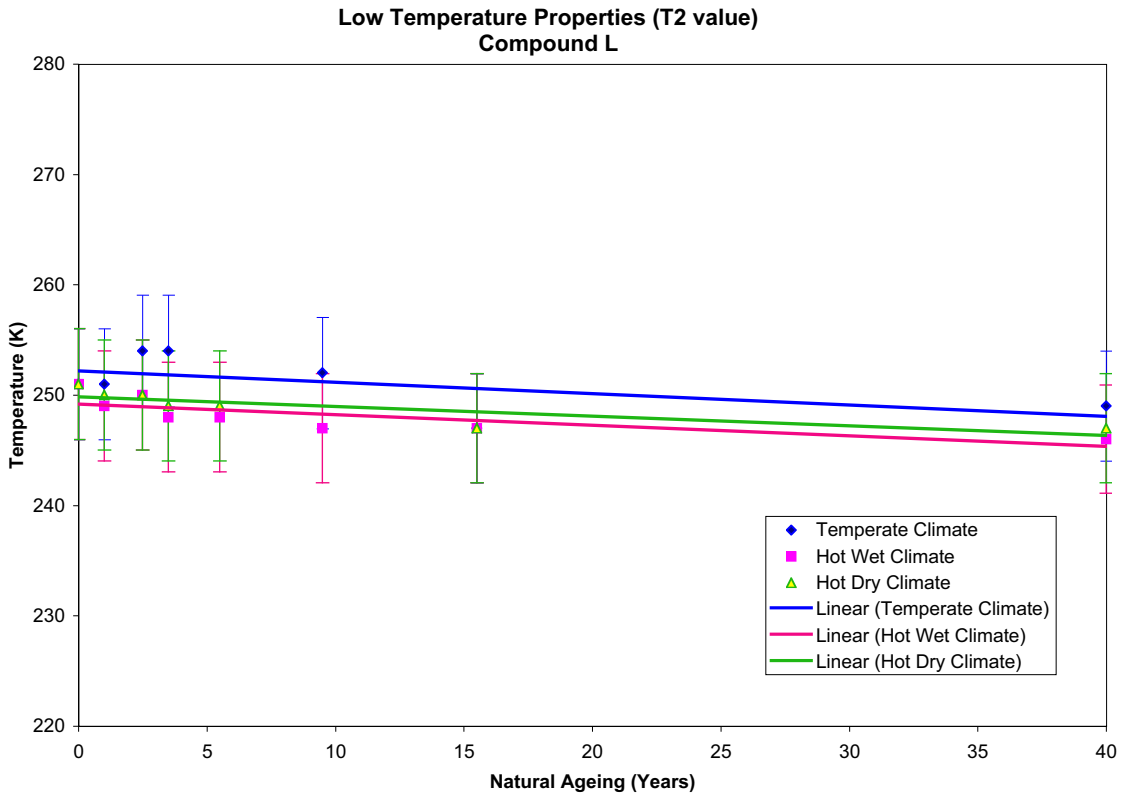

Tensile Strength
Compound L
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
25.0
20.0
15.0
10.0
0
5
10
15
20
25
30
35
40

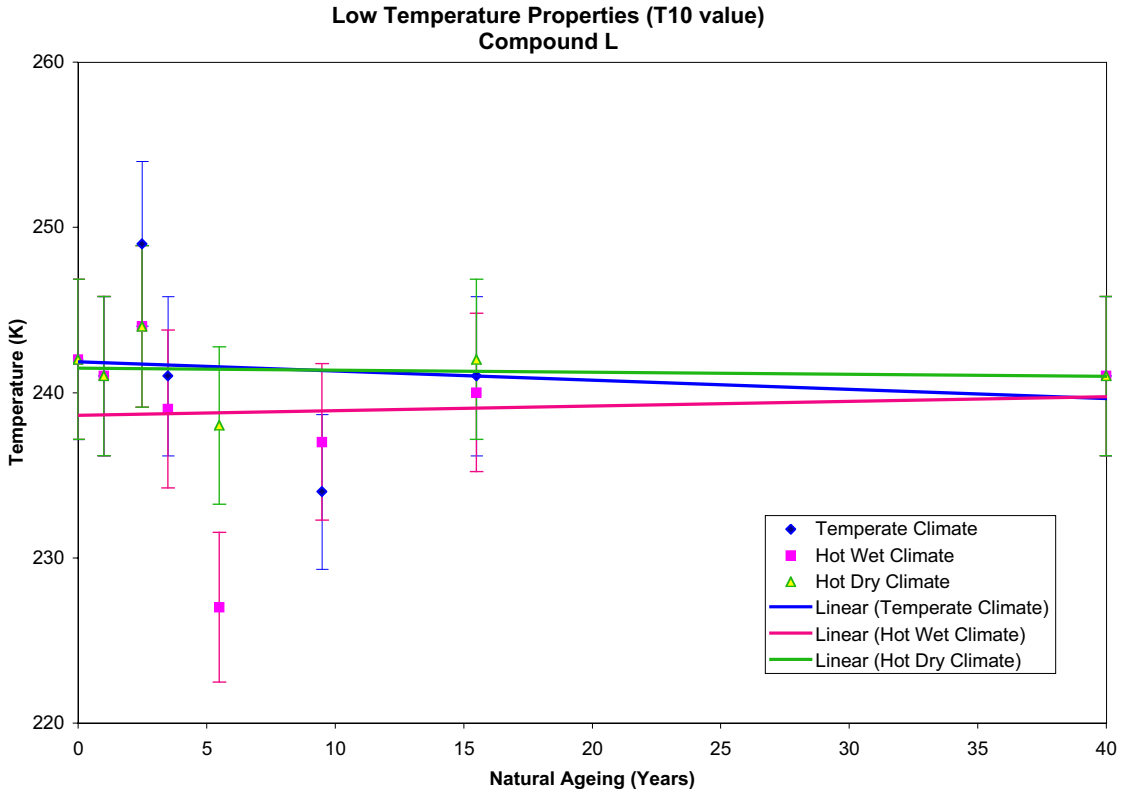

Elongation at Break
Compound L
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)
500
400
300
200
100
0
5
10
15
20
25
30
35
40




Short Term Compression Set
Compound L
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)
Compression Set (%)
Natural Ageing (Years)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

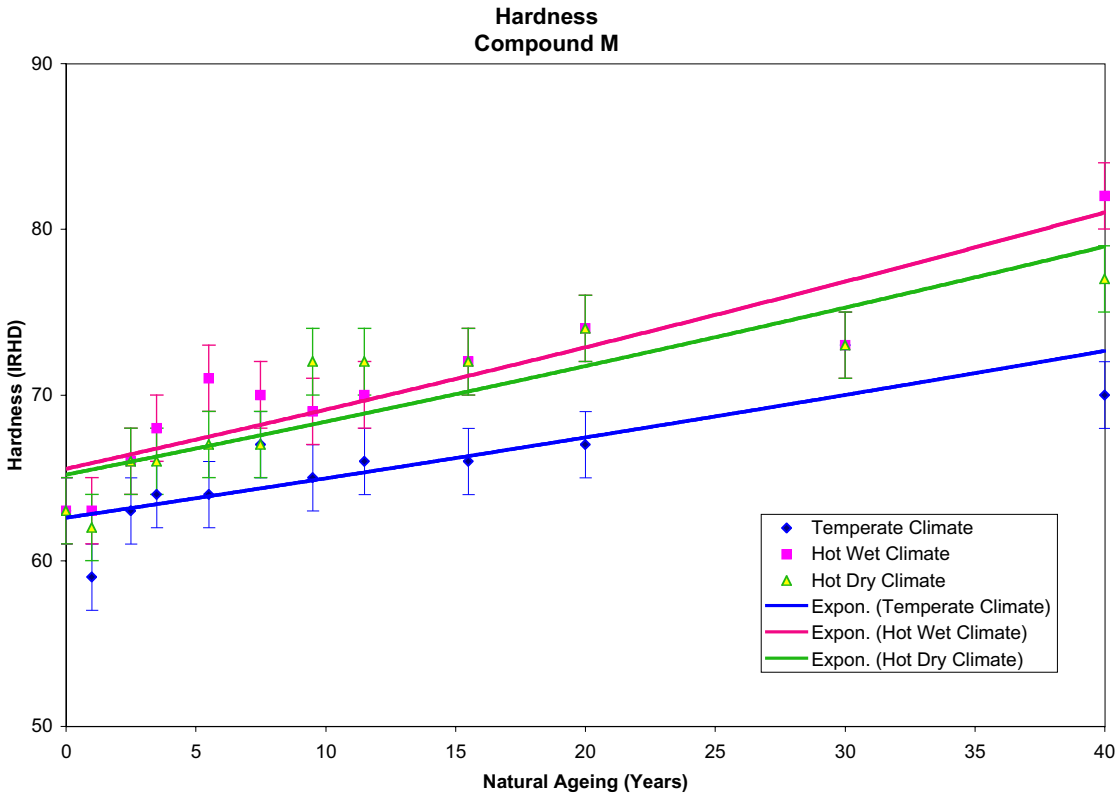

Long Term Compression Set
Compound L
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
Compression Set (%)
Natural Ageing (Years)
0
50
100
150
0
5
10
15
20
25
30
35
40

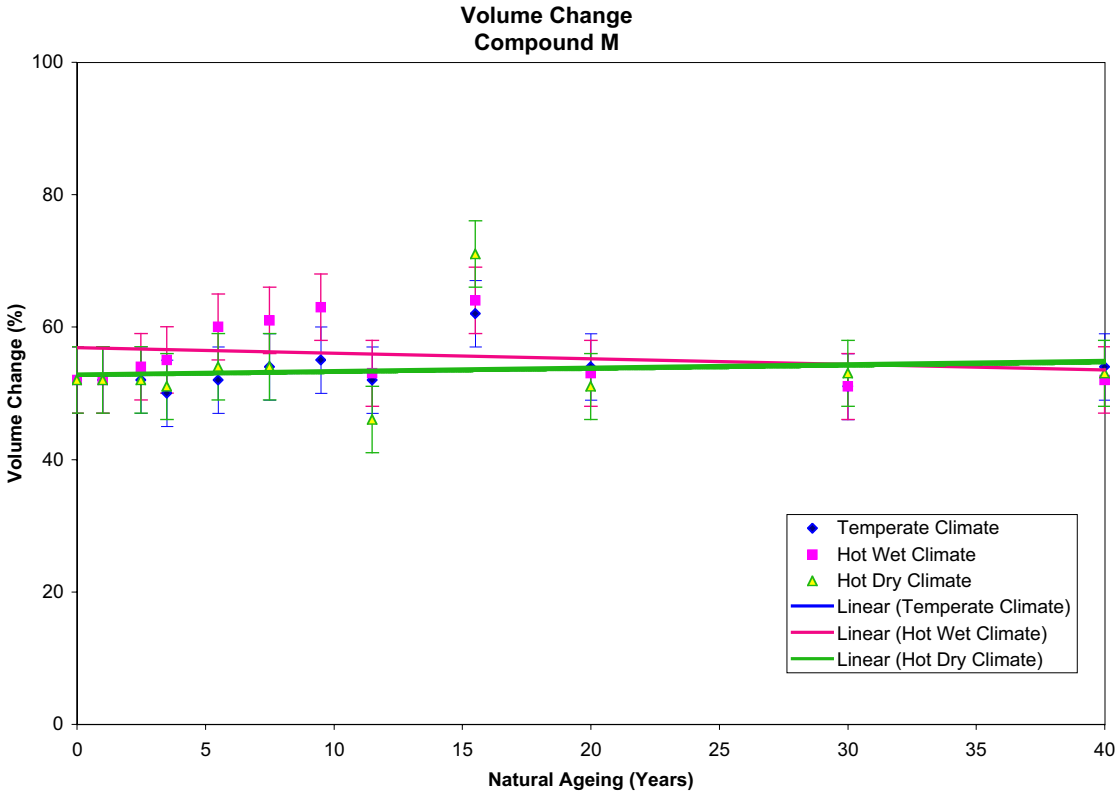


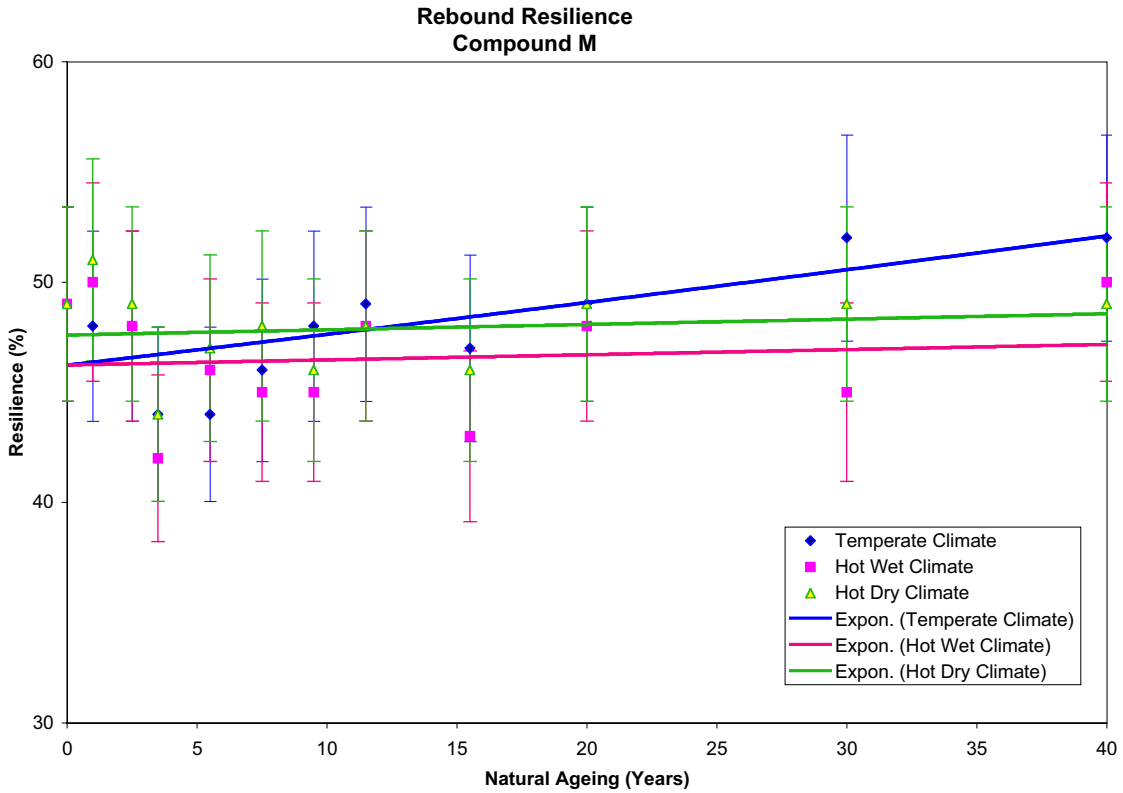


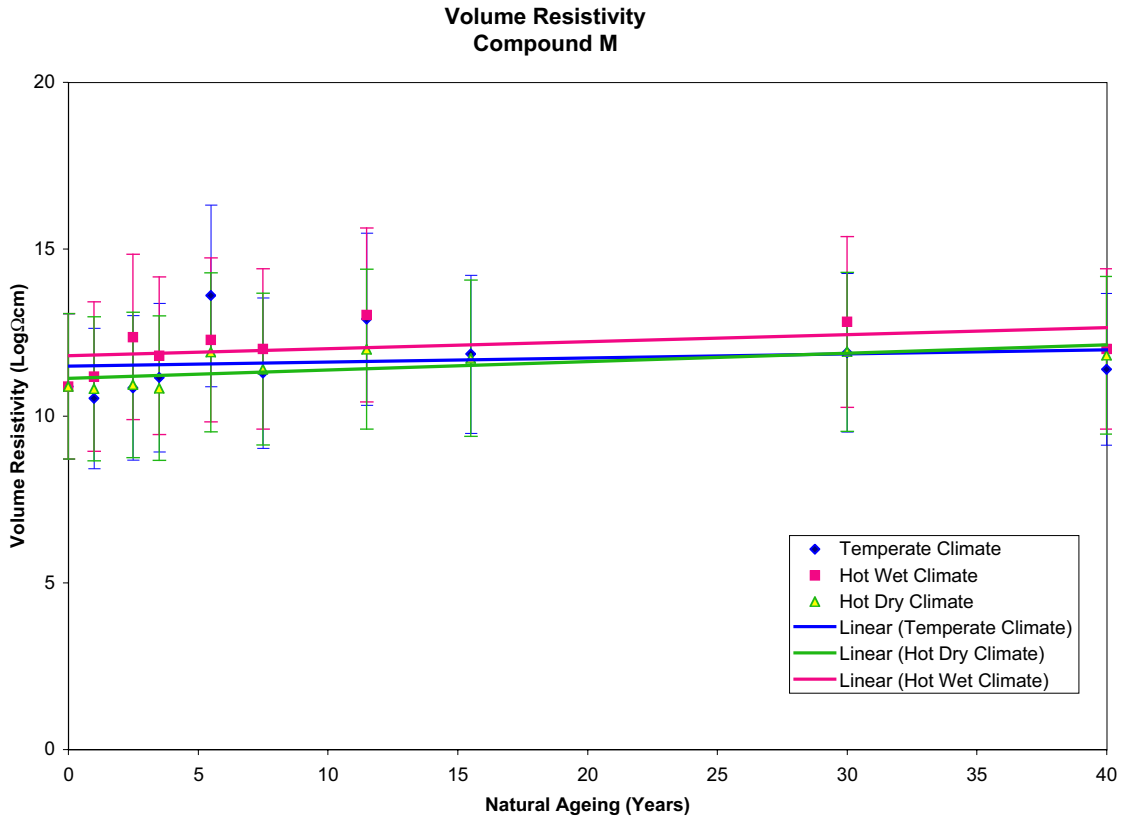
Extrapolated unaged and 40 years natural ageing data: Compound M (polychloroprene - natural ageing)

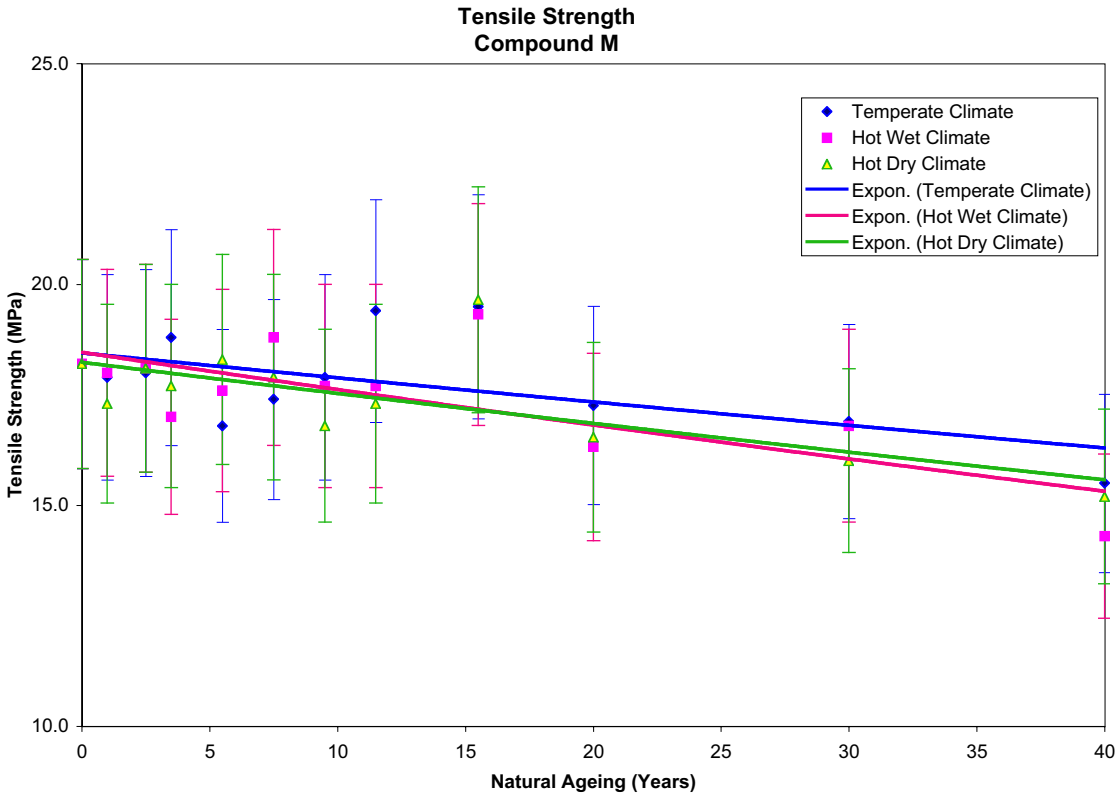
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	62.7	72.7	10	16	65.7	81.0	15	23	65.3	79.0	14	21
Volume Change (%)	53.3	55.0	1.7	3.2	57.1	53.8	-3.3	-5.8	53.3	55.0	1.7	3.2
Rebound Resilience (%)	46.3	52.1	5.8	13	46.3	47.3	1.0	2.2	47.6	48.6	1.0	2.1
Volume Resistivity (LogΩcm)	11.5	12.0	0.50	4.3	11.8	12.7	0.90	7.6	11.2	12.2	1.0	8.9
Tensile Properties												
Tensile Strength (MPa)	18.5	16.3	-2.2	-12	18.5	15.4	-3.1	-17	18.3	15.6	-2.7	-15
Elongation at Break (%)	415	288	-127	-31	388	225	-163	-42	385	225	-160	-42
Modulus at 100% (MPa)	2.92	5.08	2.2	74	4.08	7.00	2.9	72	3.50	7.00	3.5	100
Modulus at 300% (MPa)	14.6	16.3	1.7	12	15.3	19.0	3.7	24	14.5	24.0	9.5	66
Compression Set												
Short Term (%)	6.38	9.13	2.8	43	4.38	21.8	17	397	4.25	14.0	9.8	229
Long Term (%)	0.0	78.8			0.0	94.4			0.0	96.9		
Low Temperature Properties												
T2 Value (K)	255	247	-8.3	-3.3	251	252	0.50	0.2	255	251	-4.0	-1.6
T10 Value (K)	242	241	-1.1	-0.5	239	241	1.9	0.8	242	243	0.60	0.3

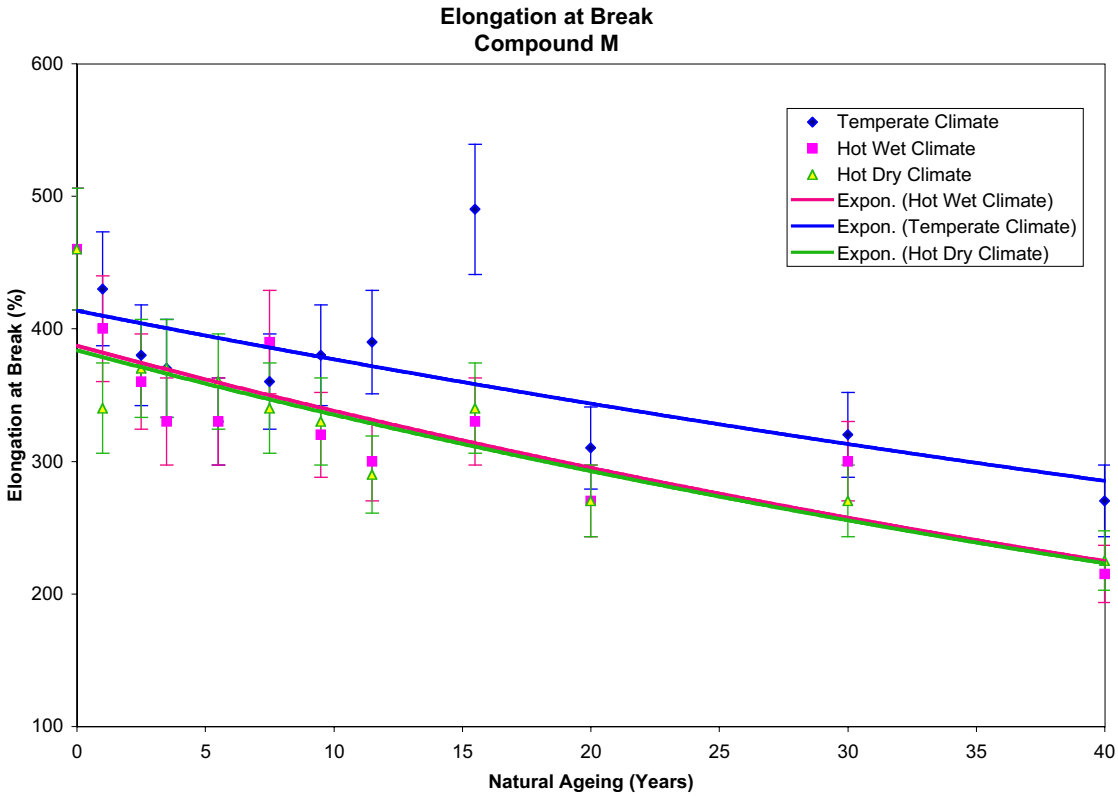

Hardness
Compound M
Hardness (IRHD)
Natural Ageing (Years)
90
80
70
60
50
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

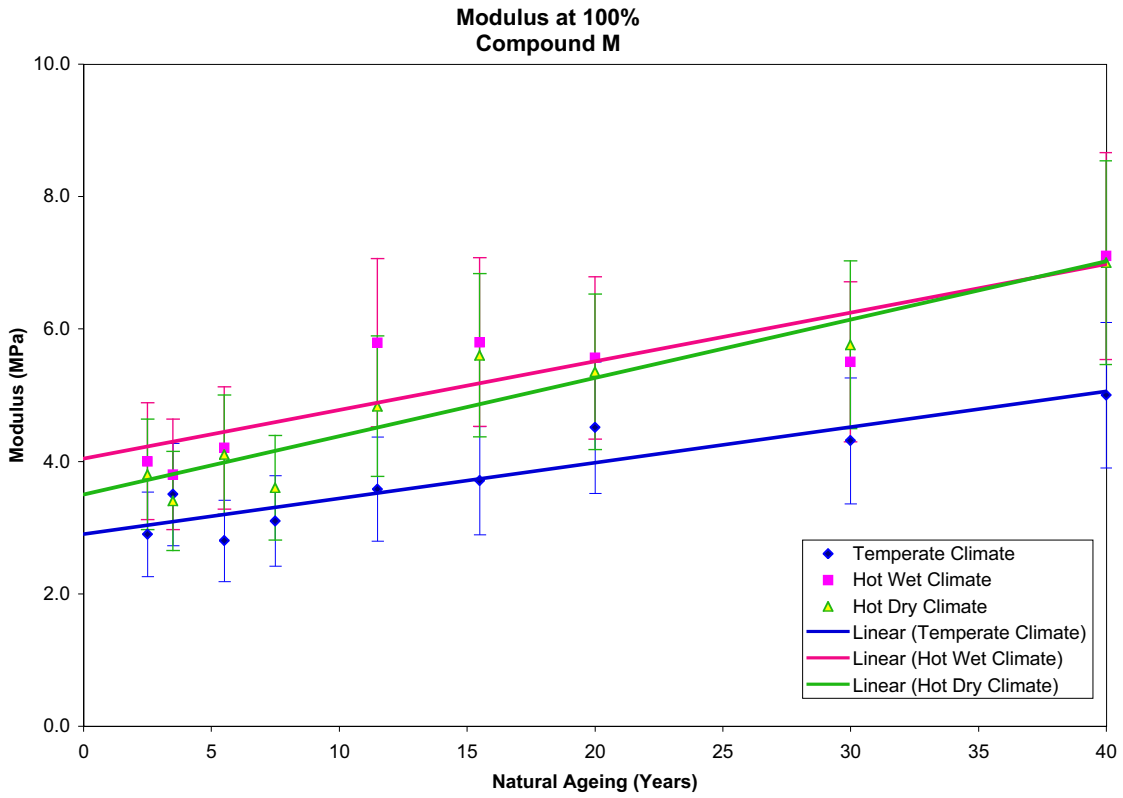

Volume Change
Compound M
Volume Change (%)
Natural Ageing (Years)
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

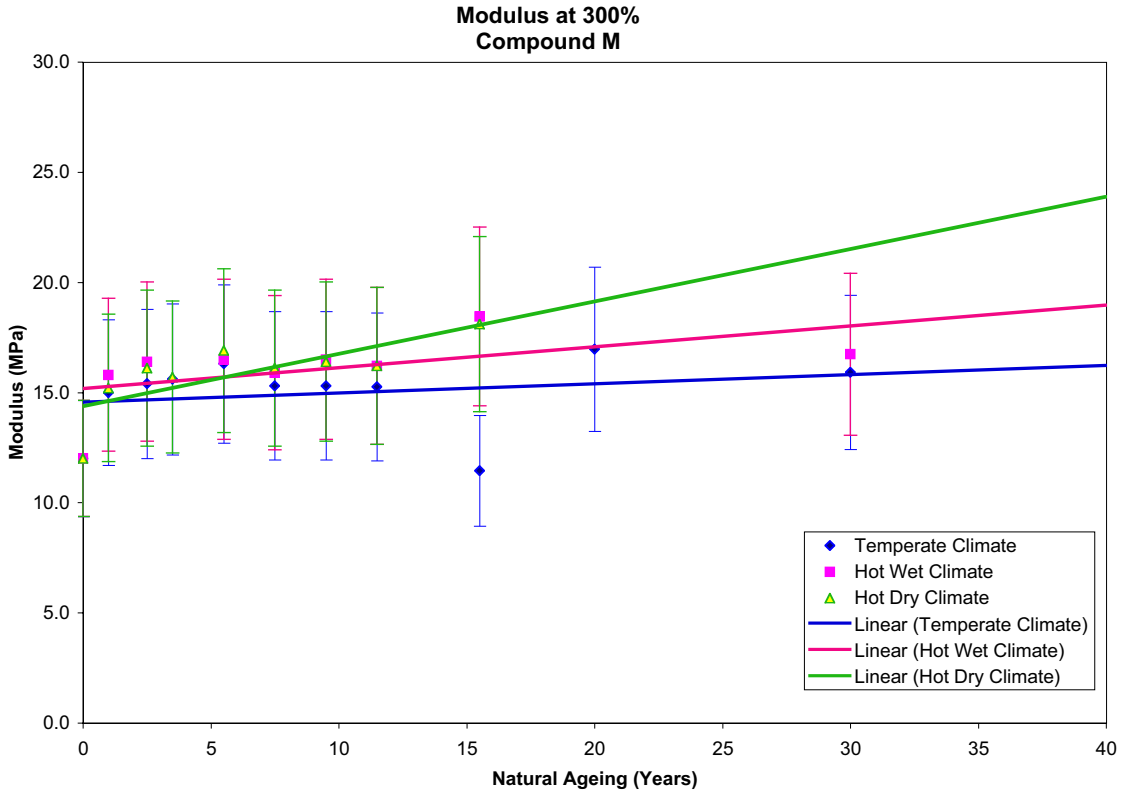


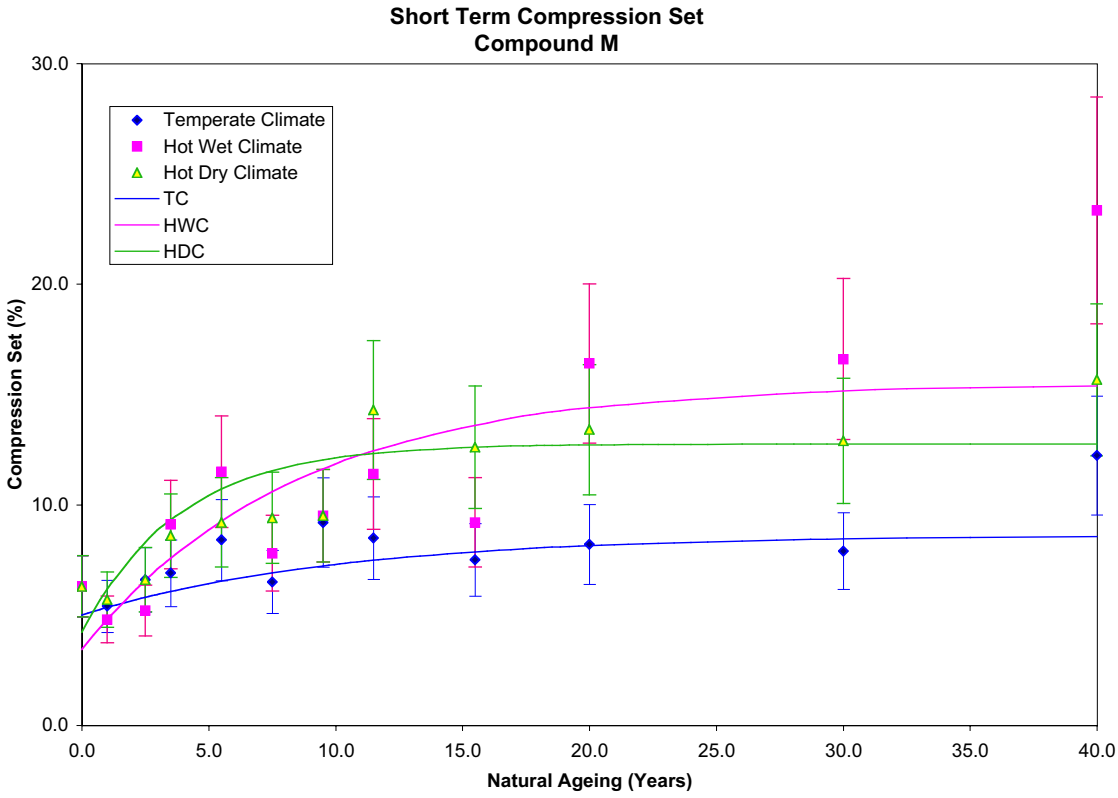


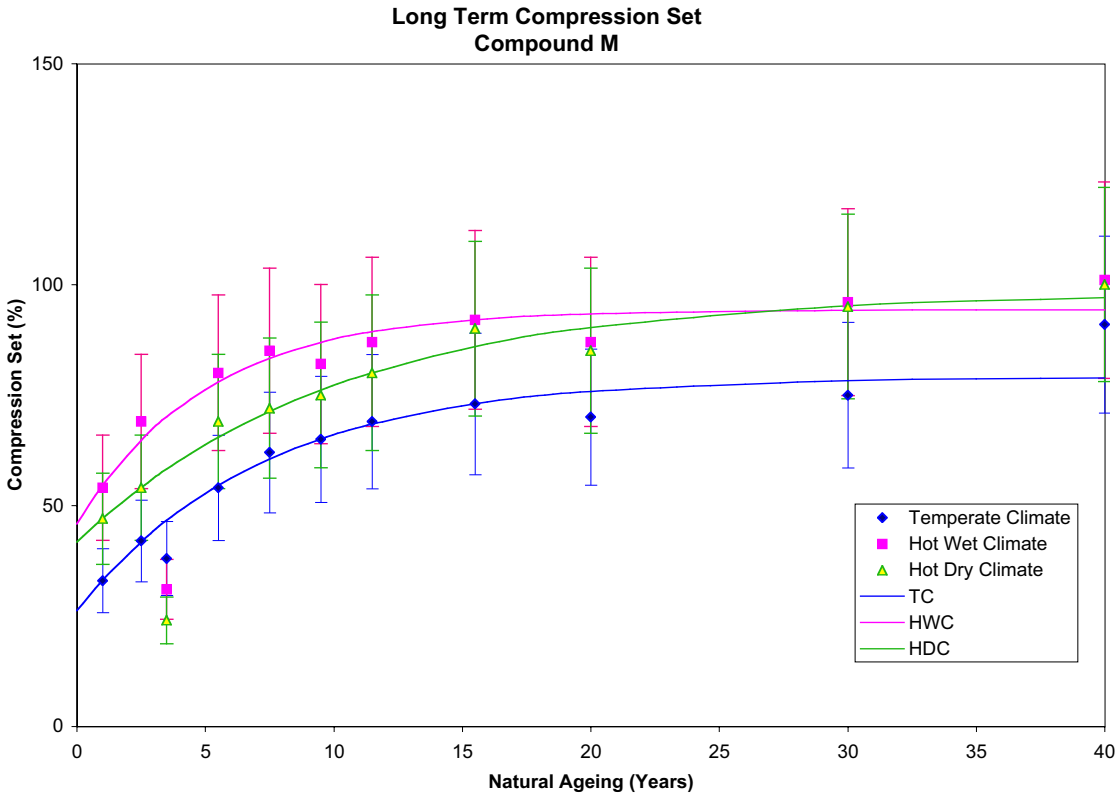

Tensile Strength
Compound M
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
25.0
20.0
15.0
10.0
0
5
10
15
20
25
30
35
40

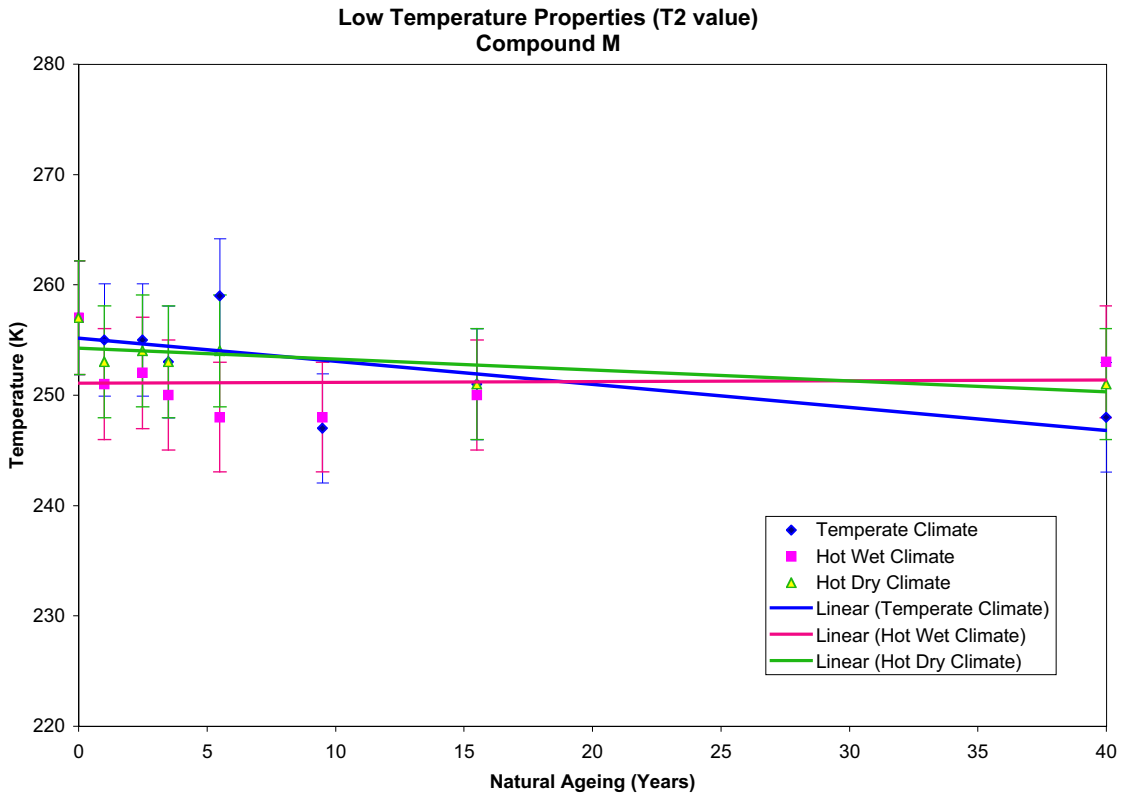

Elongation at Break
Compound M
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)
600
500
400
300
200
100
0
5
10
15
20
25
30
35
40

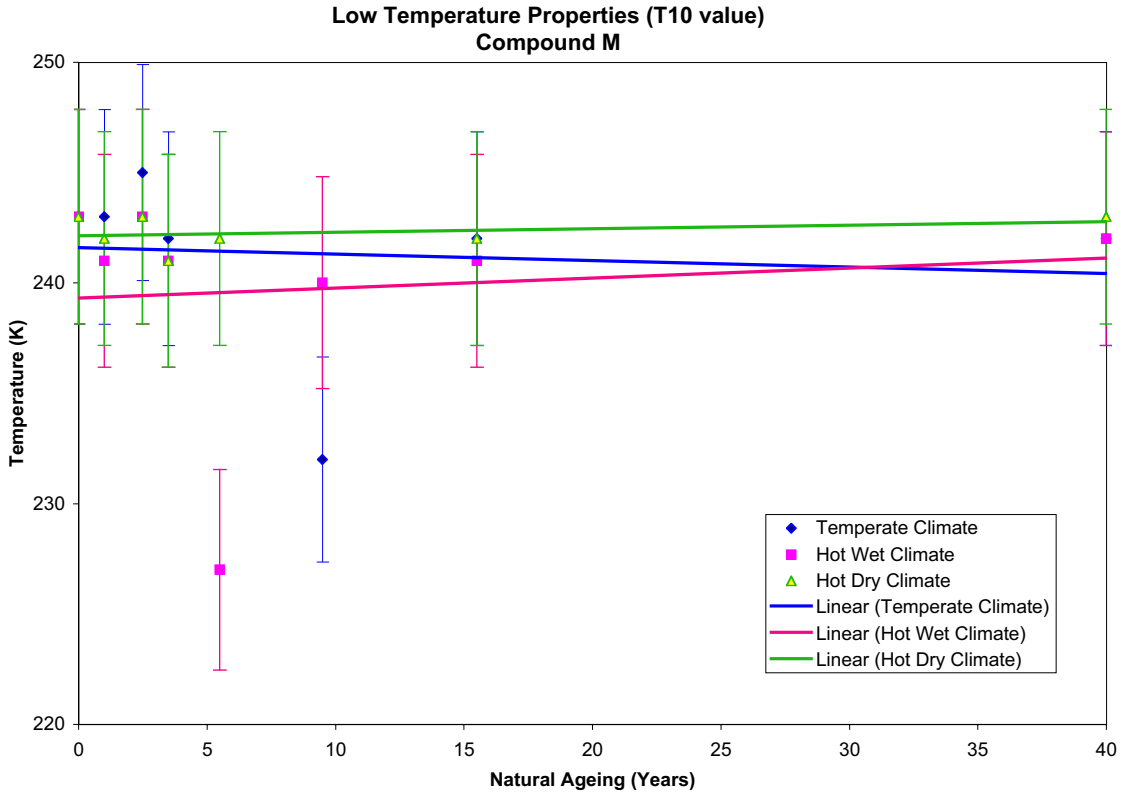





Short Term Compression Set
Compound M
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
Compression Set (%)
Natural Ageing (Years)
0.0
10.0
20.0
30.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

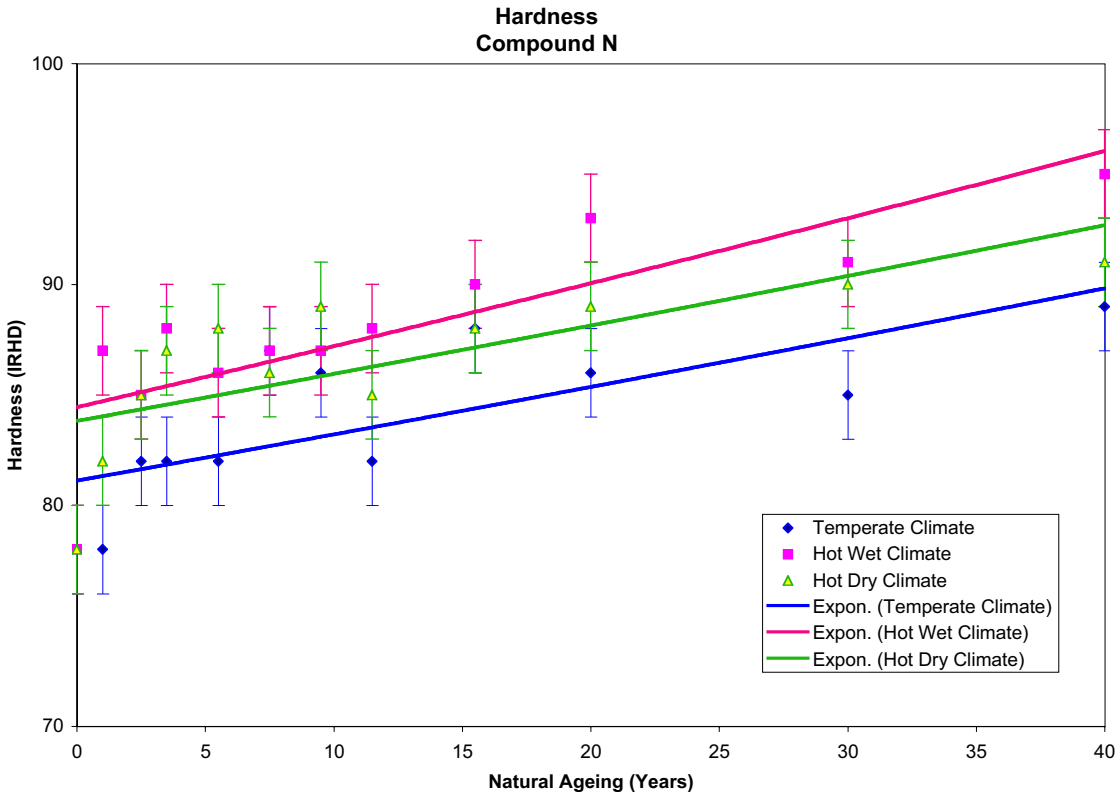

Long Term Compression Set
Compound M
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
Compression Set (%)
Natural Ageing (Years)
0
50
100
150
0
5
10
15
20
25
30
35
40

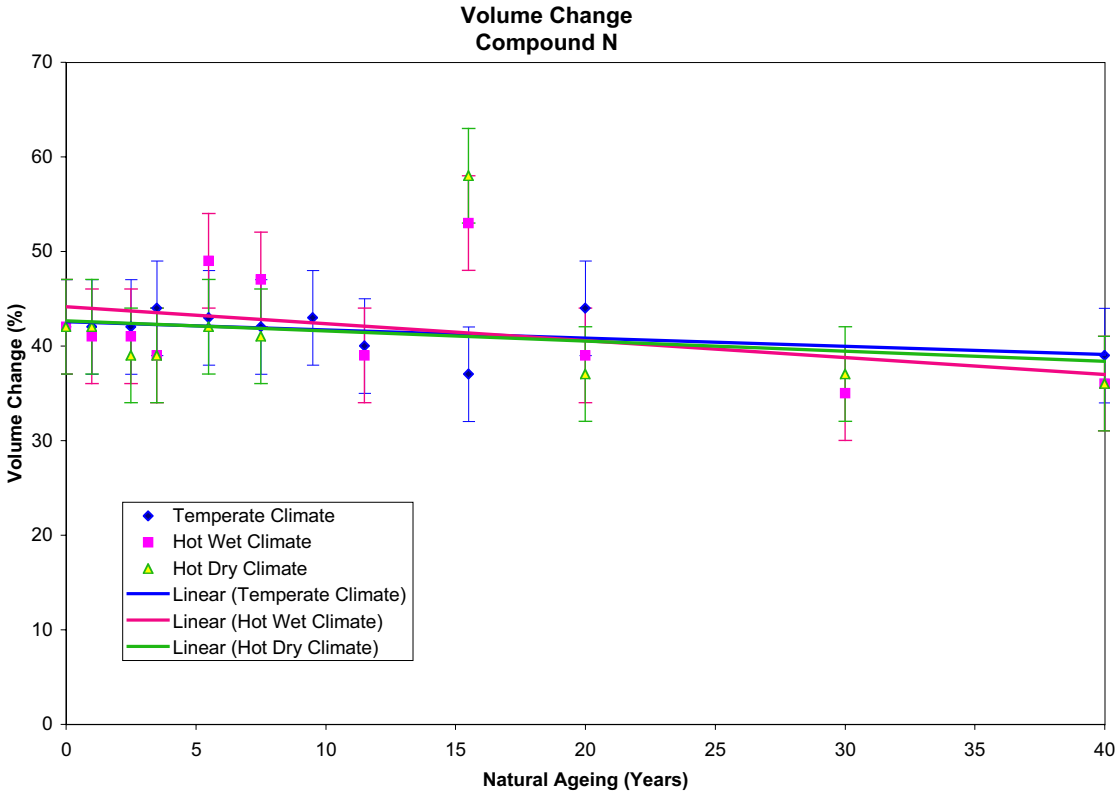


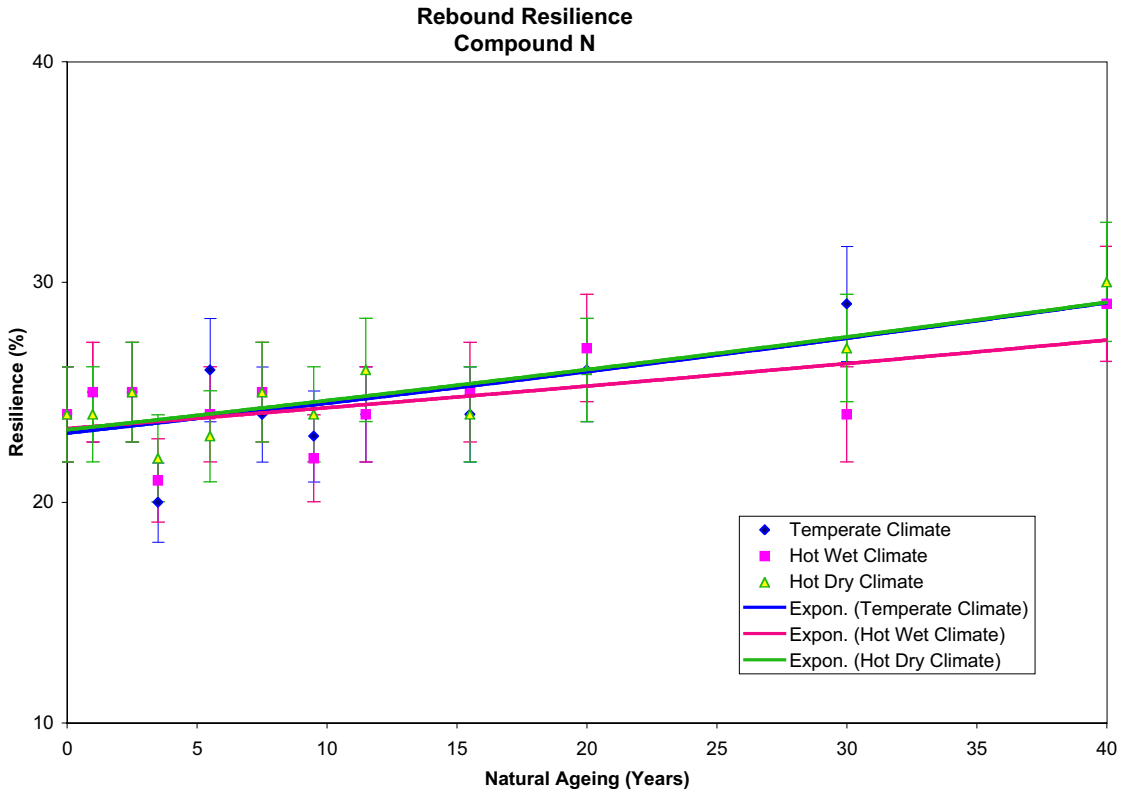


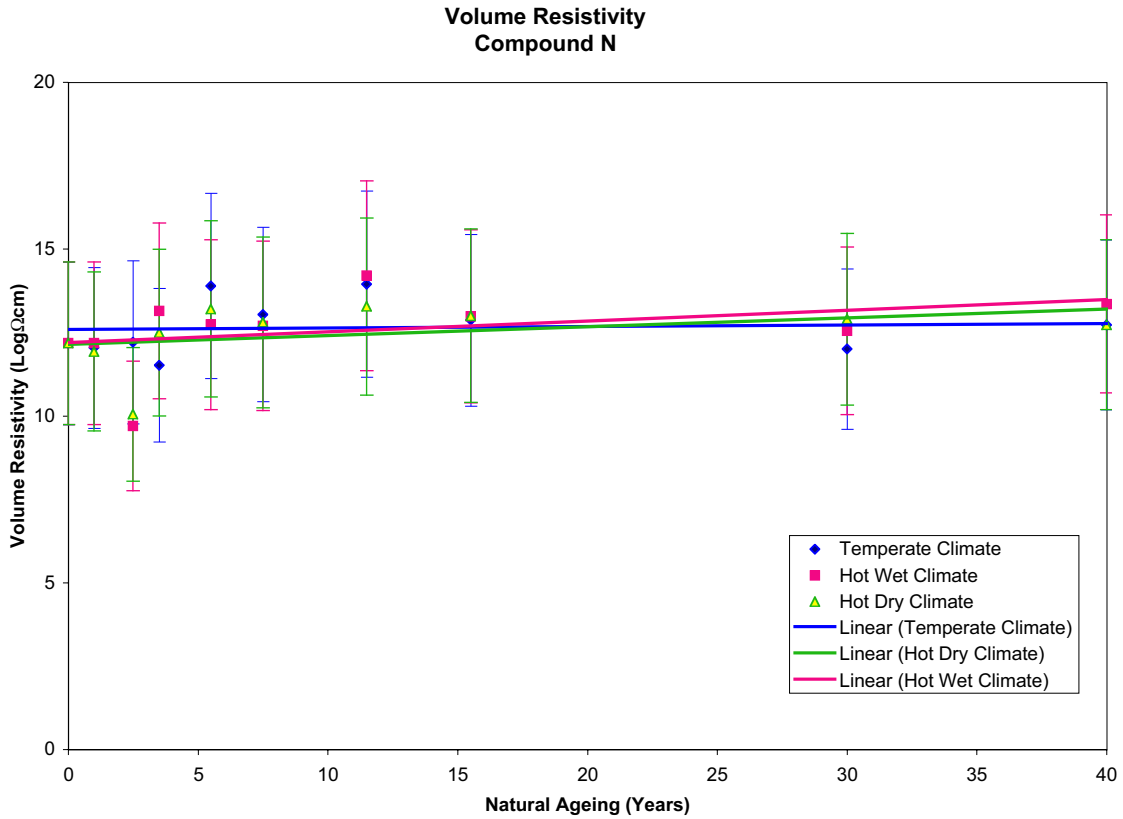
Extrapolated unaged and 40 years natural ageing data: Compound N (polychloroprene - heat ageing)

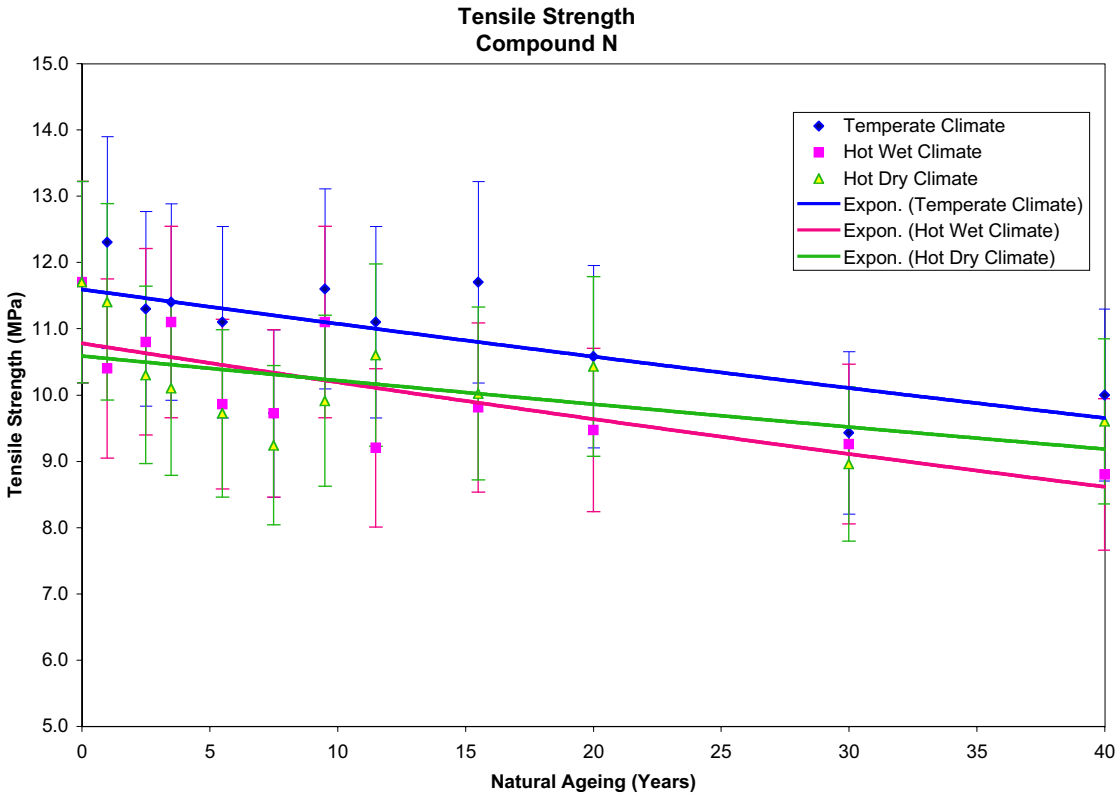
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	81.3	89.9	8.6	11	84.5	96.1	12	14	83.9	92.8	8.9	11
Volume Change (%)	42.6	39.1	-3.5	-8.2	44.3	37.3	-7.0	-16	42.6	38.5	-4.1	-10
Rebound Resilience (%)	23.3	29.1	5.8	25	23.3	27.5	4.2	18	23.3	29.1	5.8	25
Volume Resistivity (LogΩcm)	12.7	12.8	0.10	0.79	12.3	13.5	1.2	10	12.2	13.3	1.1	9.0
Tensile Properties												
Tensile Strength (MPa)	11.6	9.67	-1.9	-16	10.8	8.62	-2.2	-20	10.6	9.21	-1.4	-13
Elongation at Break (%)	368	263	-105	-29	368	130	-238	-65	357	155	-202	-57
Modulus at 100% (MPa)	3.38	6.63	3.3	96	4.06	8.81	4.8	117	3.75	8.81	5.1	135
Modulus at 300% (MPa)	10.4	9.38	-1.0	-10	10.4	6.88	-3.5	-34	10.3	5.31	-5.0	-48
Compression Set												
Short Term (%)	8.02	7.9	-0.10	-1.2	9.17	14.7	5.5	60	9.17	10.8	1.6	18
Long Term (%)	0.0	81.1			0.0	90.9			0.0	93.3		
Low Temperature Properties												
T2 Value (K)	271	254	-17	-6.2	268	258	-9.2	-3.4	268	251	-17	-6.3
T10 Value (K)	249	247	-2.8	-1.1	246	246	0.7	0.3	248	246	-1.6	-0.7

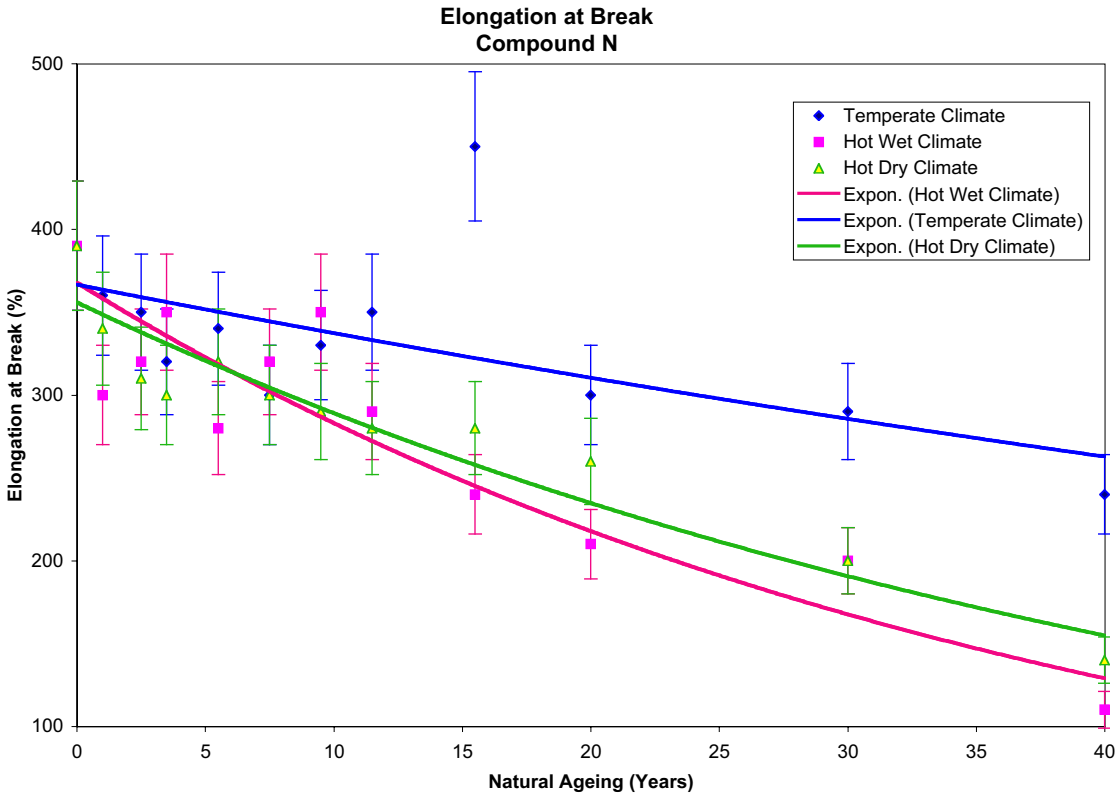

Hardness
Compound N
Hardness (IRHD)
Natural Ageing (Years)
100
90
80
70
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

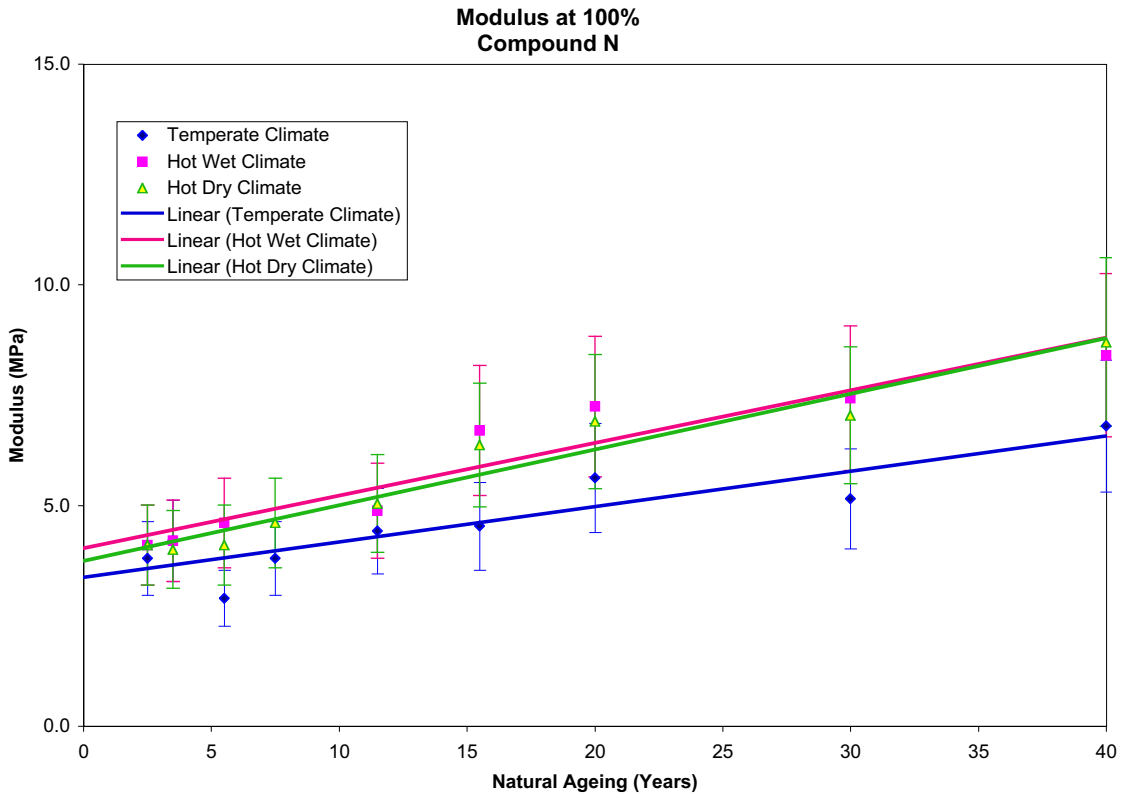

Volume Change
Compound N
Volume Change (%)
Natural Ageing (Years)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

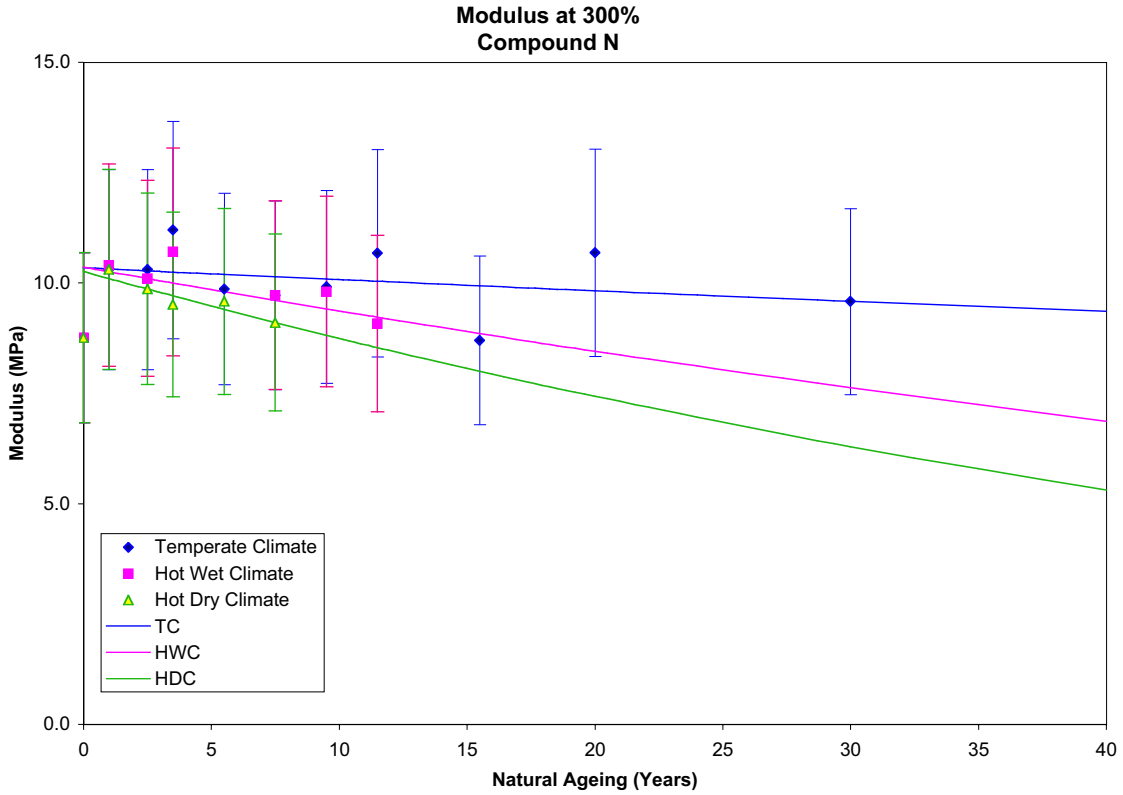


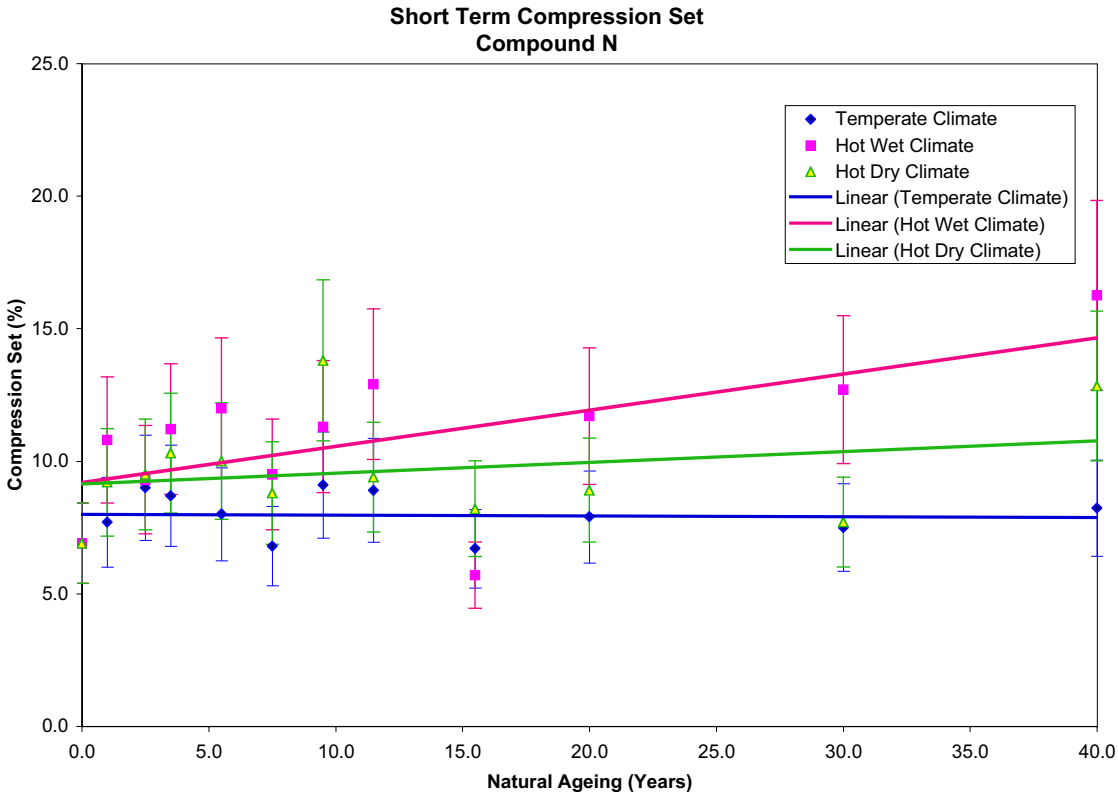


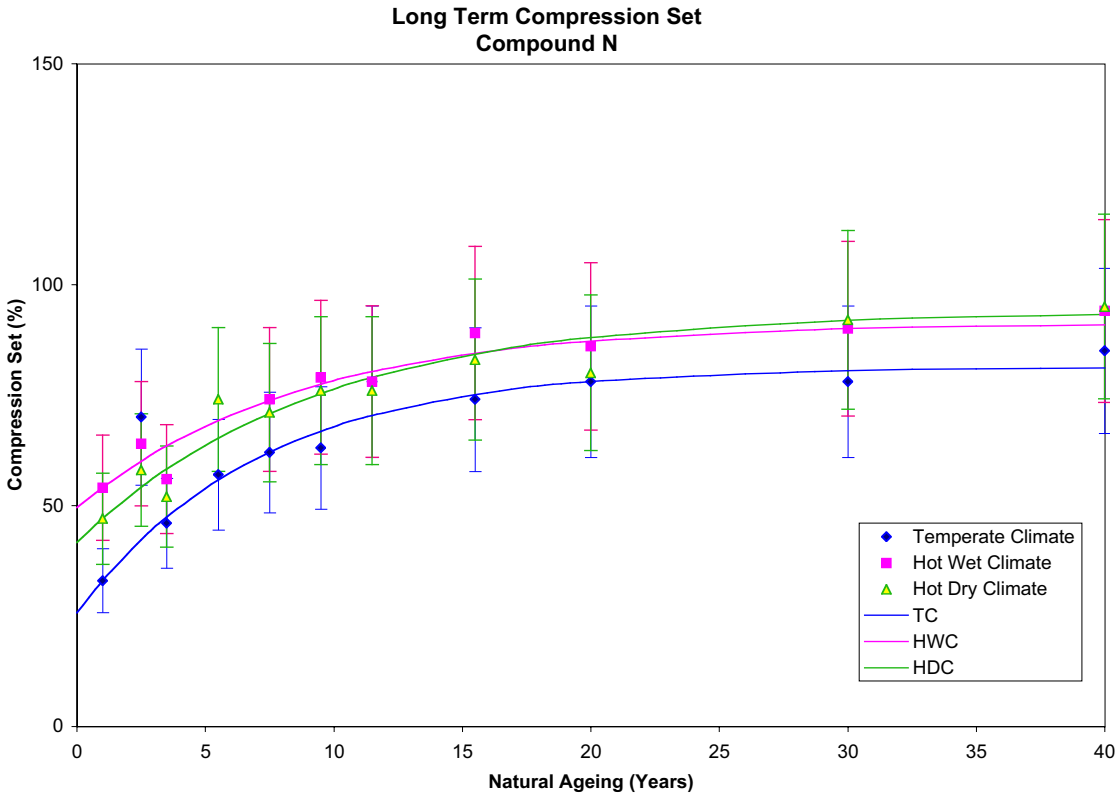

Tensile Strength
Compound N
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

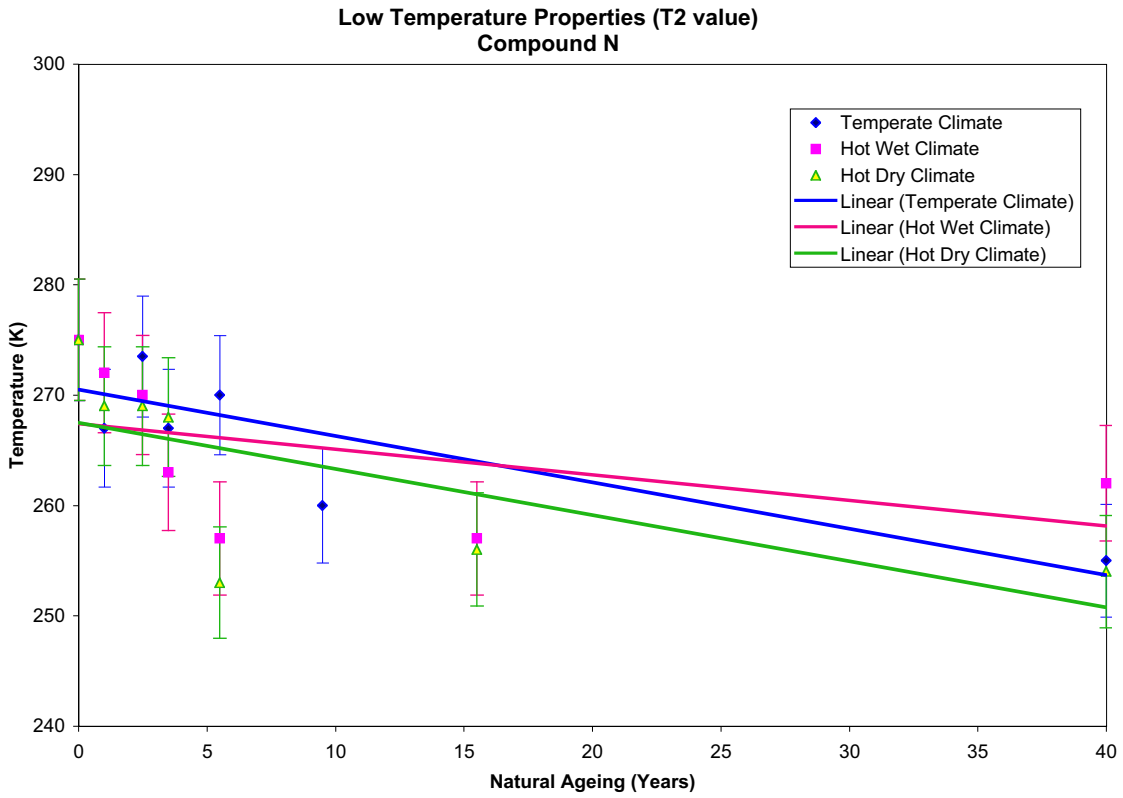

Elongation at Break
Compound N
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

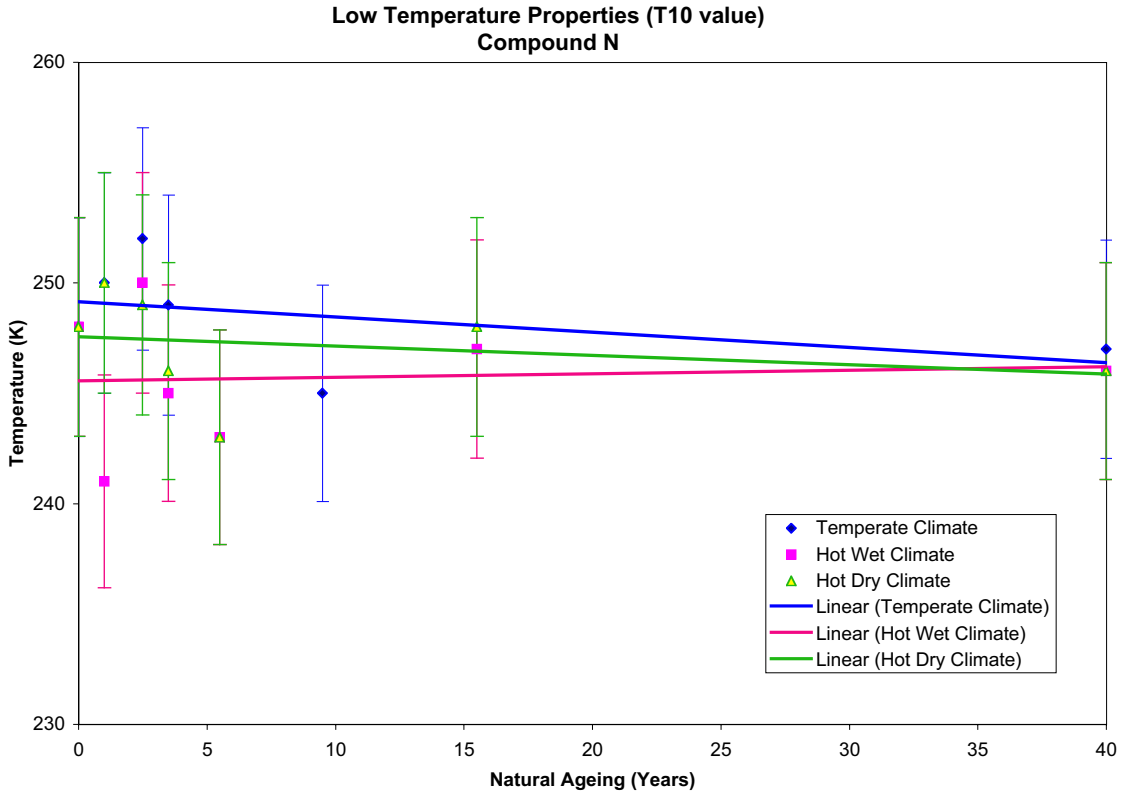





Short Term Compression Set
Compound N
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

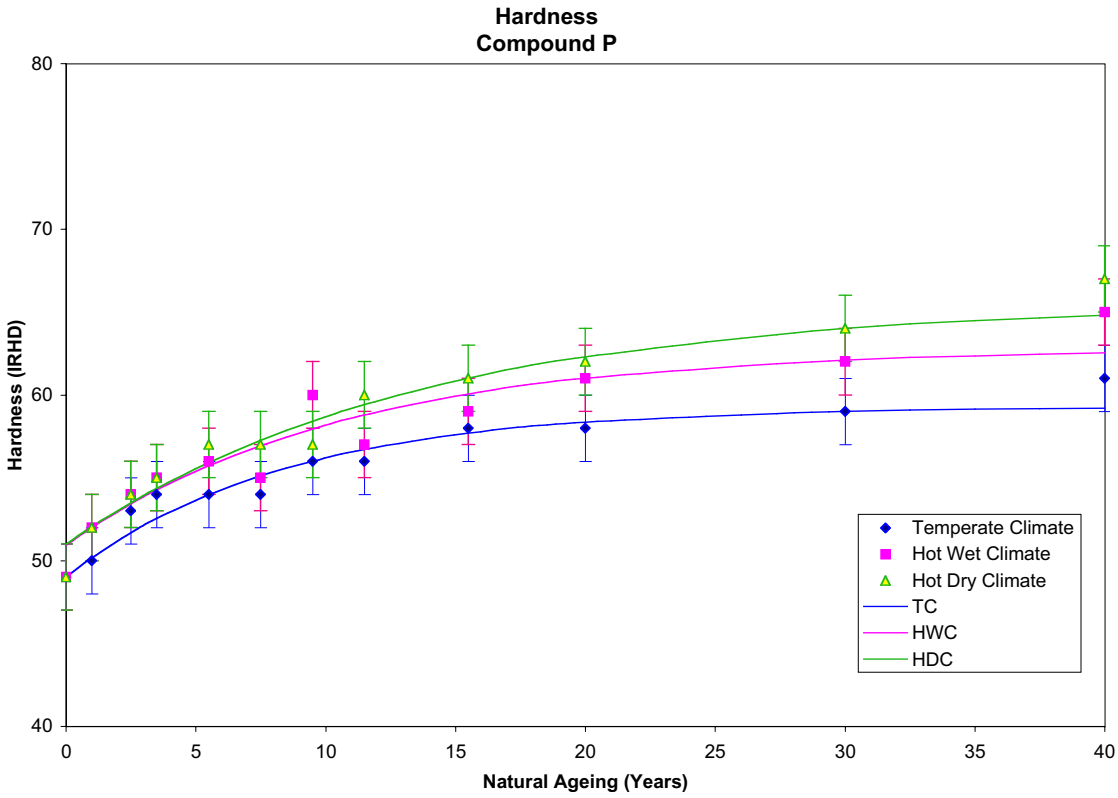

Long Term Compression Set
Compound N
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
0
50
100
150
0
5
10
15
20
25
30
35
40

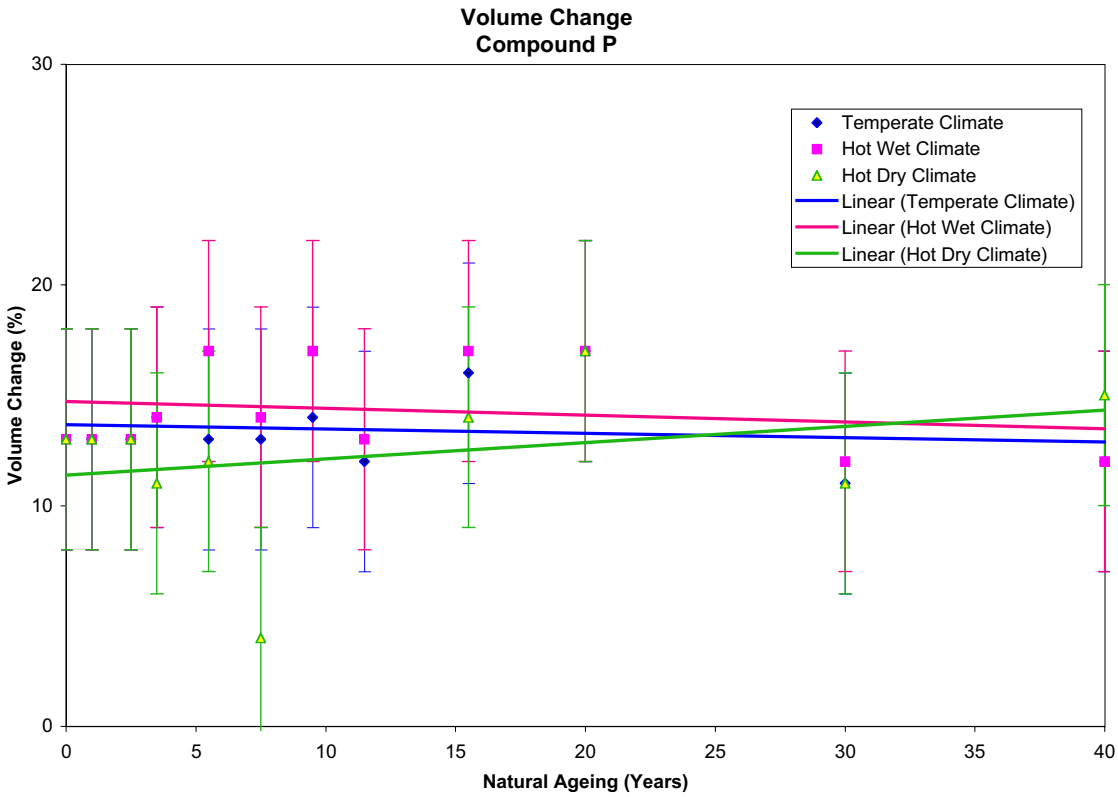


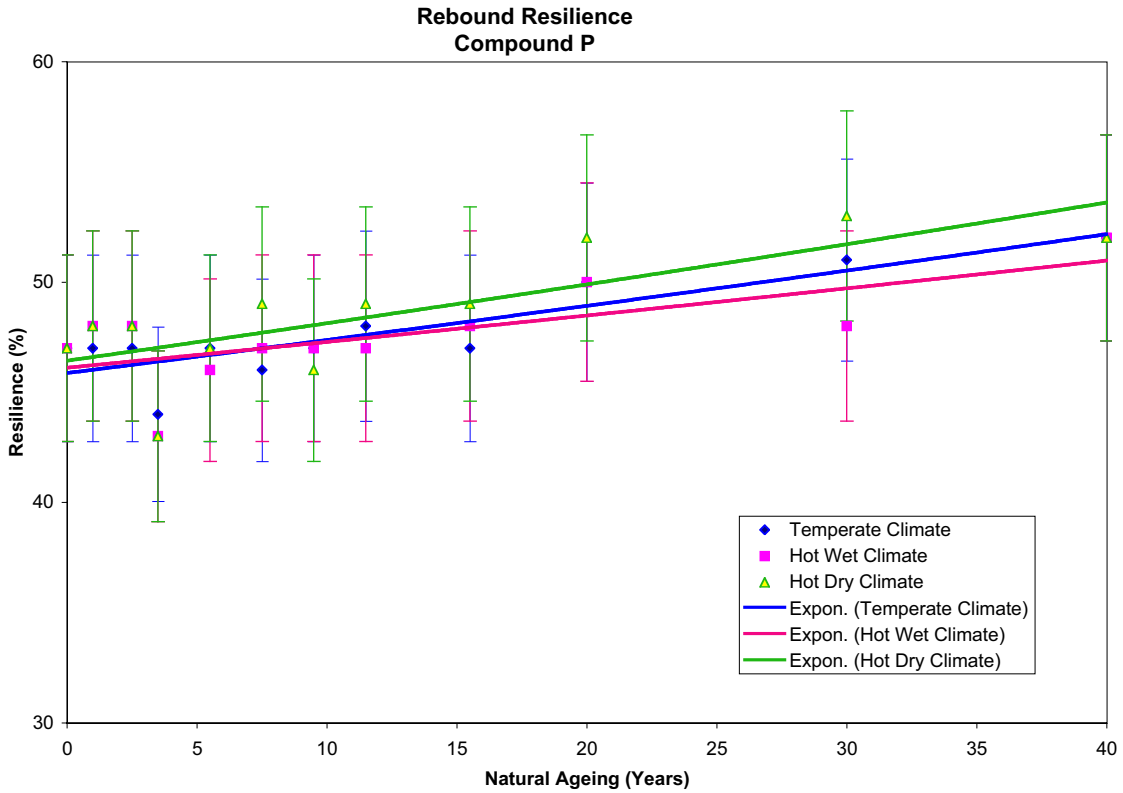


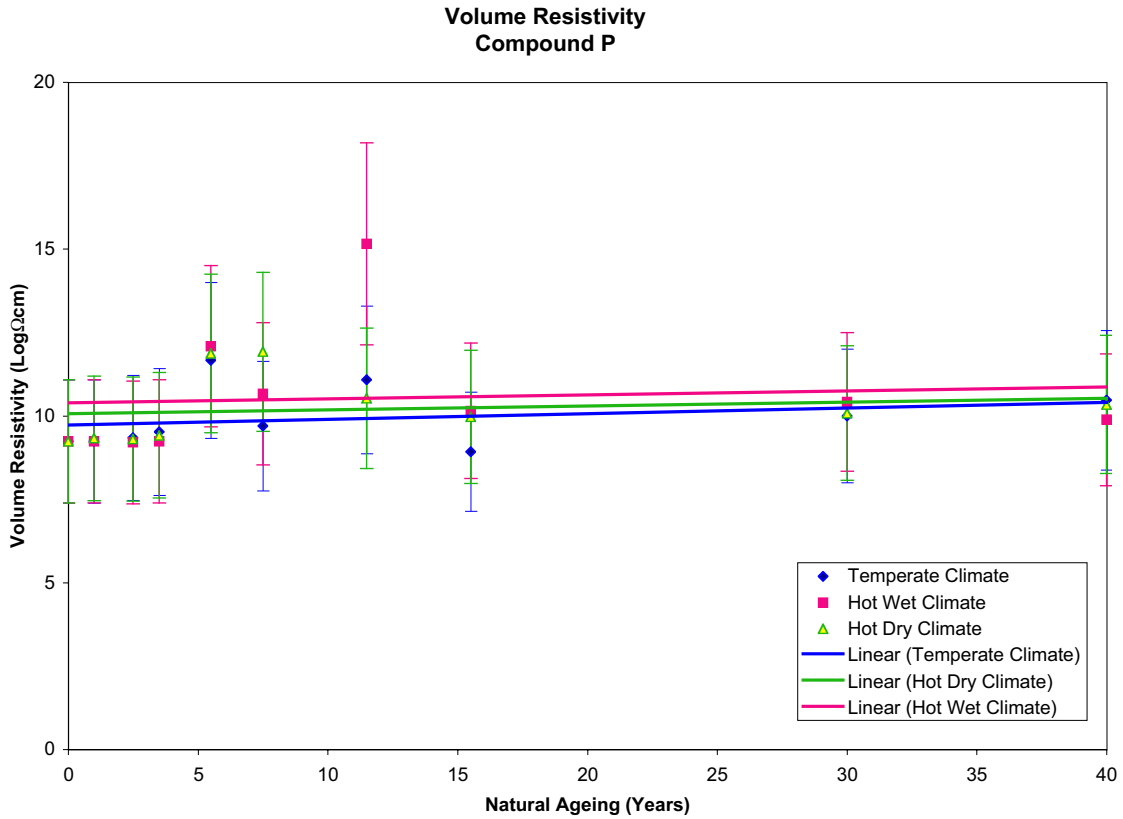
Extrapolated unaged and 40 years natural ageing data: Compound P (nitrile rubber - general purpose)

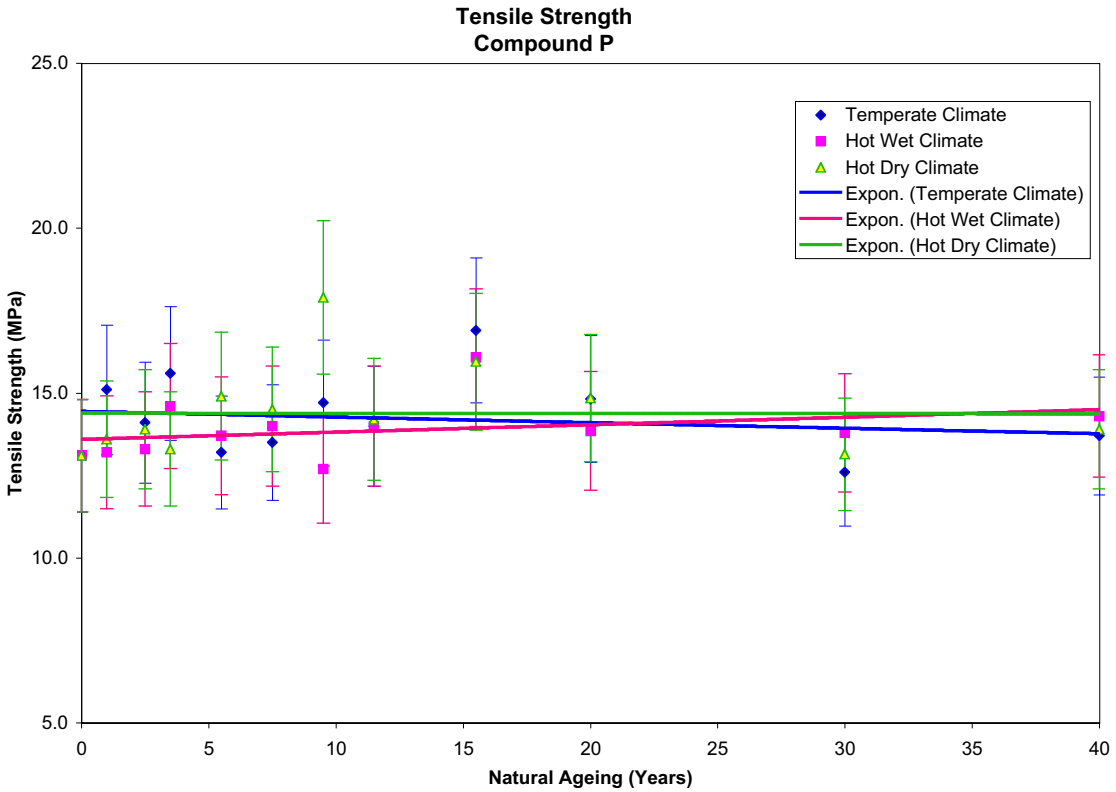
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	49.0	59.2	10	21	50.9	62.5	12	23	50.7	64.8	14	28
Volume Change (%)	13.8	13.0	-0.80	-5.8	14.8	13.5	-1.3	-8.8	11.5	14.4	2.9	25
Rebound Resilience (%)	46.0	52.3	6.3	14	46.3	51.0	4.7	10	46.5	53.6	7.1	15
Volume Resistivity (LogΩcm)	9.83	10.4	0.57	5.8	10.4	10.9	0.50	4.8	10.1	10.5	0.40	4.0
Tensile Properties												
Tensile Strength (MPa)	14.5	13.8	-0.70	-4.8	13.7	14.5	0.80	5.8	14.5	14.5	0.0	0.0
Elongation at Break (%)	490	325	-165	-34	420	220	-200	-48	445	213	-233	-52
Modulus at 100% (MPa)	1.73	3.03	1.3	75	2.13	4.83	2.7	127	1.83	4.83	3.0	164
Modulus at 300% (MPa)	8.10	13.1	5.0	62	8.10	22.3	14	175	8.10	22.3	14	175
Compression Set												
Short Term (%)	6.92	4.83	-2.1	-30	7.75	5.75	-2.0	-26	6.54	3.92	-2.6	-40
Long Term (%)	0.0	77.9			0.0	93.0			0.0	91.0		
Low Temperature Properties												
T2 Value (K)	258	249	-9.3	-3.6	259	253	-6.6	-2.5	260	254	-6.2	-2.4
T10 Value (K)	244	244	0.0	0.0	245	248	2.7	1.1	247	246	-0.40	-0.2

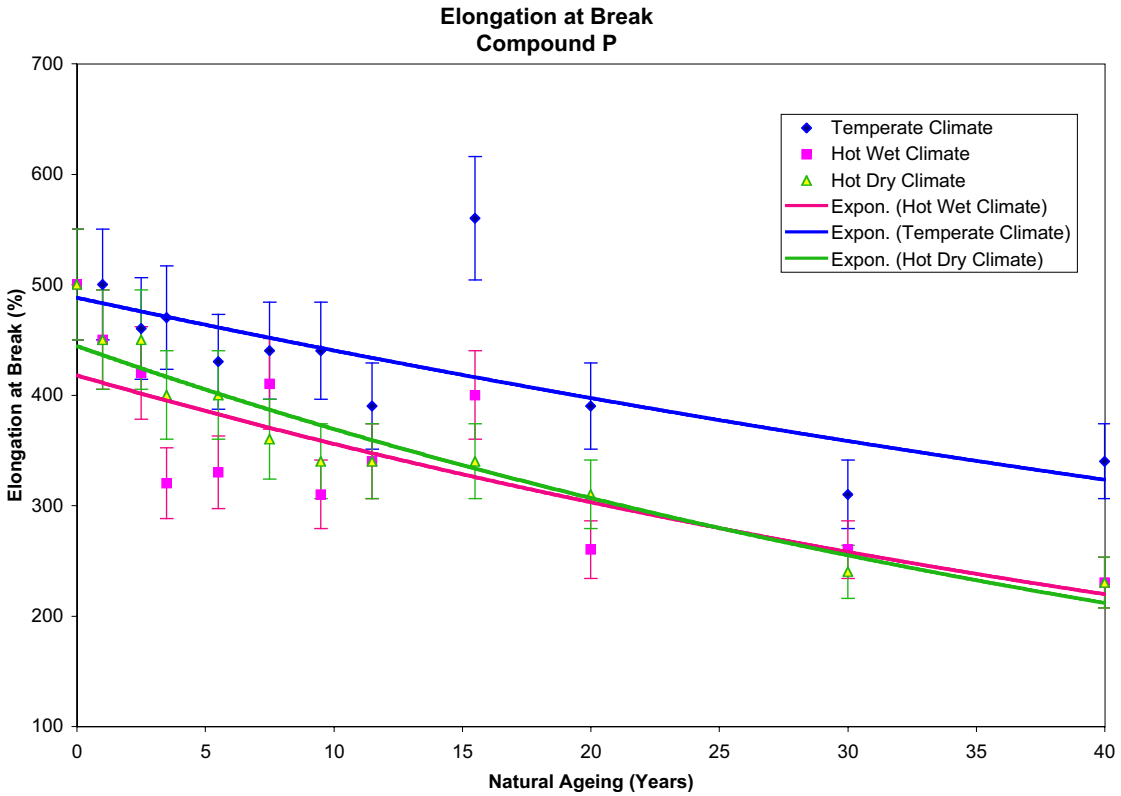

Hardness
Compound P
Hardness (IRHD)
Natural Ageing (Years)
80
70
60
50
40
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

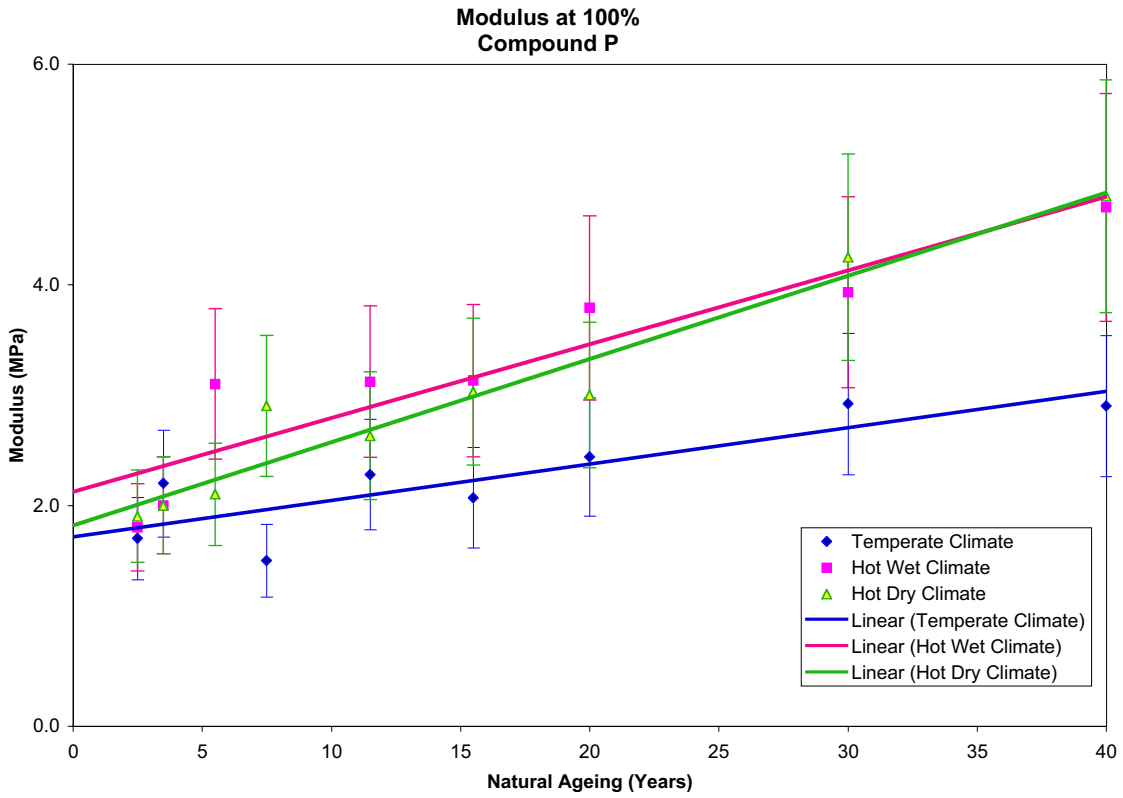

Volume Change
Compound P
Volume Change (%)
Natural Ageing (Years)
30
20
10
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

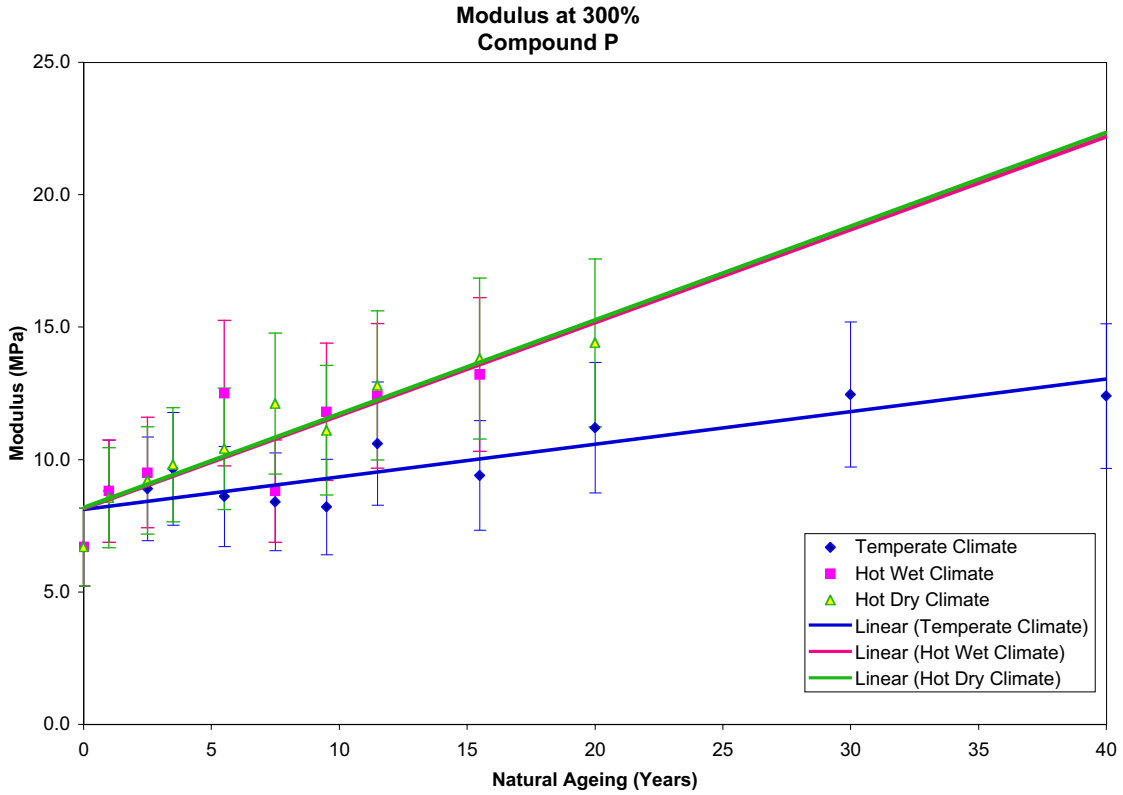


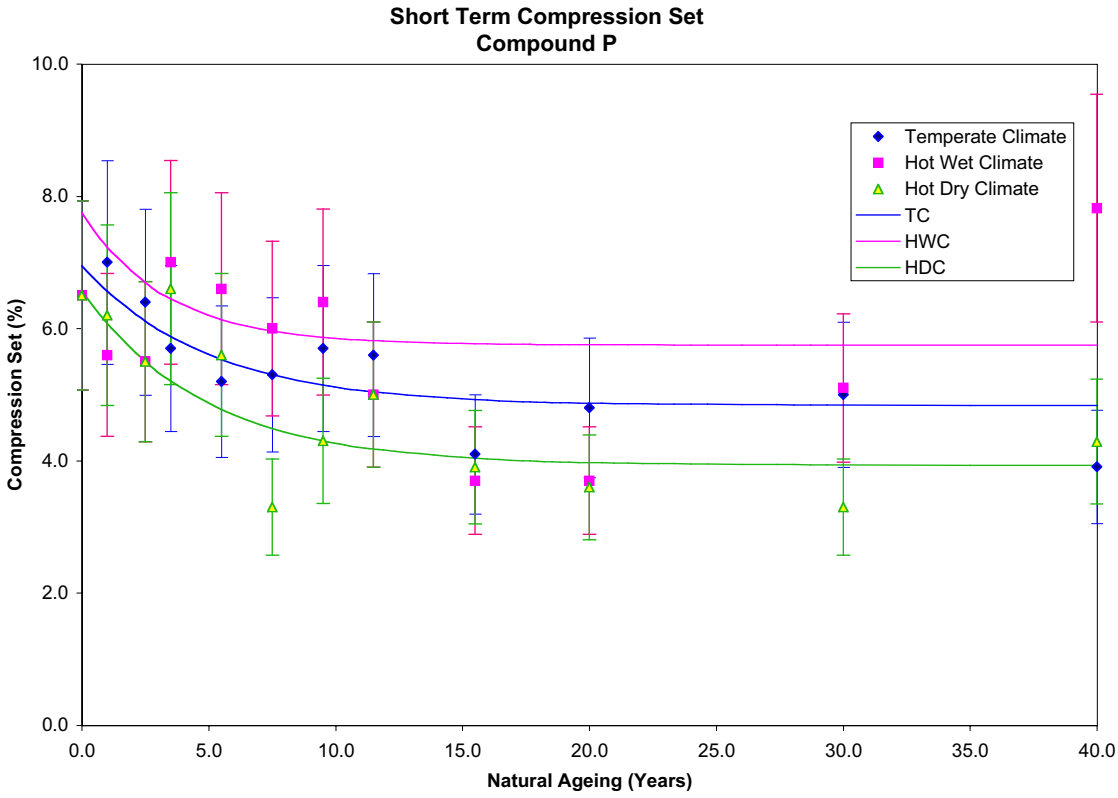


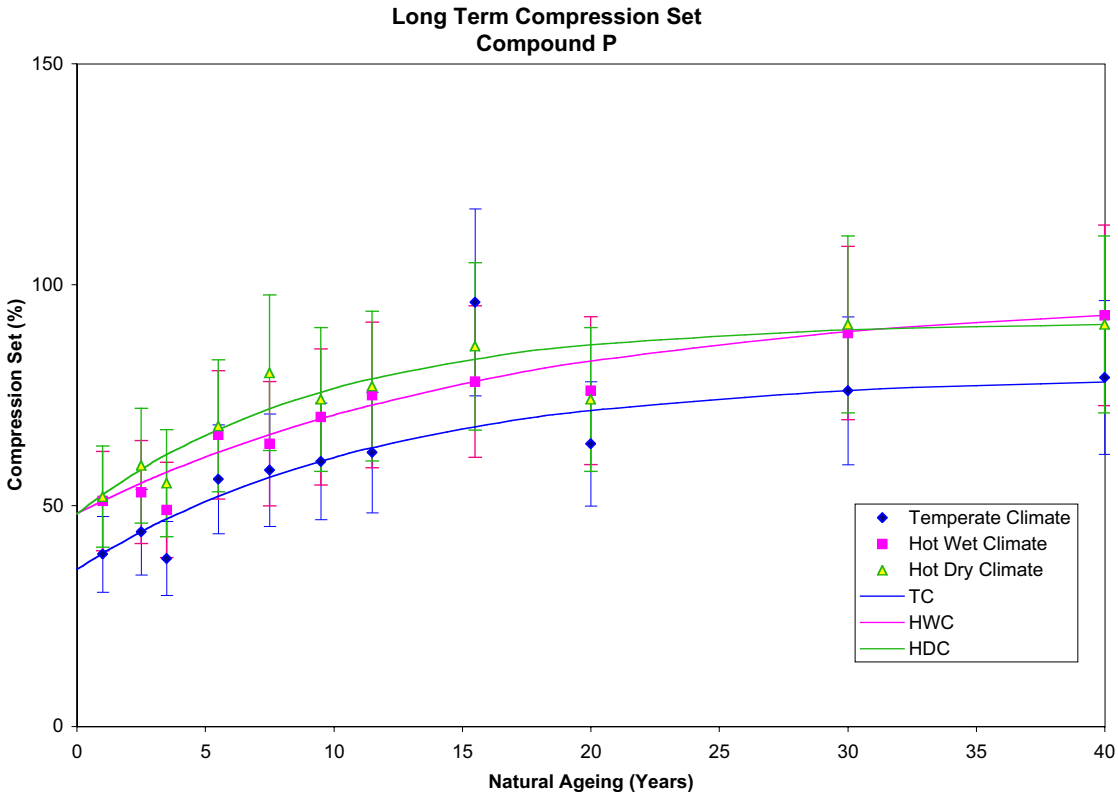

Tensile Strength
Compound P
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
25.0
20.0
15.0
10.0
5.0
0
5
10
15
20
25
30
35
40

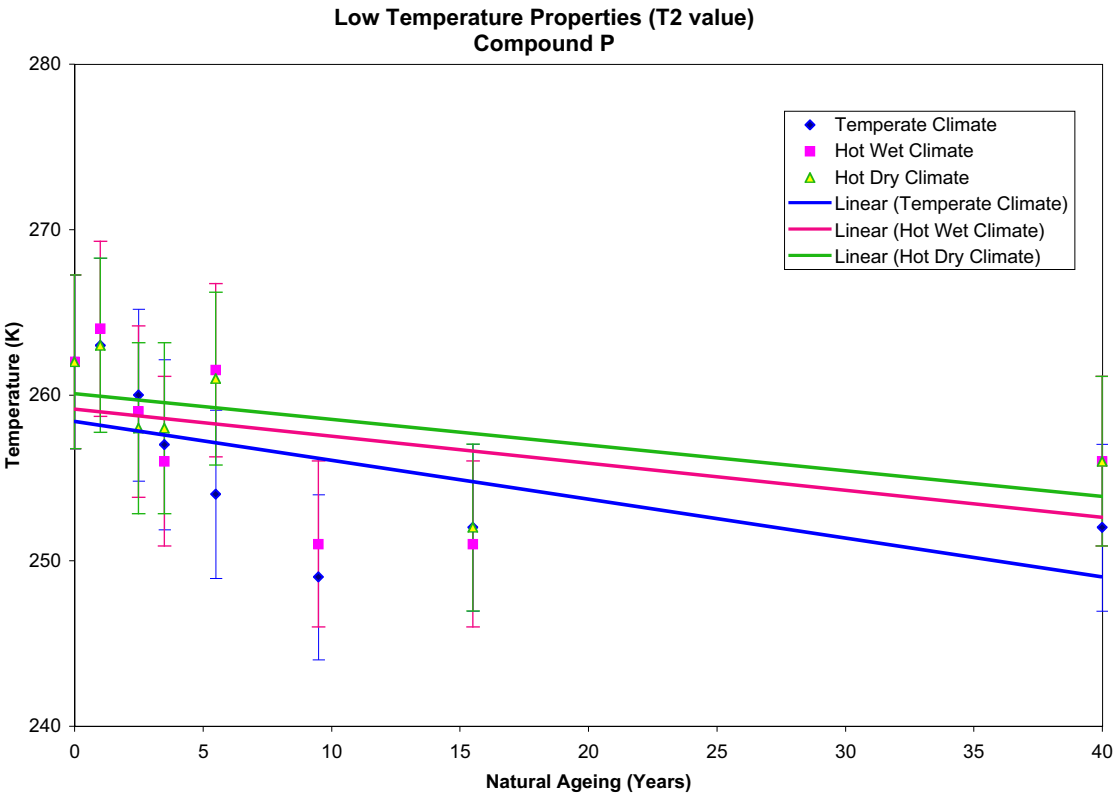

Elongation at Break
Compound P
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)
700
600
500
400
300
200
100
0
5
10
15
20
25
30
35
40

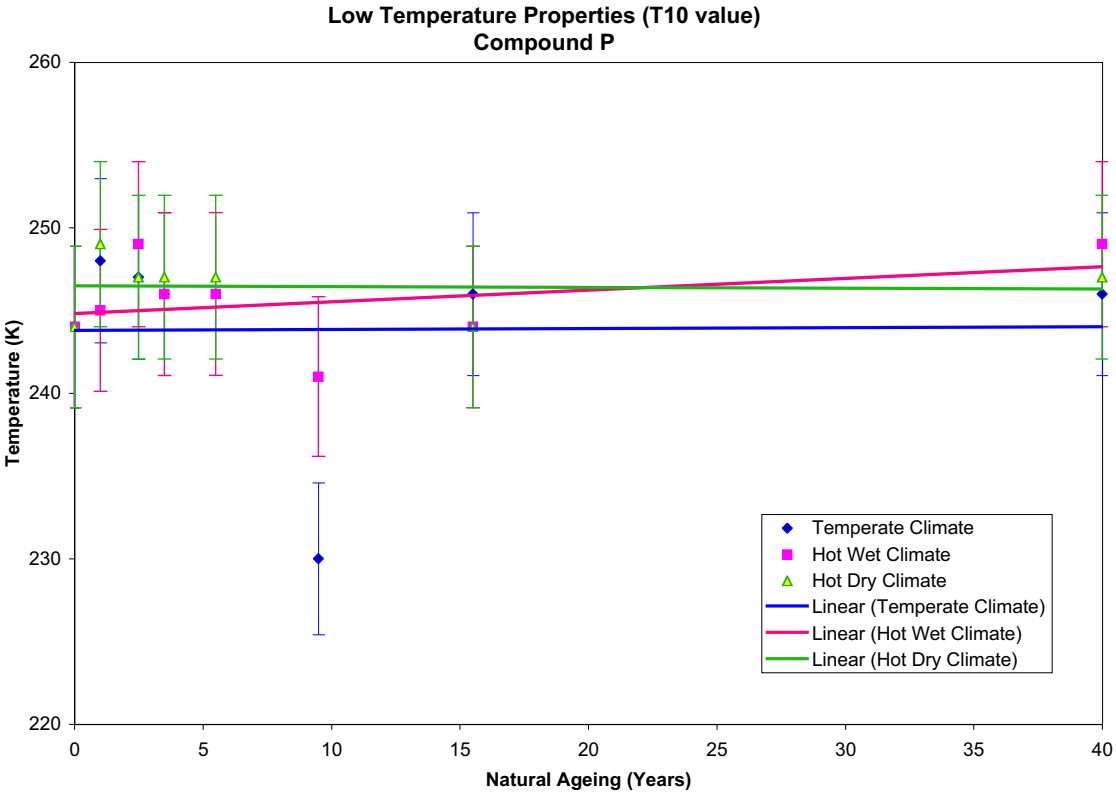





Short Term Compression Set
Compound P
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
10.0
8.0
6.0
4.0
2.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

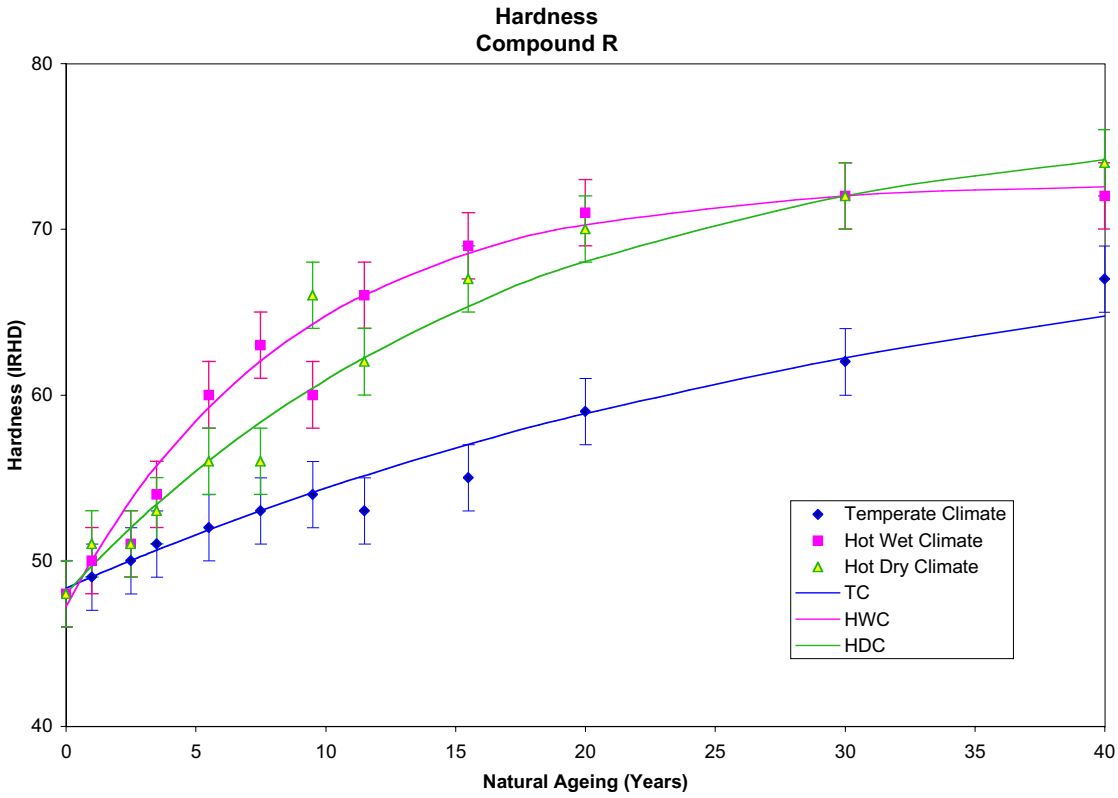

Long Term Compression Set
Compound P
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
150
100
50
0
0
5
10
15
20
25
30
35
40

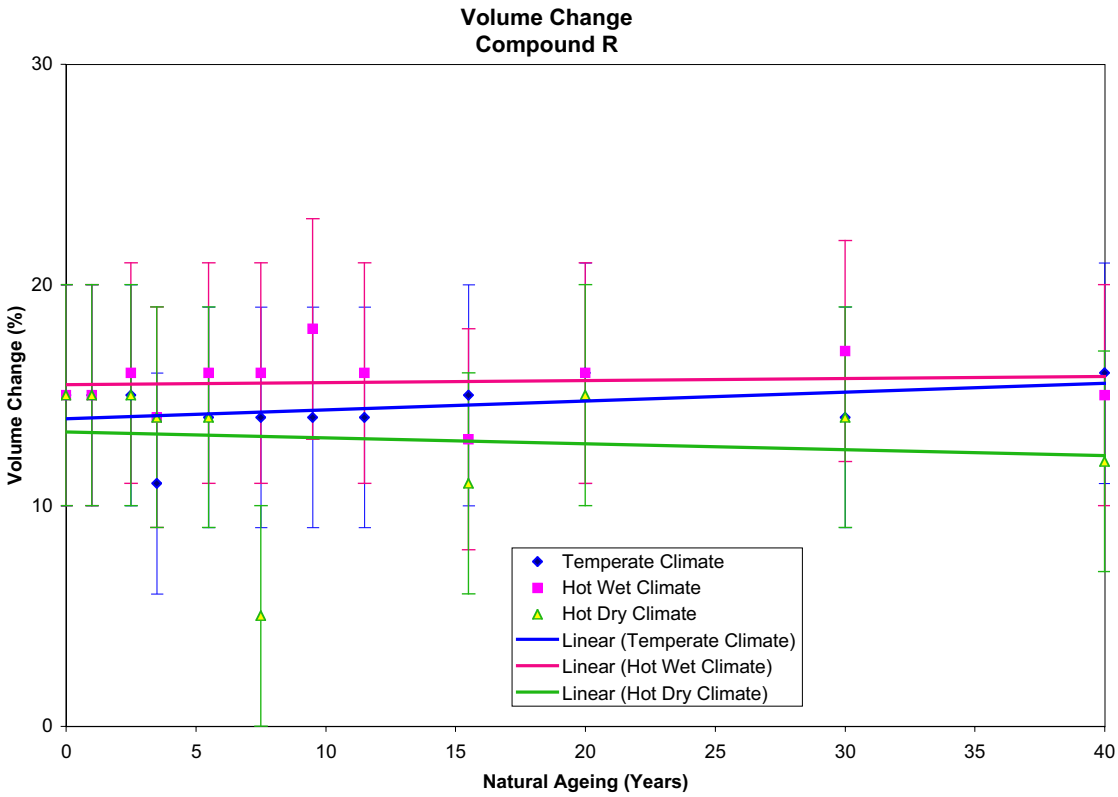


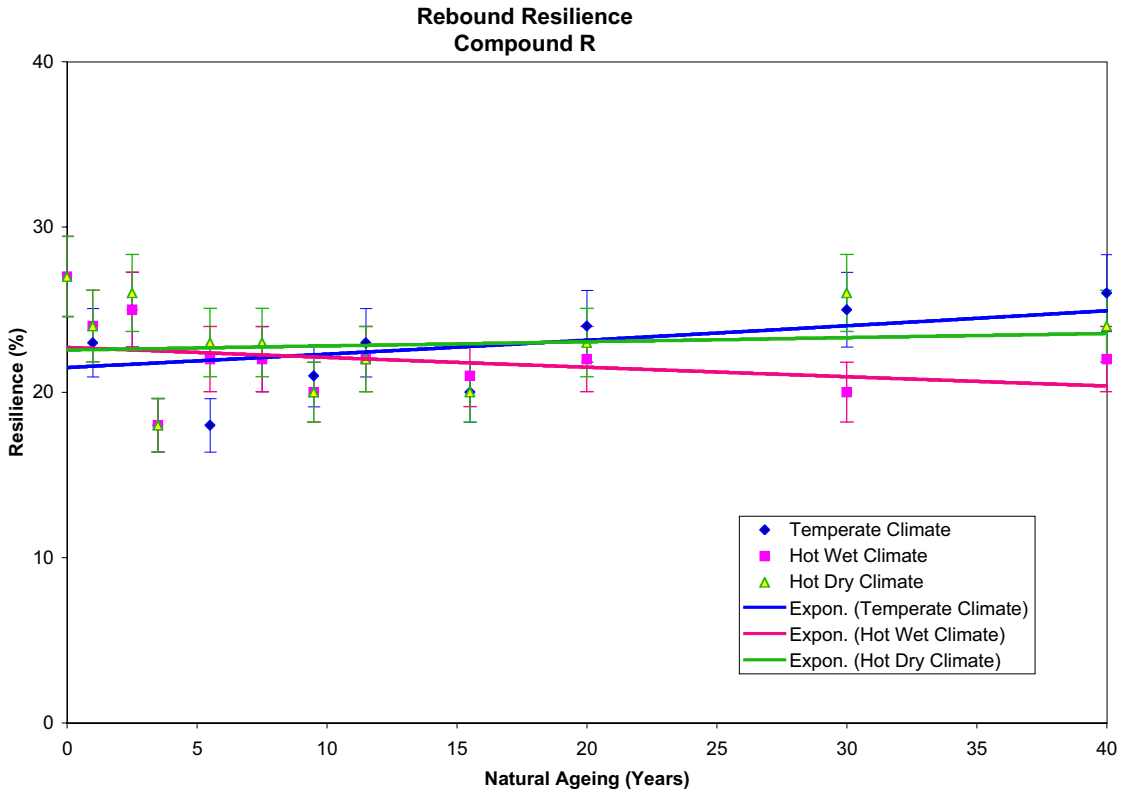


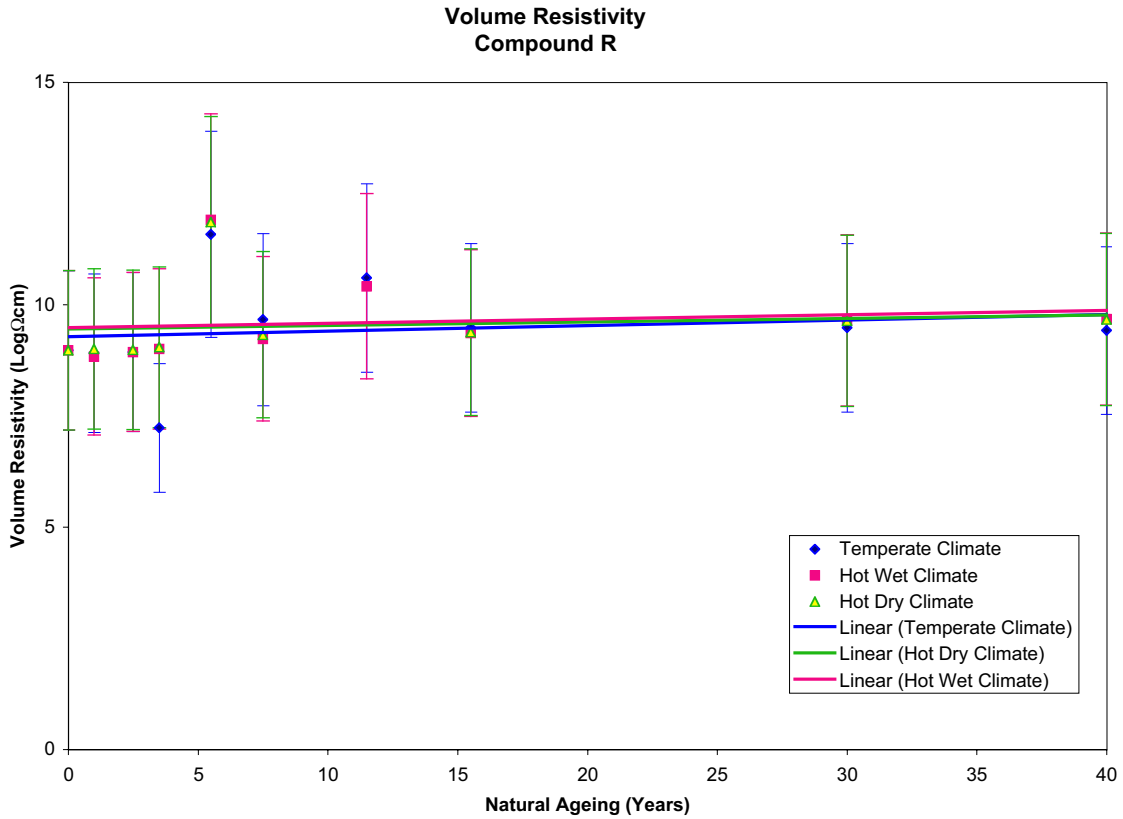
Extrapolated unaged and 40 years natural ageing data: Compound R (nitrile rubber - good ageing)

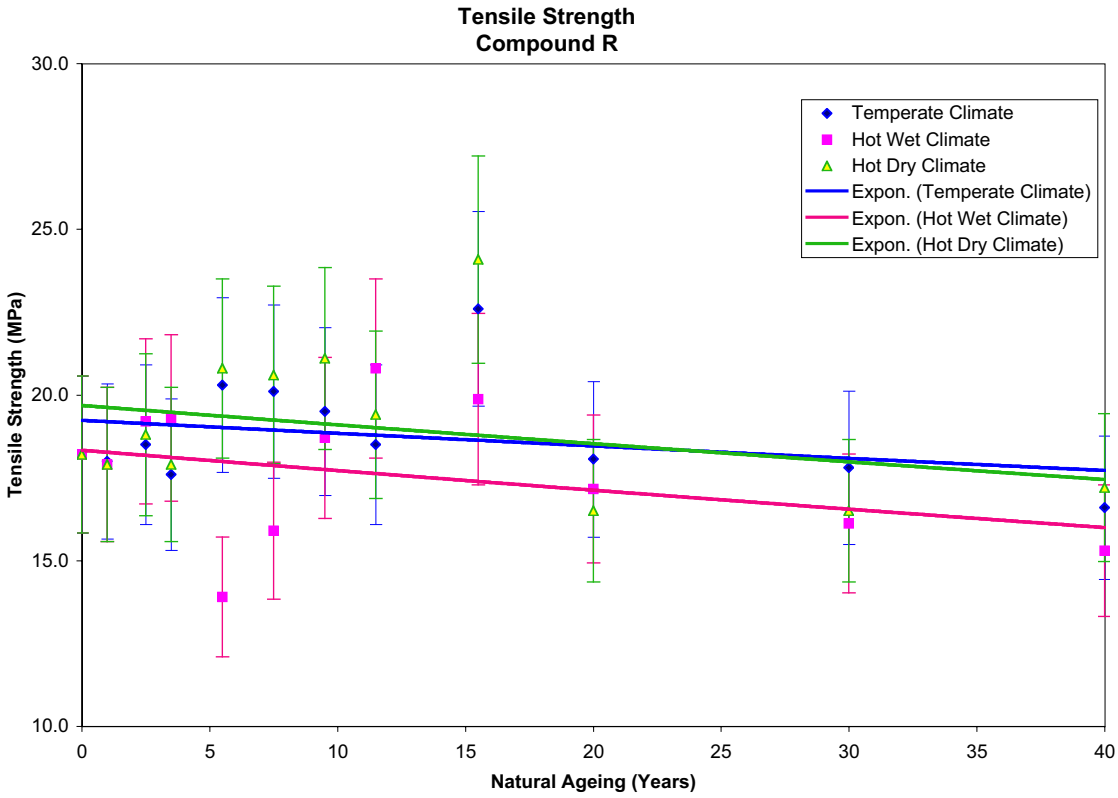
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	48.3	64.8	17	34	47.2	72.6	25	54	48.0	74.2	26	55
Volume Change (%)	13.9	15.5	1.6	12	15.5	15.9	0.4	2.6	13.4	12.3	-1.1	-8.2
Rebound Resilience (%)	21.5	25.0	3.5	16	22.7	20.3	-2.4	-11	22.7	23.7	1.0	4.4
Volume Resistivity (LogΩcm)	9.31	9.81	0.50	5.4	9.50	9.88	0.38	4.0	9.50	9.81	0.31	3.3
Tensile Properties												
Tensile Strength (MPa)	19.3	17.7	-1.6	-8.3	18.3	16.0	-2.3	-13	19.7	17.5	-2.2	-11
Elongation at Break (%)	628	450	-178	-28	585	370	-215	-37	593	347	-247	-42
Modulus at 100% (MPa)	1.30	2.94	1.6	126	1.75	4.00	2.3	129	1.65	4.55	2.9	176
Modulus at 300% (MPa)	6.67	10.8	4.1	62	6.67	12.8	6.1	92	6.67	14.0	7.3	110
Compression Set												
Short Term (%)	6.63	4.88	-1.8	-26	7.63	4.31	-3.3	-44	6.13	4.59	-1.5	-25
Long Term (%)	0.0	81.9			0.0	92.5			0.0	93.0		
Low Temperature Properties												
T2 Value (K)	267	264	-3.4	-1.3	267	265	-1.3	-0.5	267	264	-3.4	-1.3
T10 Value (K)	258	258	-0.20	-0.1	259	260	1.0	0.4	259	259	0.10	0.0

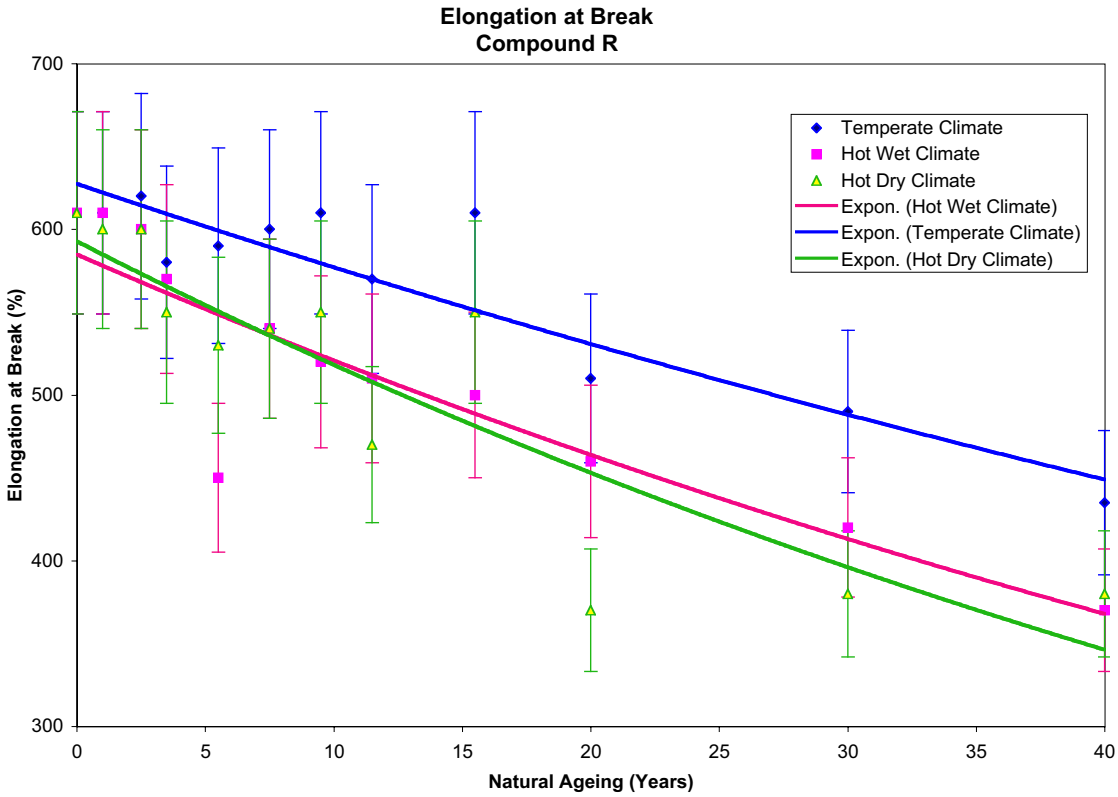

Hardness
Compound R
Hardness (IRHD)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

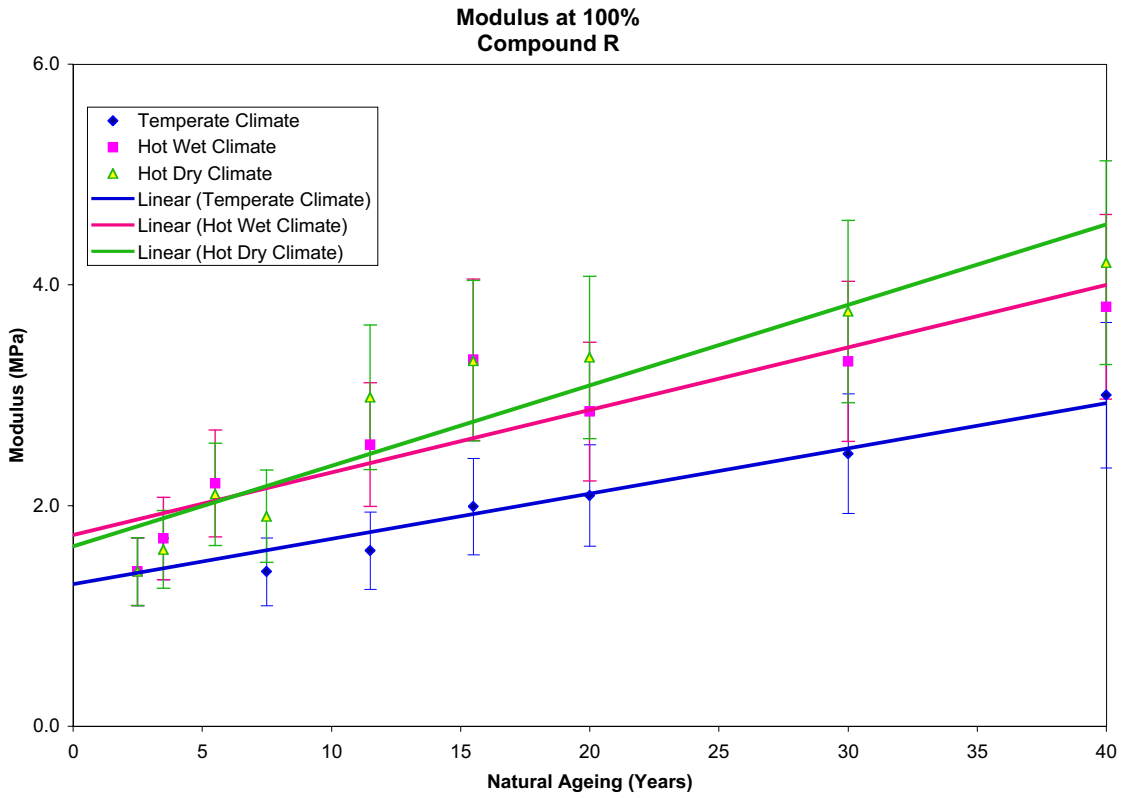

Volume Change
Compound R
Volume Change (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

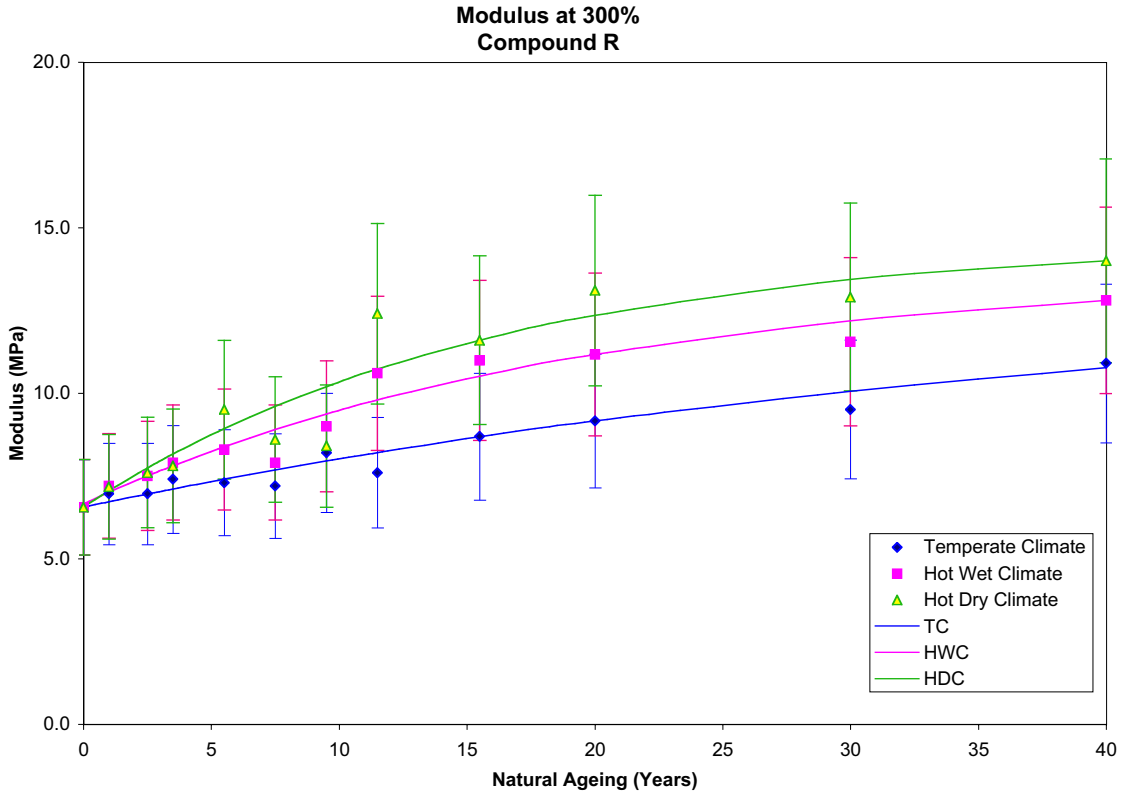


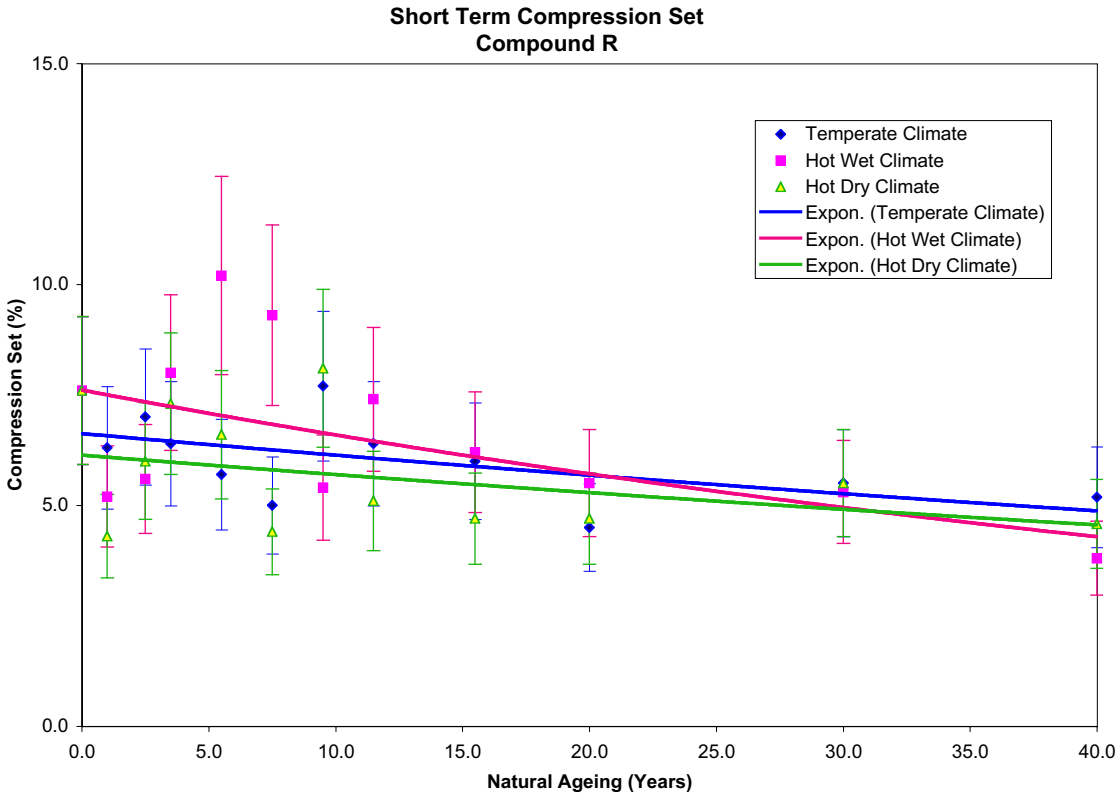


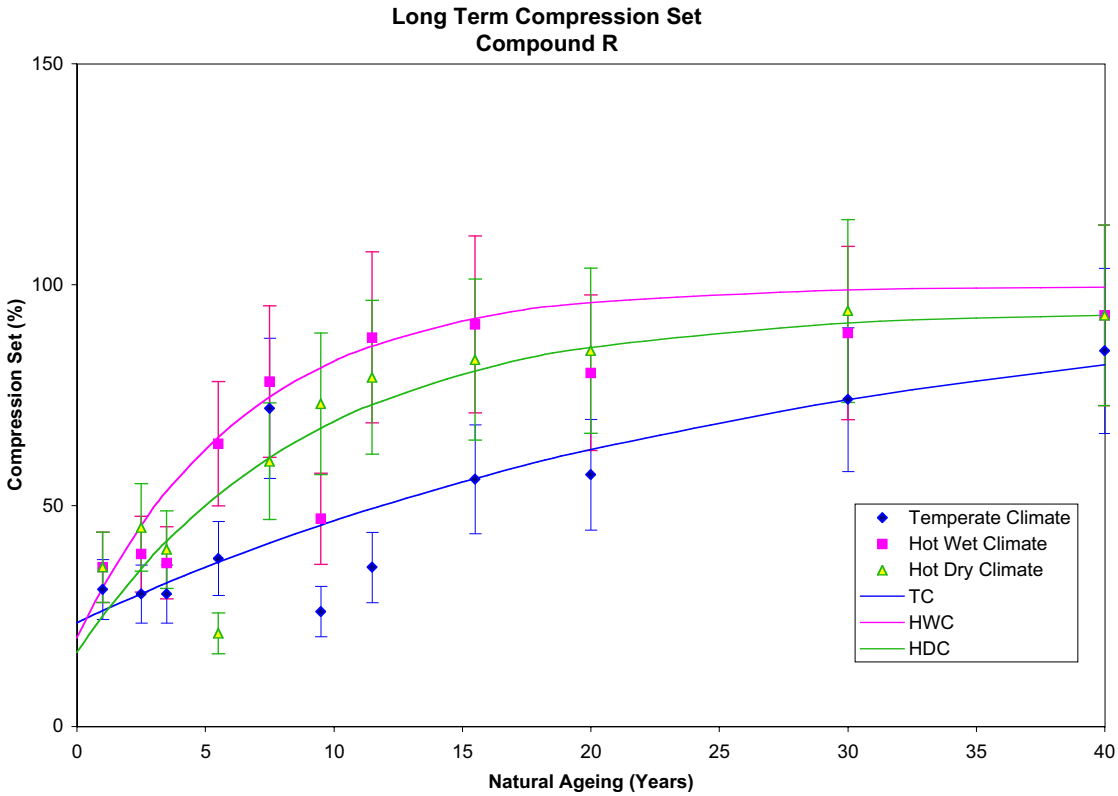

Tensile Strength
Compound R
Tensile Strength (MPa)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
30.0
25.0
20.0
15.0
10.0
0
5
10
15
20
25
30
35
40

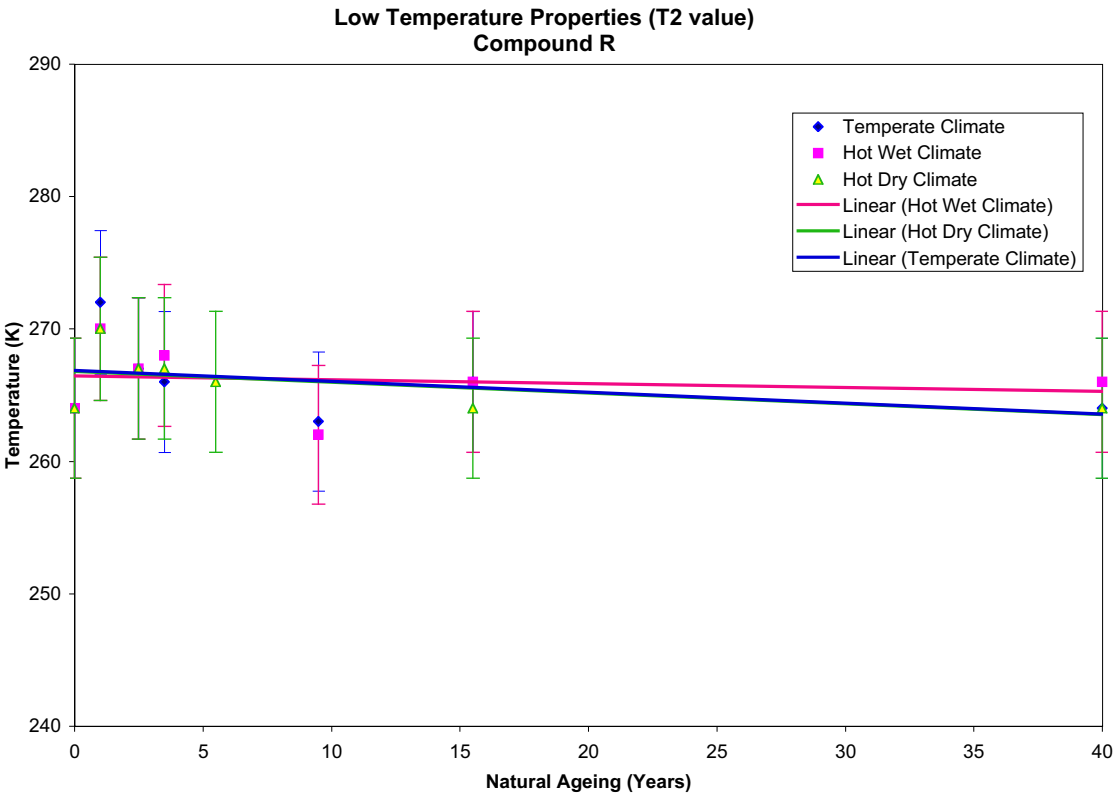

Elongation at Break
Compound R
Elongation at Break (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)
700
600
500
400
300
0
5
10
15
20
25
30
35
40

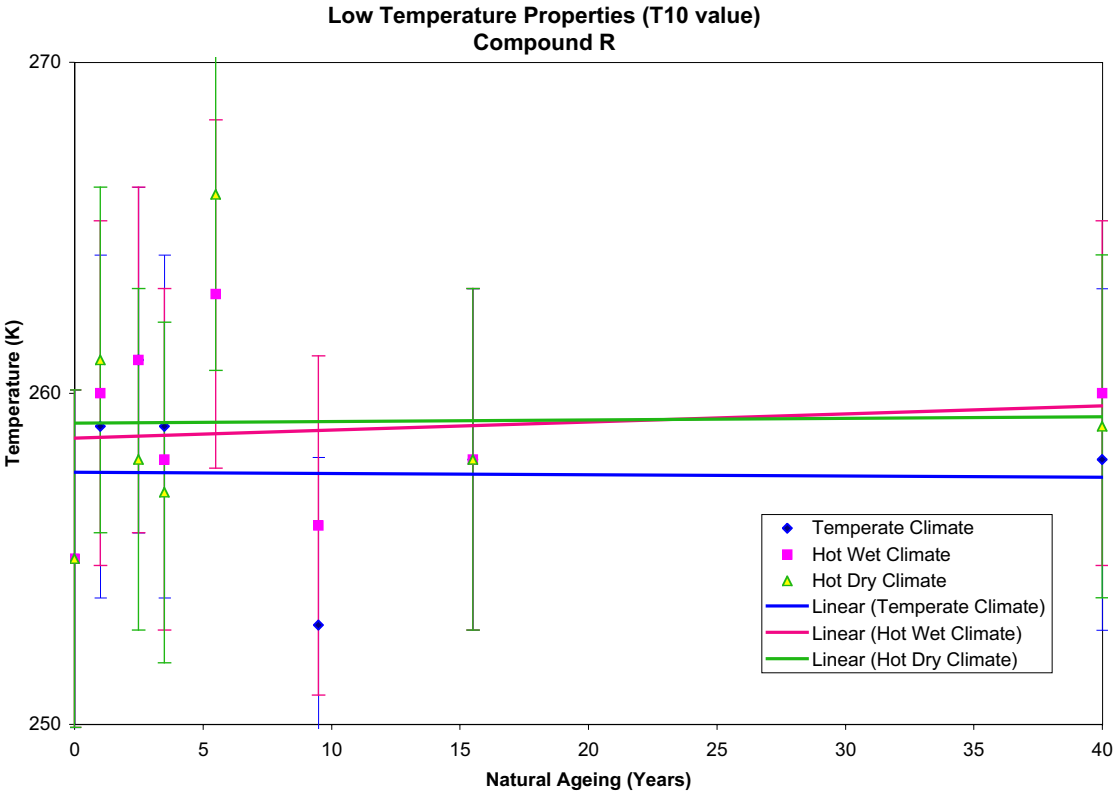





Short Term Compression Set
Compound R
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

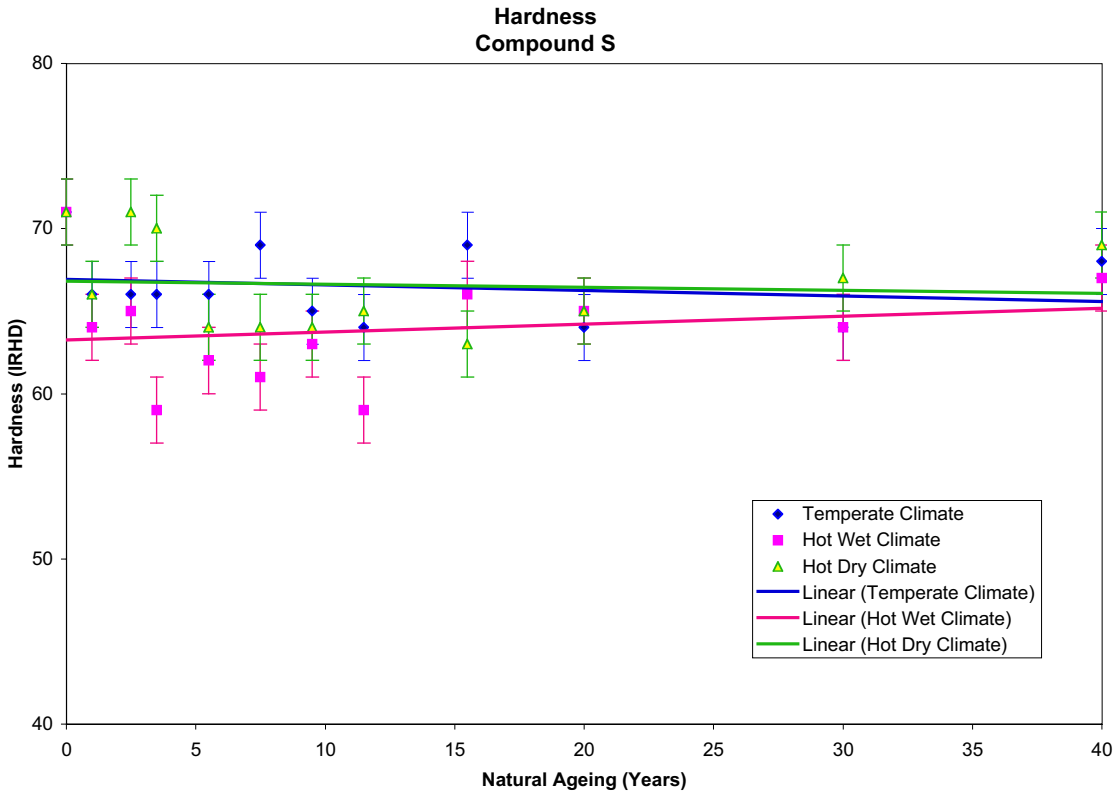

Long Term Compression Set
Compound R
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
0
50
100
150
0
5
10
15
20
25
30
35
40

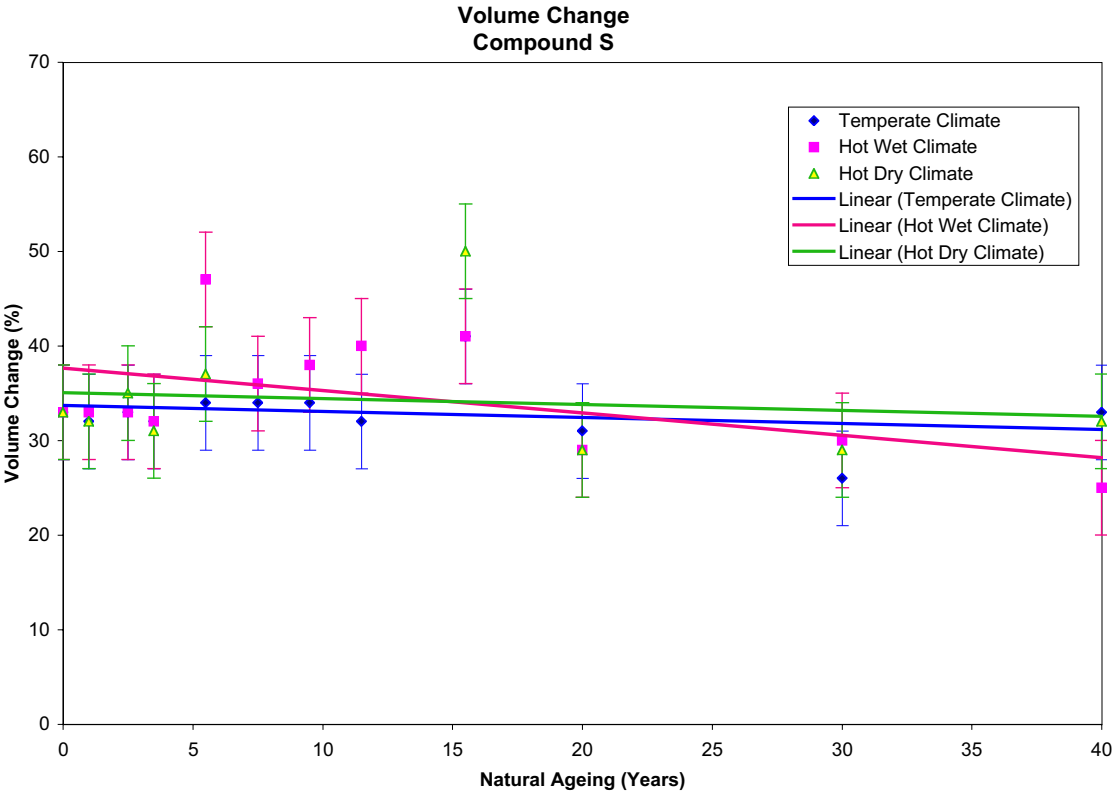


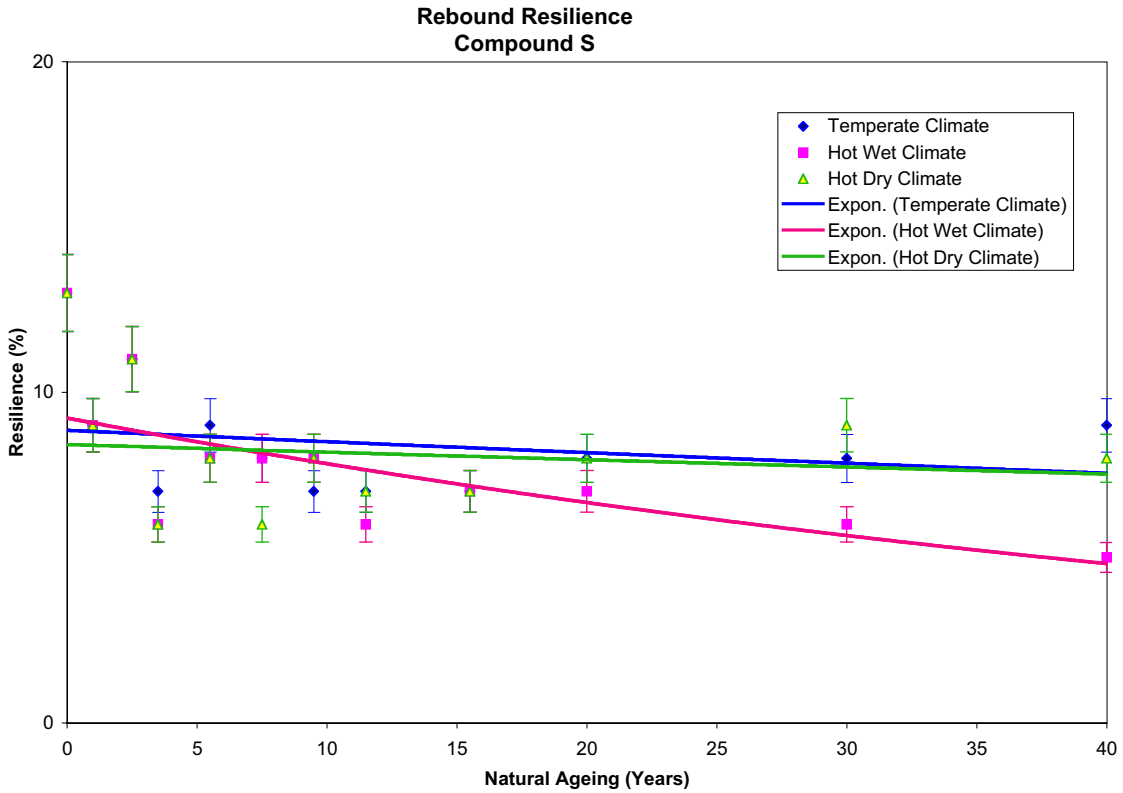


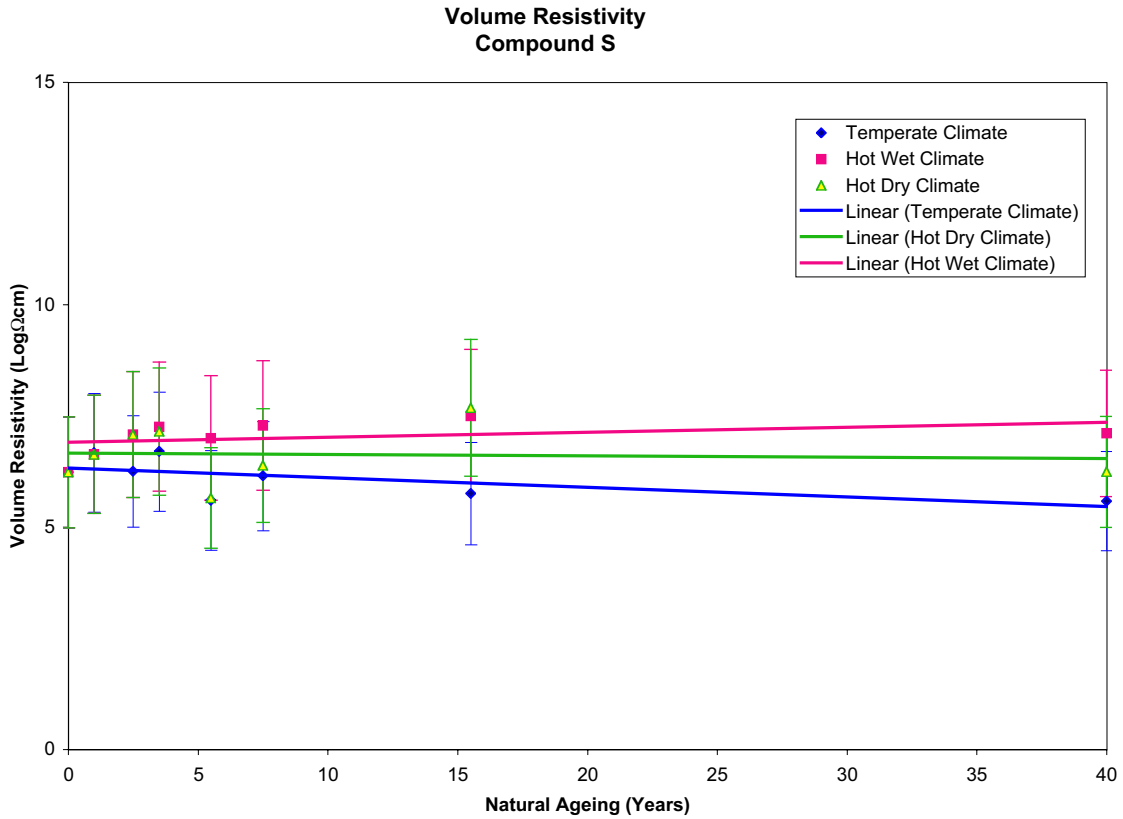
Extrapolated unaged and 40 years natural ageing data: Compound S (acrylate rubber)

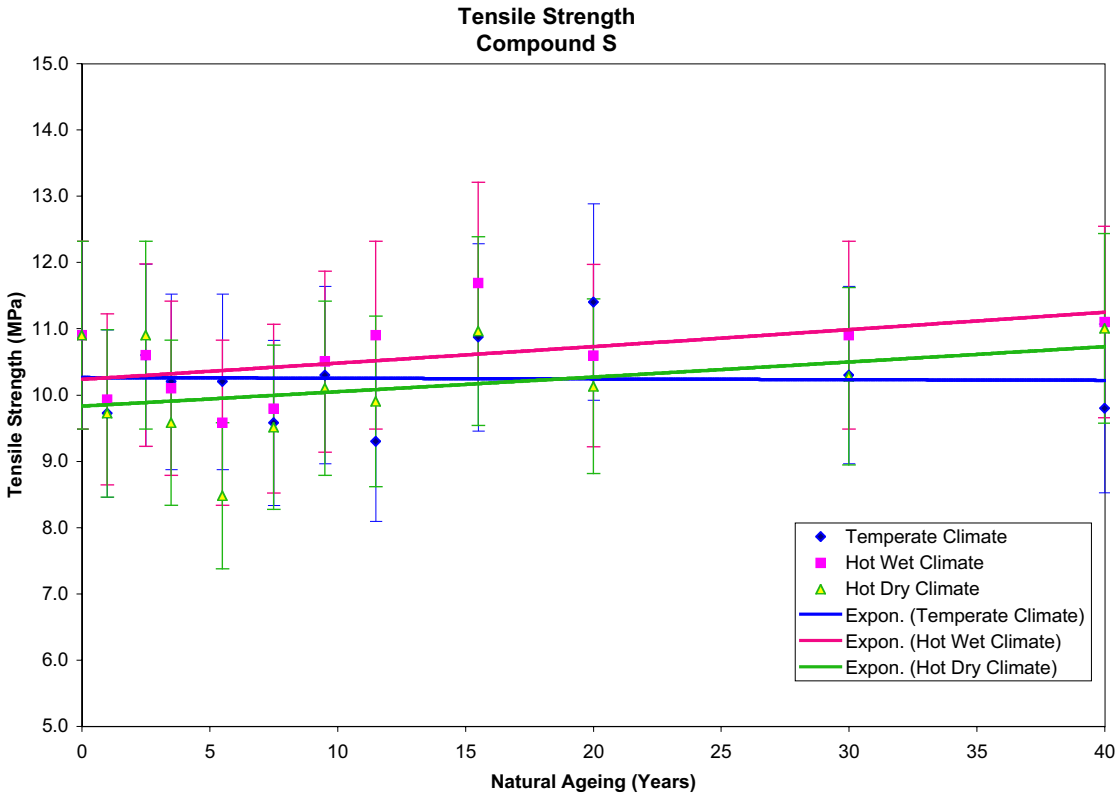
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	69.0	65.7	-3.3	-4.8	69.0	65.2	-3.8	-5.5	69.0	66.2	-2.8	-4.1
Volume Change (%)	33.8	31.2	-2.6	-7.7	37.9	28.3	-9.6	-25	33.8	32.7	-1.1	-3.3
Rebound Resilience (%)	8.83	7.58	-1.3	-14	9.25	4.83	-4.4	-48	8.42	7.58	-0.84	-10
Volume Resistivity (LogΩcm)	6.31	5.50	-0.81	-13	6.94	7.38	0.44	6.3	6.63	6.56	-0.07	-1.1
Tensile Properties												
Tensile Strength (MPa)	10.2	10.2	0.0	0.0	10.2	11.2	1.0	10	9.87	10.7	0.83	8.4
Elongation at Break (%)	148	140	-8.1	-5.5	149	145	-4.4	-2.9	139	134	-4.4	-3.2
Modulus at 100% (MPa)	7.06	6.97	-0.09	-1.3	7.00	7.41	0.41	5.9	7.37	8.06	0.69	9.4
Modulus at 300% (MPa)	-	-			-	-			-	-		
Compression Set												
Short Term (%)	4.92	5.33	0.41	8.3	5.04	4.31	-0.73	-14	4.83	4.63	-0.20	-4.1
Long Term (%)	0.0	40.8			0.0	46.5			0.0	61.3		
Low Temperature Properties												
T2 Value (K)	268	269	1.0	0.4	267	270	3.0	1.1	268	270	1.8	0.7
T10 Value (K)	261	262	1.7	0.7	260	263	3.1	1.2	263	264	1.7	0.6

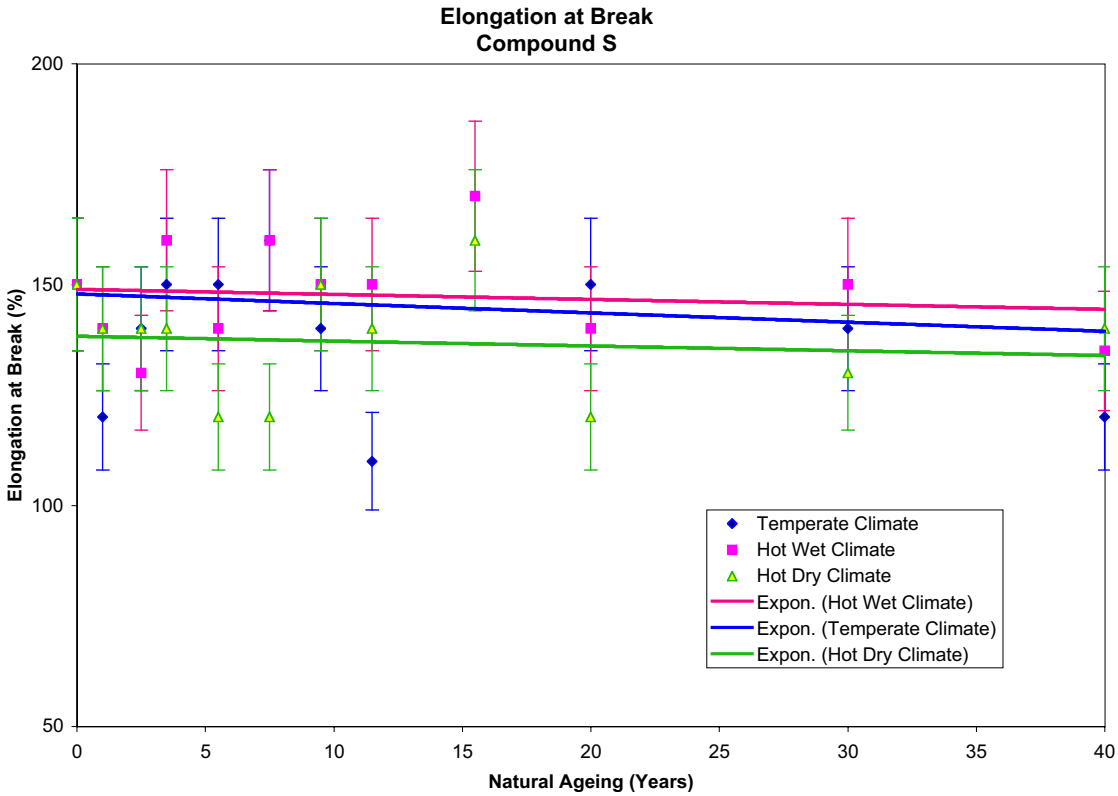

Hardness
Compound S
Hardness (IRHD)
Natural Ageing (Years)
80
70
60
50
40
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

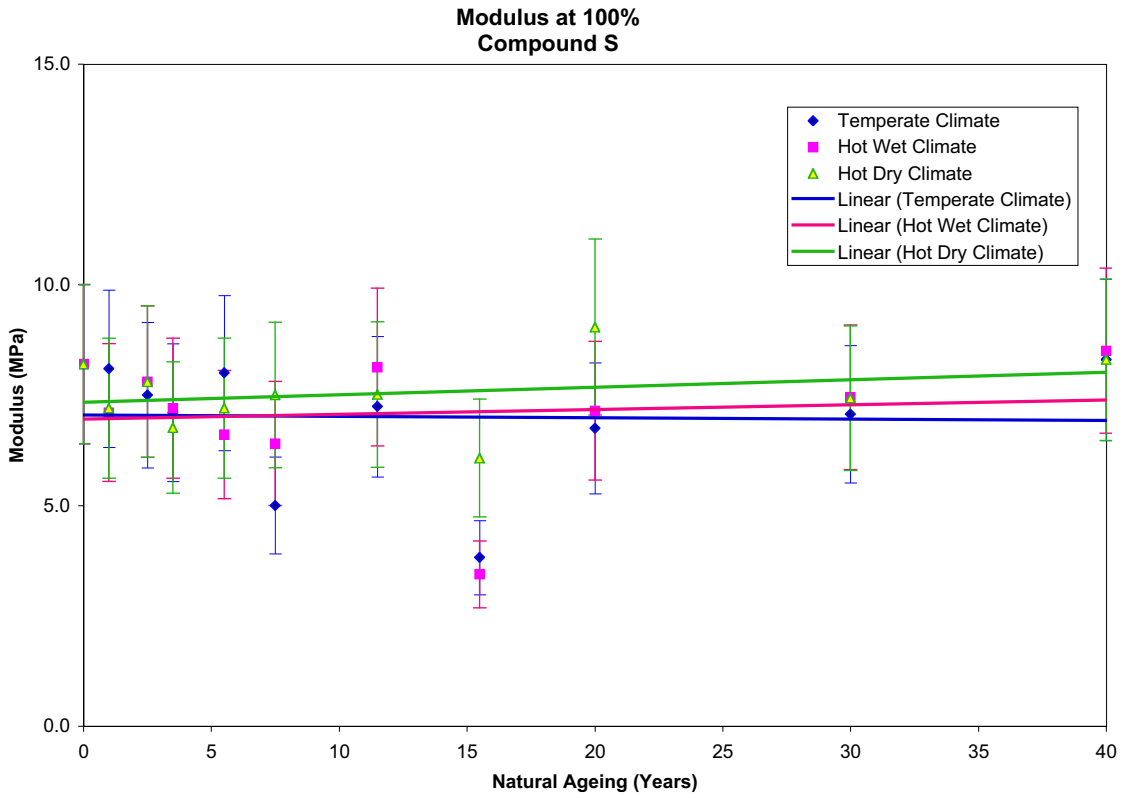

Volume Change
Compound S
Volume Change (%)
Natural Ageing (Years)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

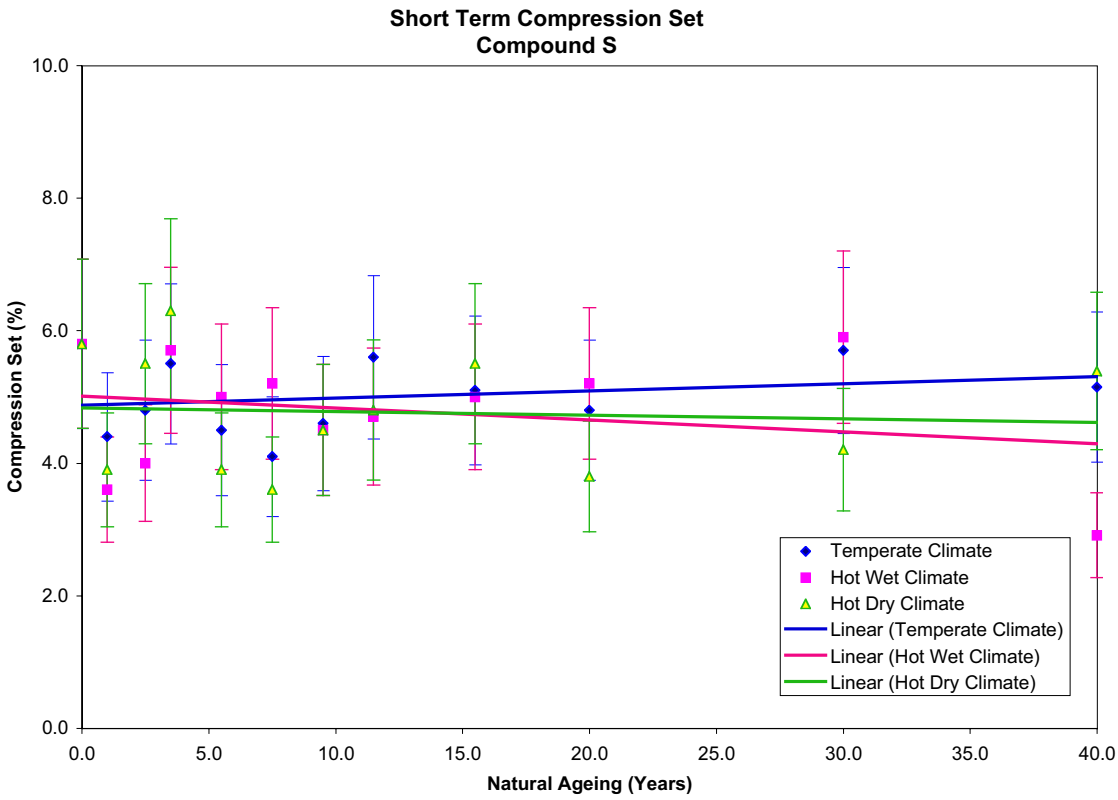


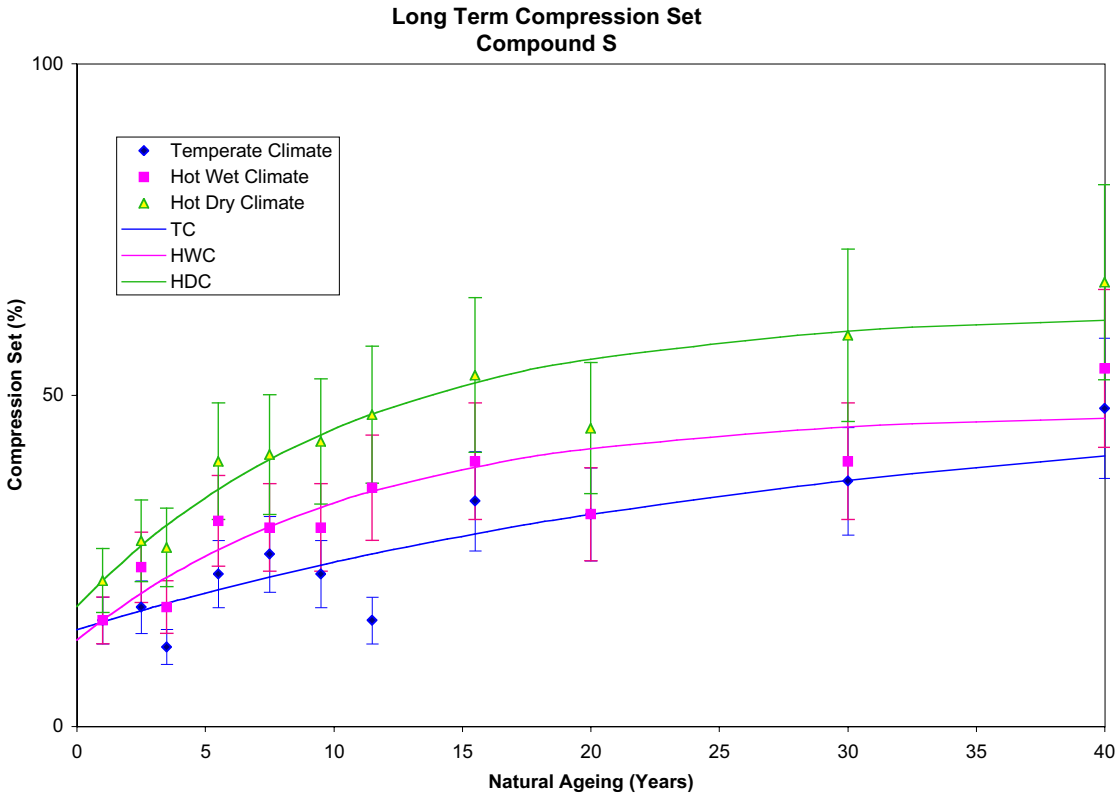


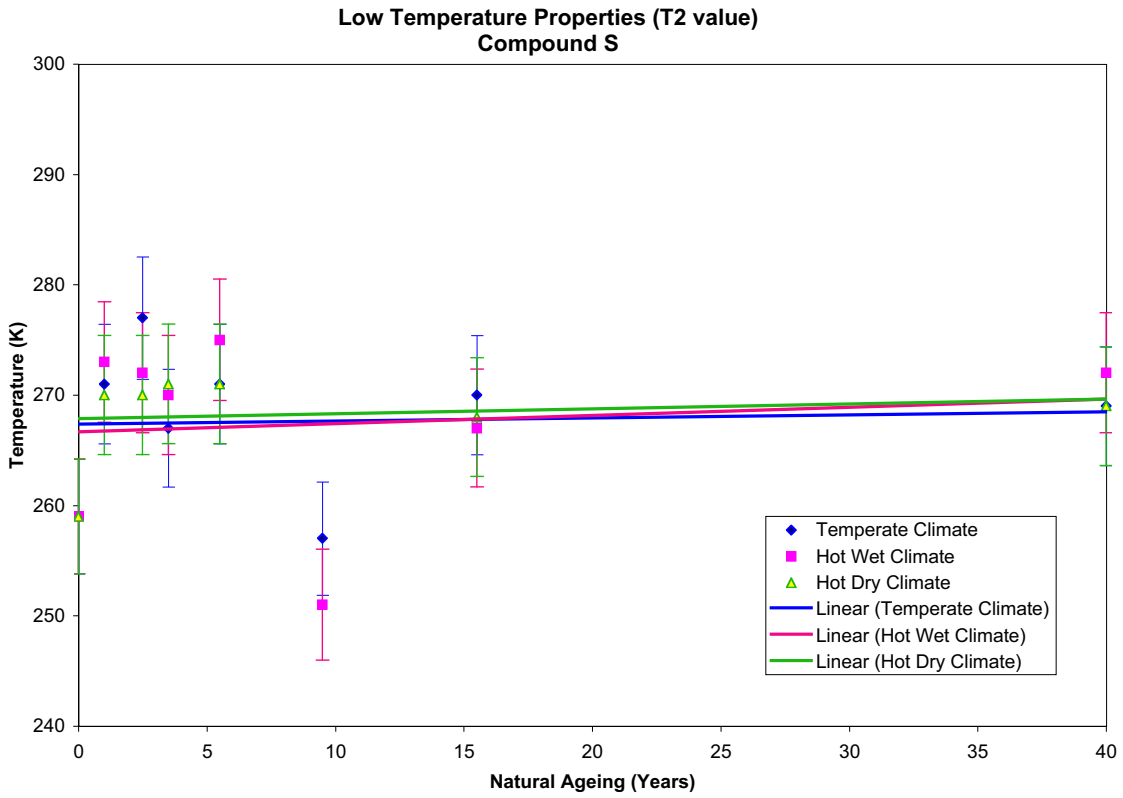

Tensile Strength
Compound S
Tensile Strength (MPa)
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

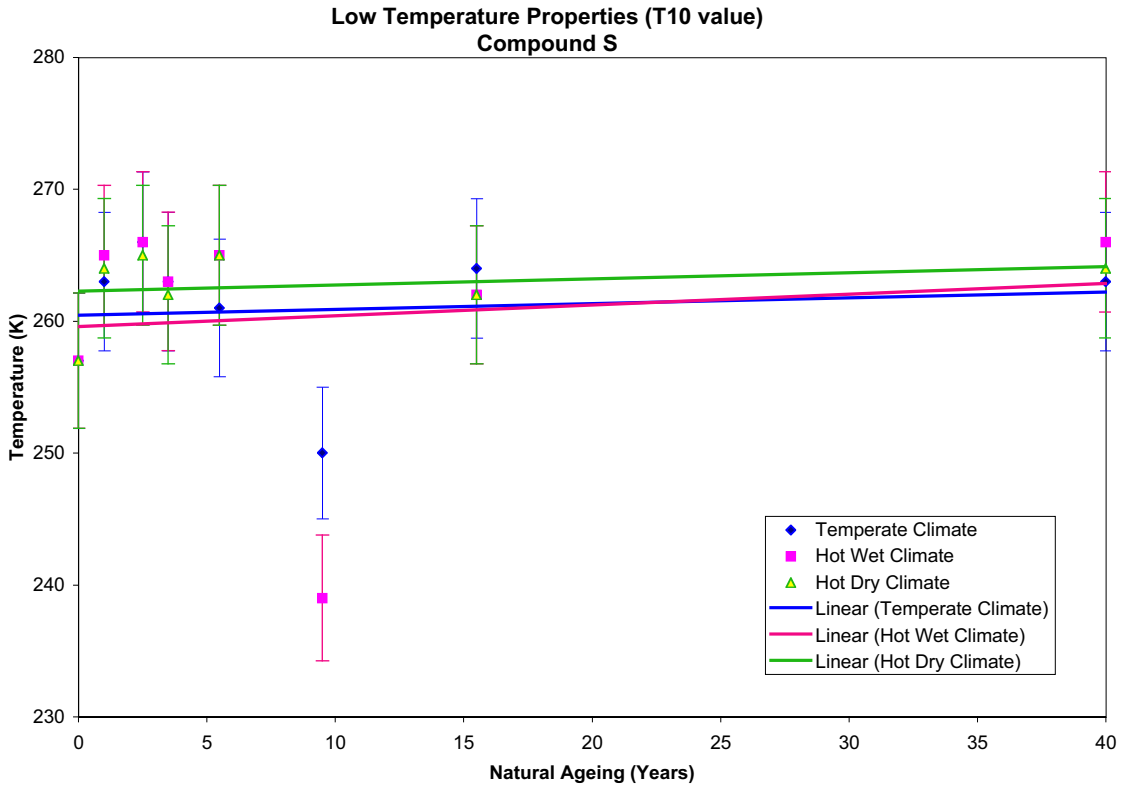

Elongation at Break
Compound S
Elongation at Break (%)
200
150
100
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)




Short Term Compression Set
Compound S
Compression Set (%)
Natural Ageing (Years)
10.0
8.0
6.0
4.0
2.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

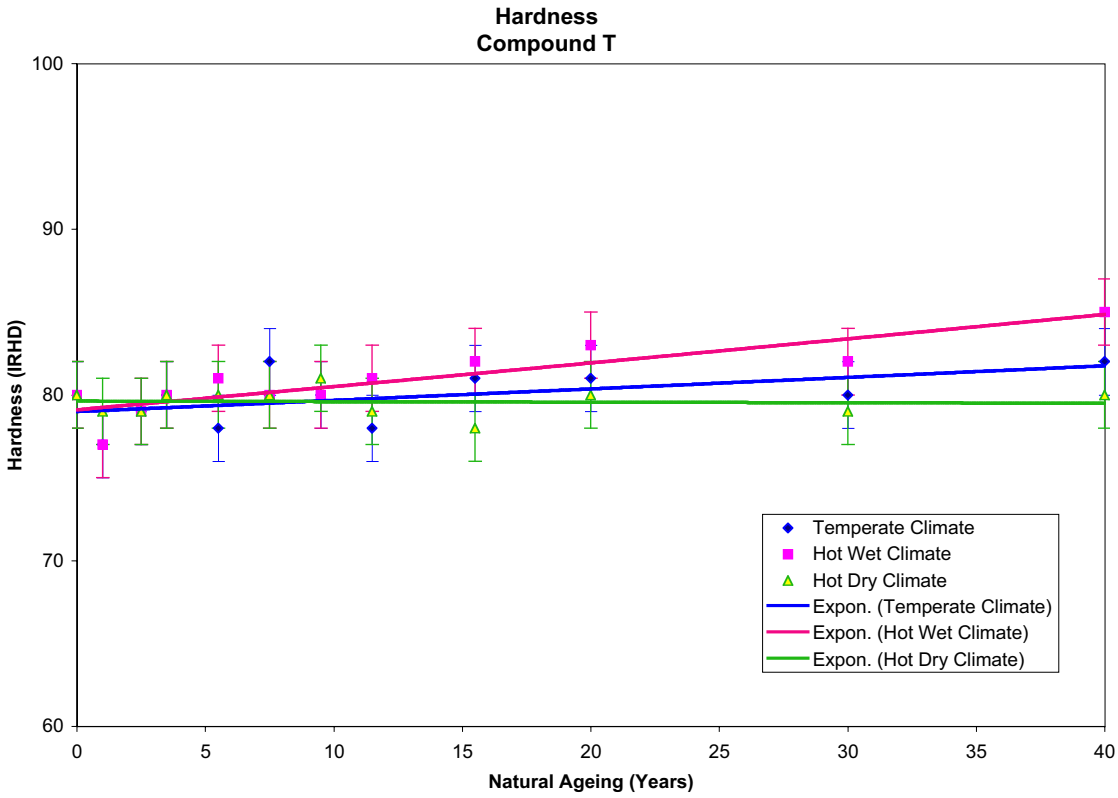

Long Term Compression Set
Compound S
Compression Set (%)
Natural Ageing (Years)
100
50
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

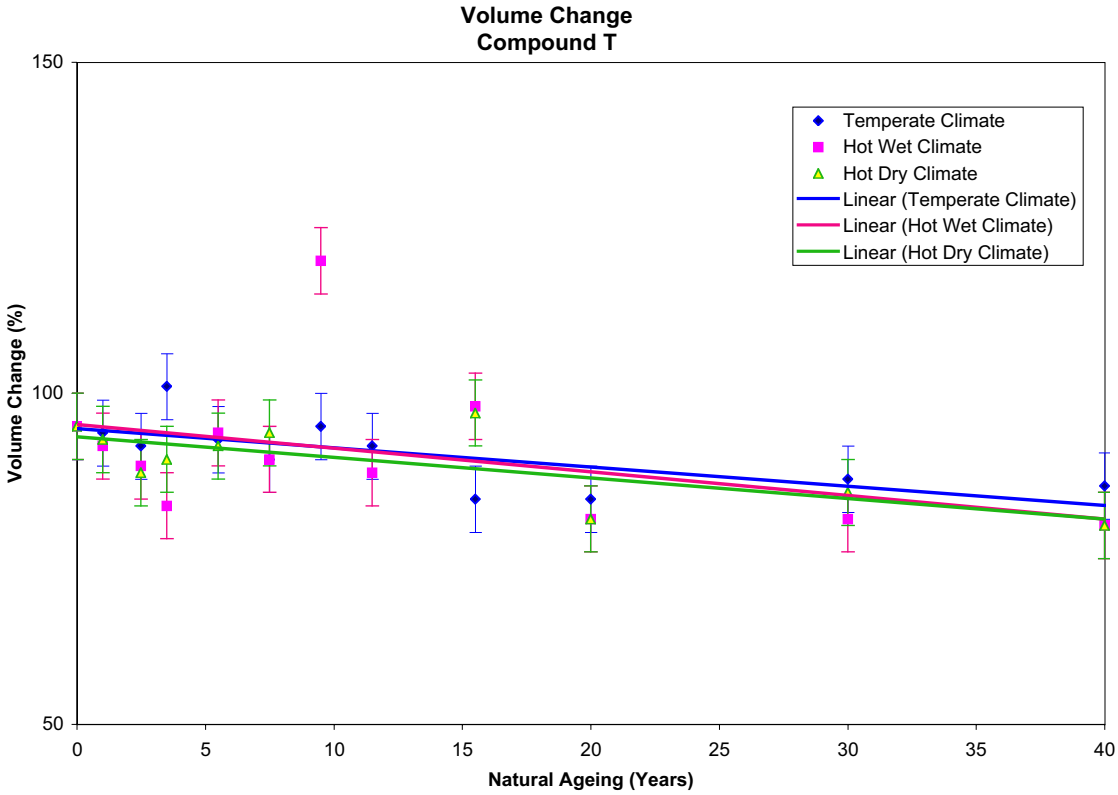


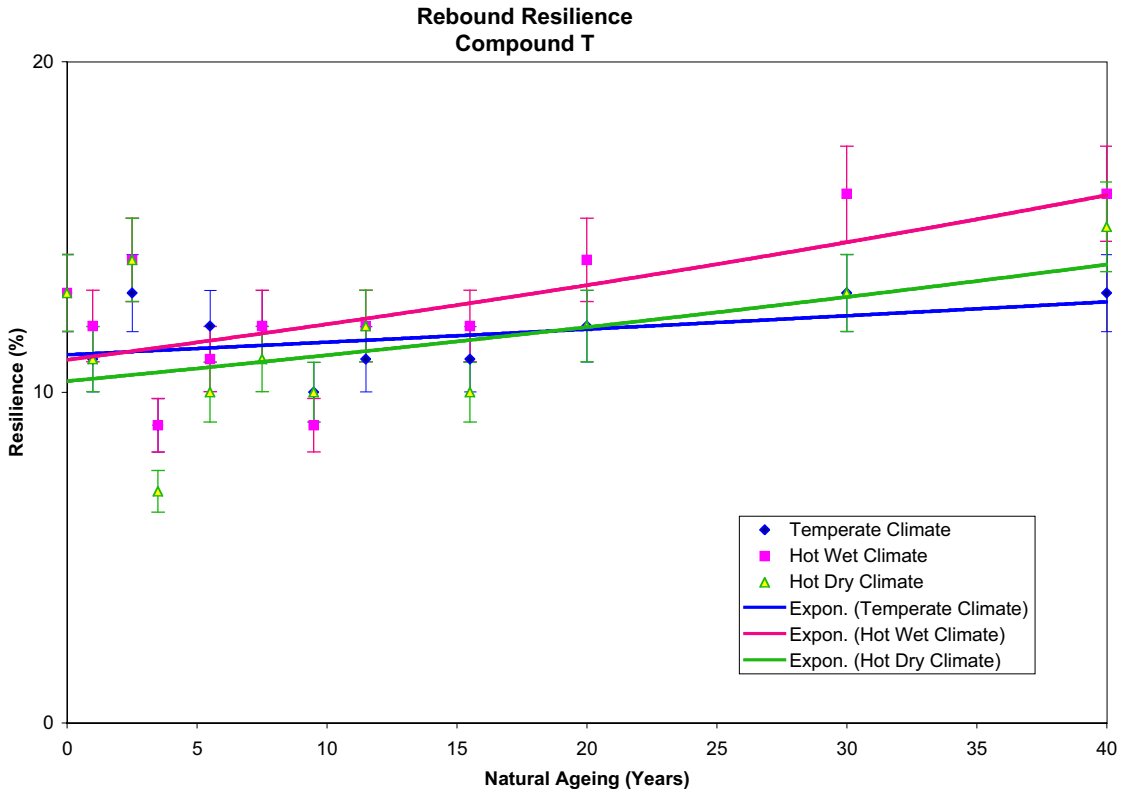


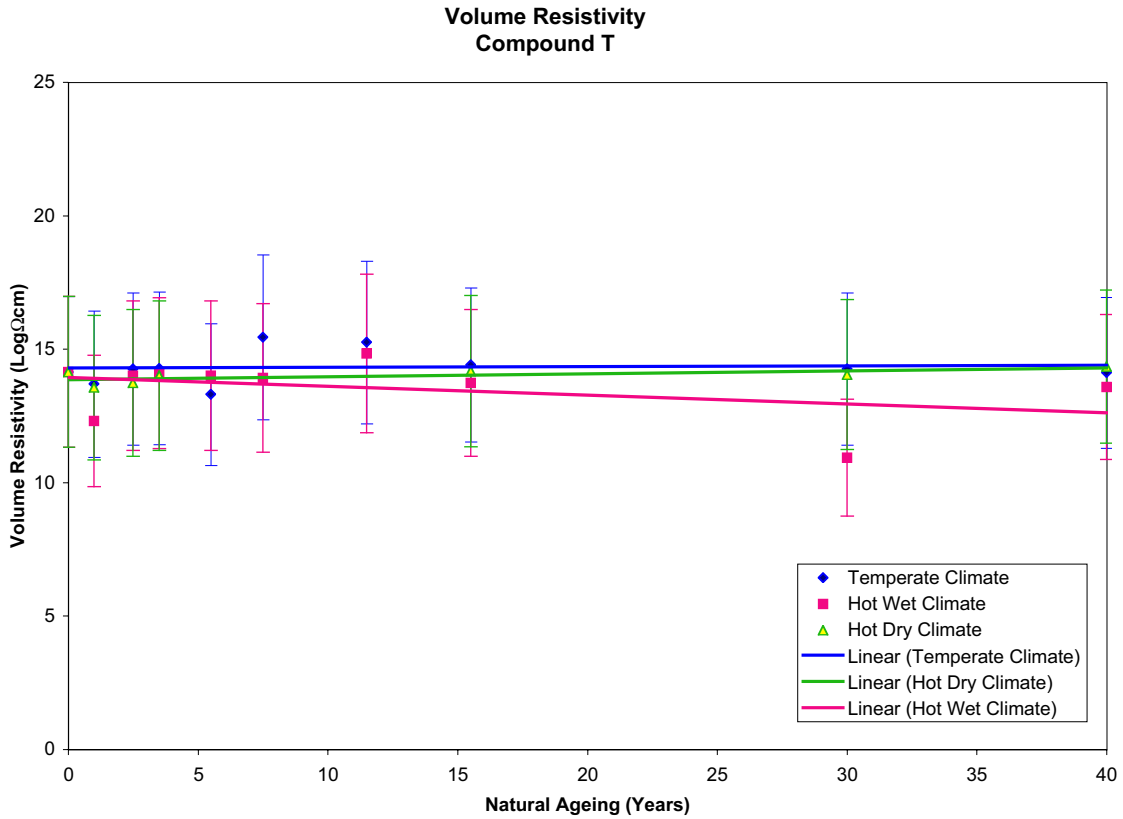
Extrapolated unaged and 40 years natural ageing data: Compound T (chlorosulphonated polyethylene)

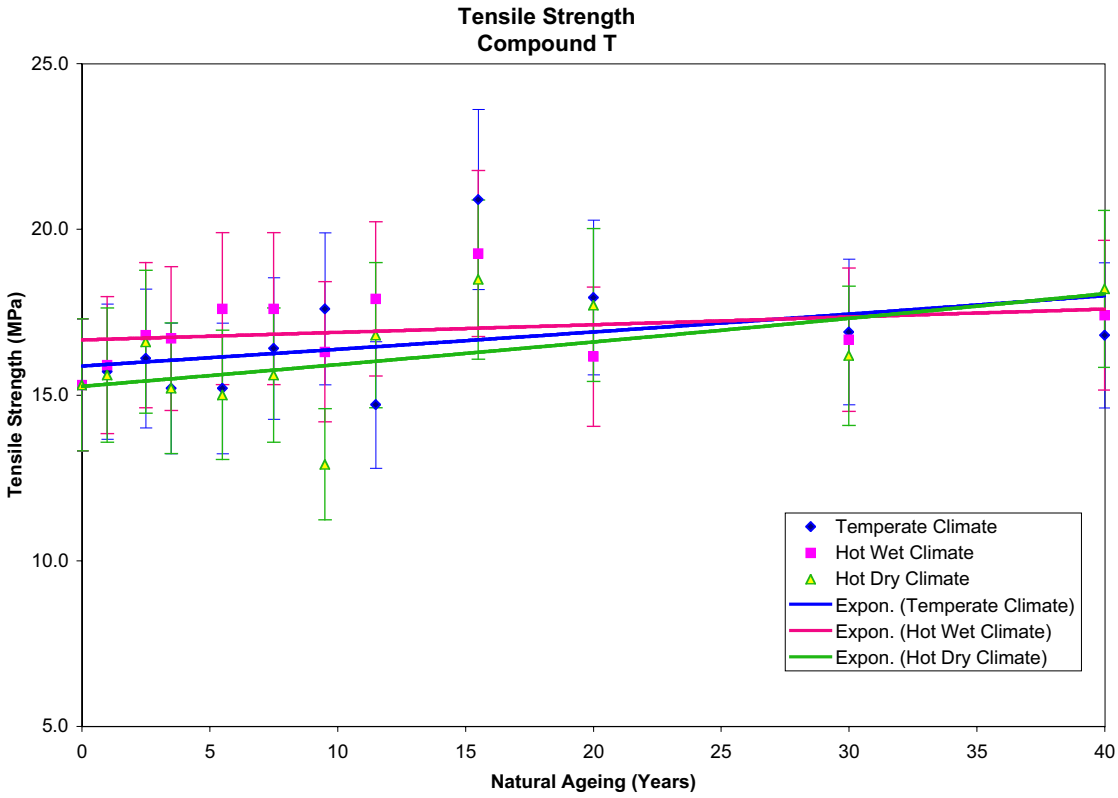
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	79.2	81.8	2.6	3.3	79.2	85.0	5.8	7.3	79.7	79.7	0.0	0.0
Volume Change (%)	95.0	83.3	-12	-12	95.0	80.8	-14	-15	93.3	80.8	-13	-13
Rebound Resilience (%)	11.2	12.8	1.6	14	11.0	16.0	5.0	45	10.3	13.8	3.5	34
Volume Resistivity (LogΩcm)	14.4	14.5	0.10	0.69	14.0	12.7	-1.3	-9.3	14.0	14.4	0.40	2.9
Tensile Properties												
Tensile Strength (MPa)	15.9	18.1	2.2	14	16.7	17.7	1.0	6.0	15.3	18.1	2.8	18
Elongation at Break (%)	391	260	-131	-34	420	260	-160	-38	358	243	-115	-32
Modulus at 100% (MPa)	7.42	11.5	4.1	55	6.75	11.0	4.3	63	7.42	12.0	4.6	62
Modulus at 300% (MPa)	13.5	19.1	5.6	41	12.5	18.6	6.1	49	13.5	18.6	5.1	38
Compression Set												
Short Term (%)	29.2	22.1	-7.1	-24	38.0	31.0	-7.0	-18	25.6	18.2	-7.4	-29
Long Term (%)	0.0	97.0			0.0	103			0.0	97.0		
Low Temperature Properties												
T2 Value (K)	274	273	-1.0	-0.4	275	273	-1.5	-0.6	275	275	-0.40	-0.2
T10 Value (K)	267	264	-2.3	-0.9	267	265	-2.4	-0.9	266	266	-0.80	-0.3

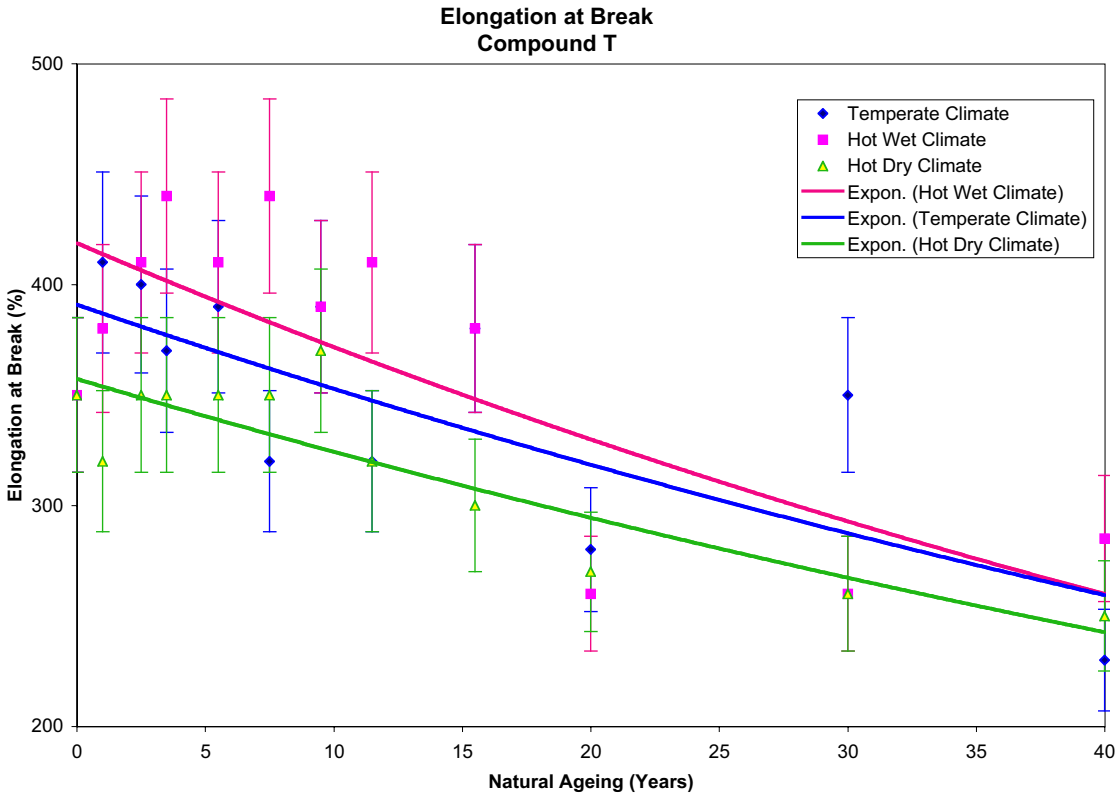

Hardness
Compound T
Hardness (IRHD)
100
90
80
70
60
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

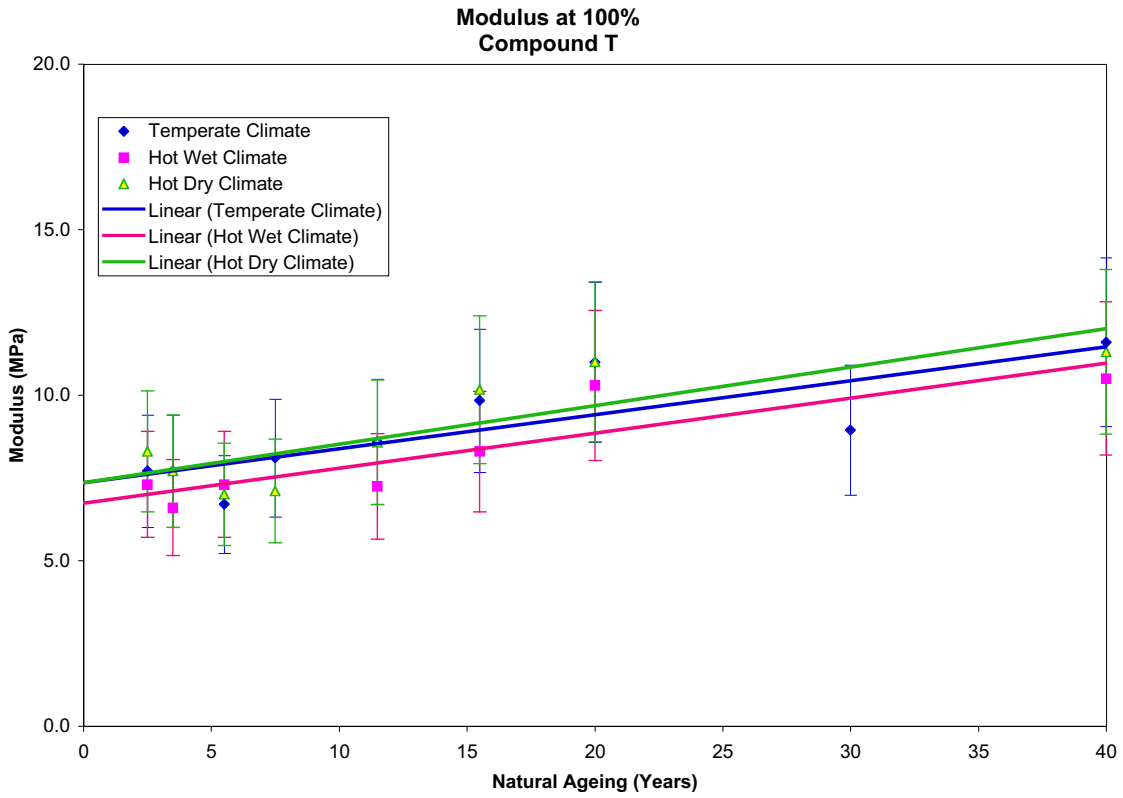

Volume Change
Compound T
Volume Change (%)
150
100
50
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

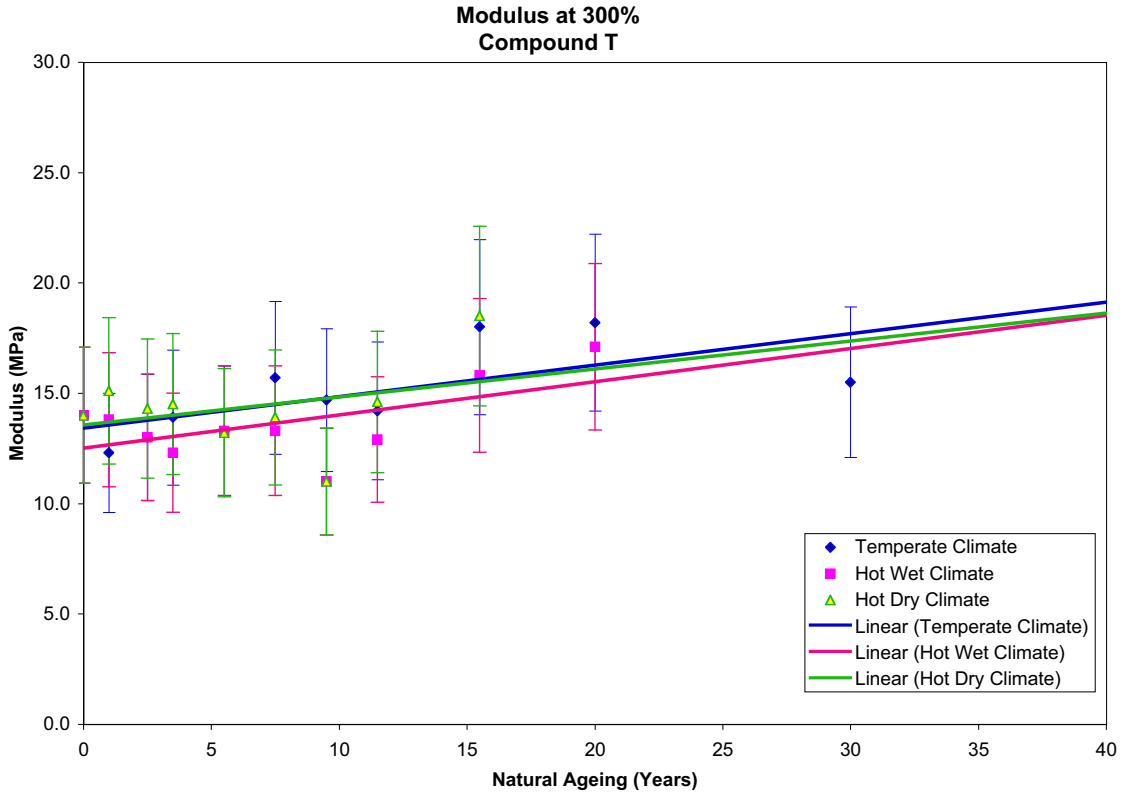


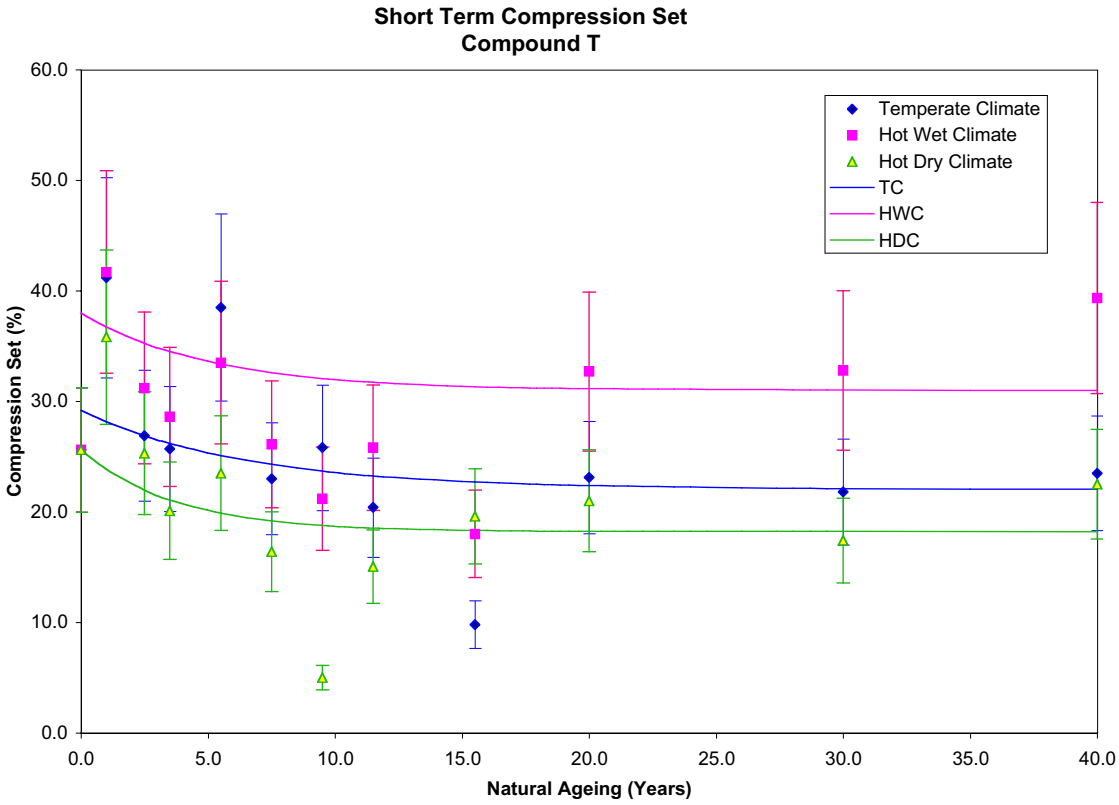


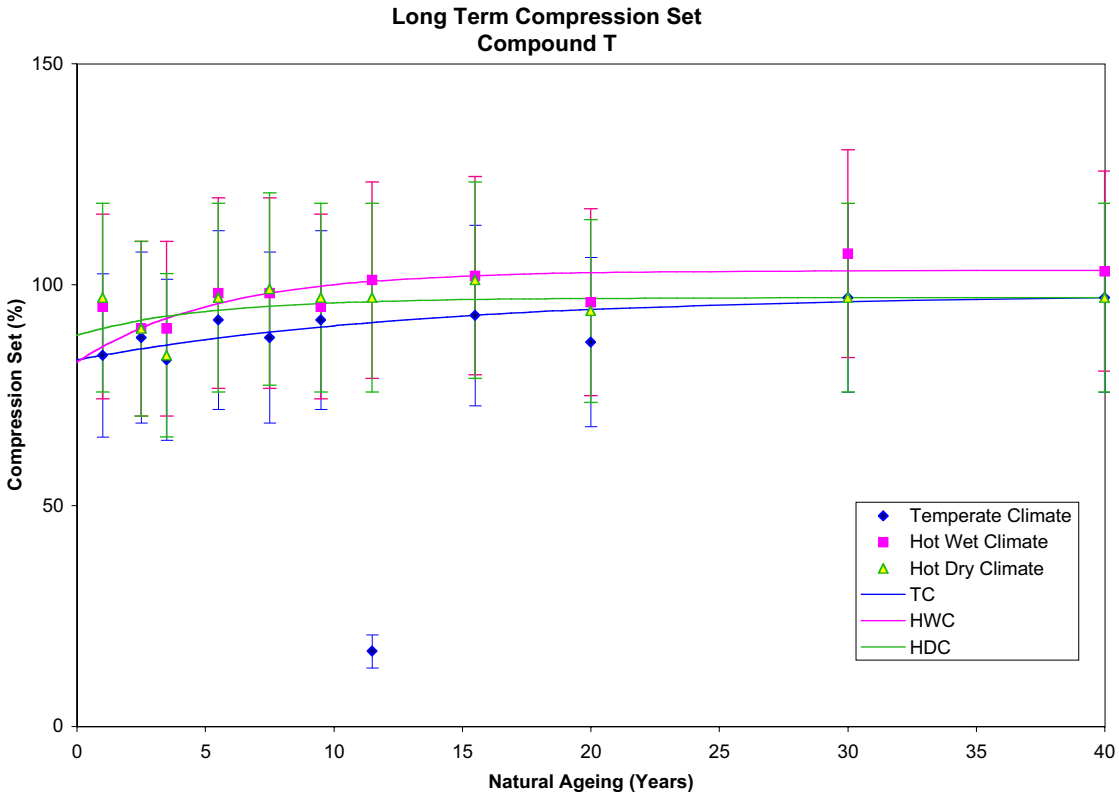

Tensile Strength
Compound T
Tensile Strength (MPa)
25.0
20.0
15.0
10.0
5.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

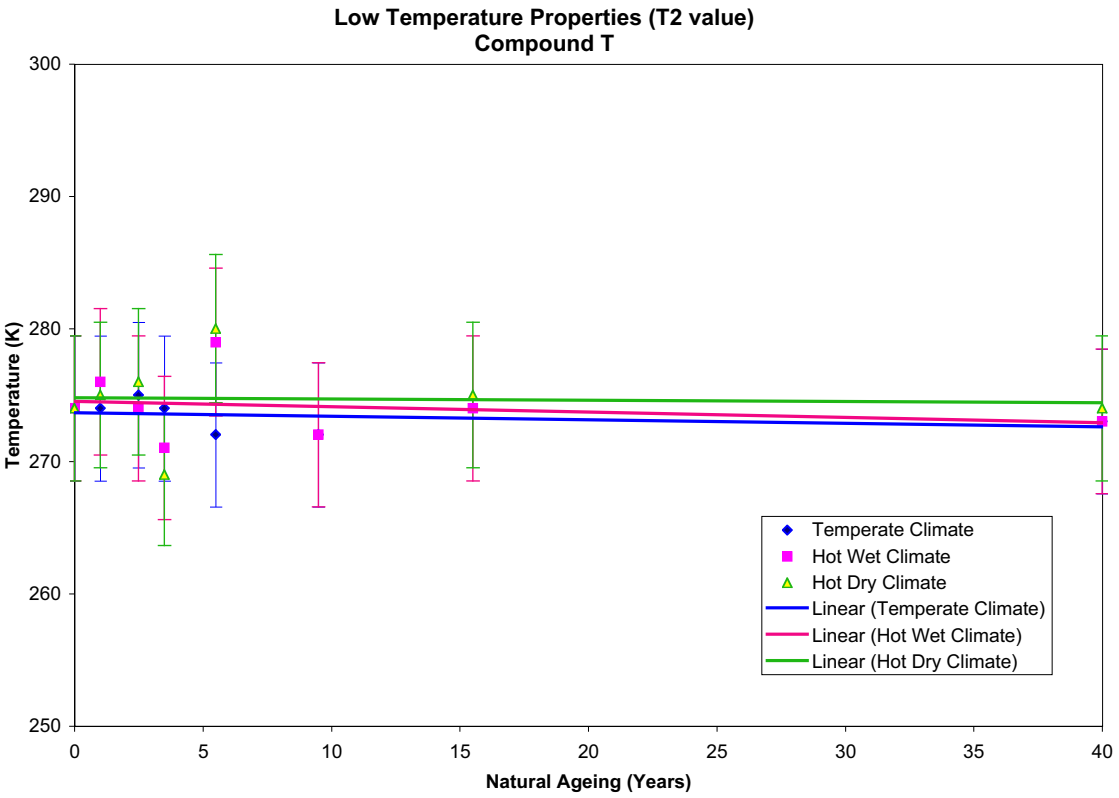

Elongation at Break
Compound T
Elongation at Break (%)
500
400
300
200
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)

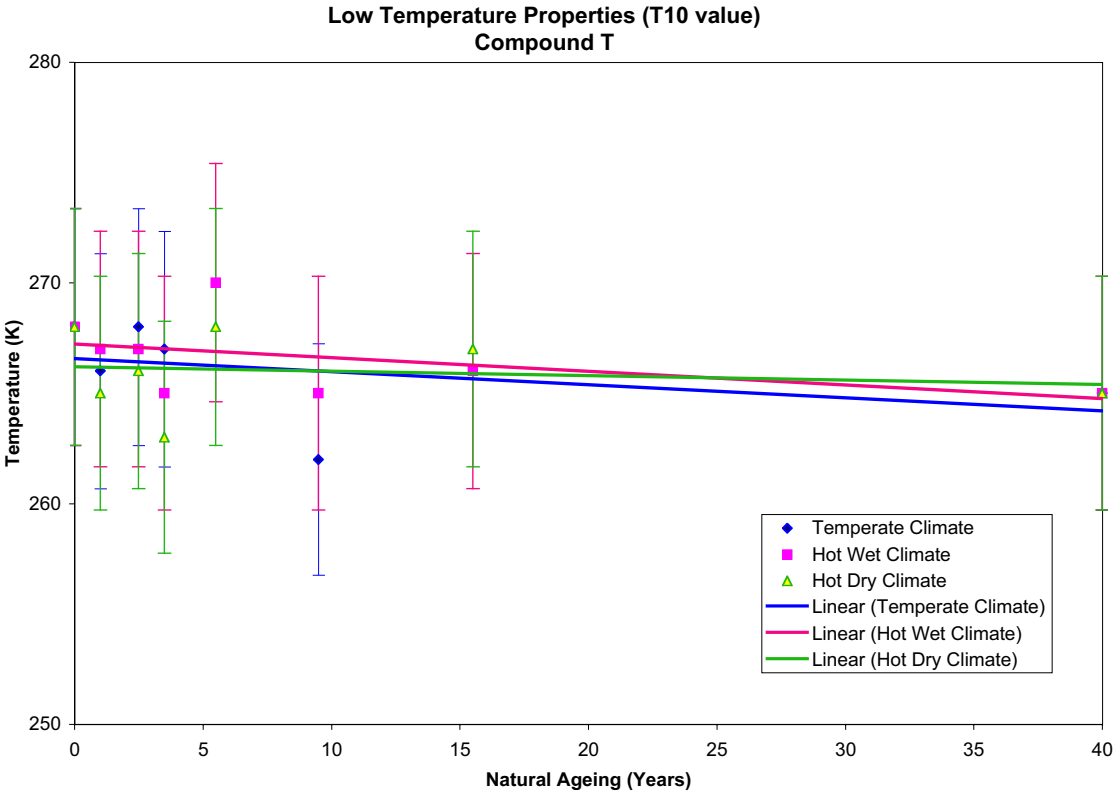





Short Term Compression Set
Compound T
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

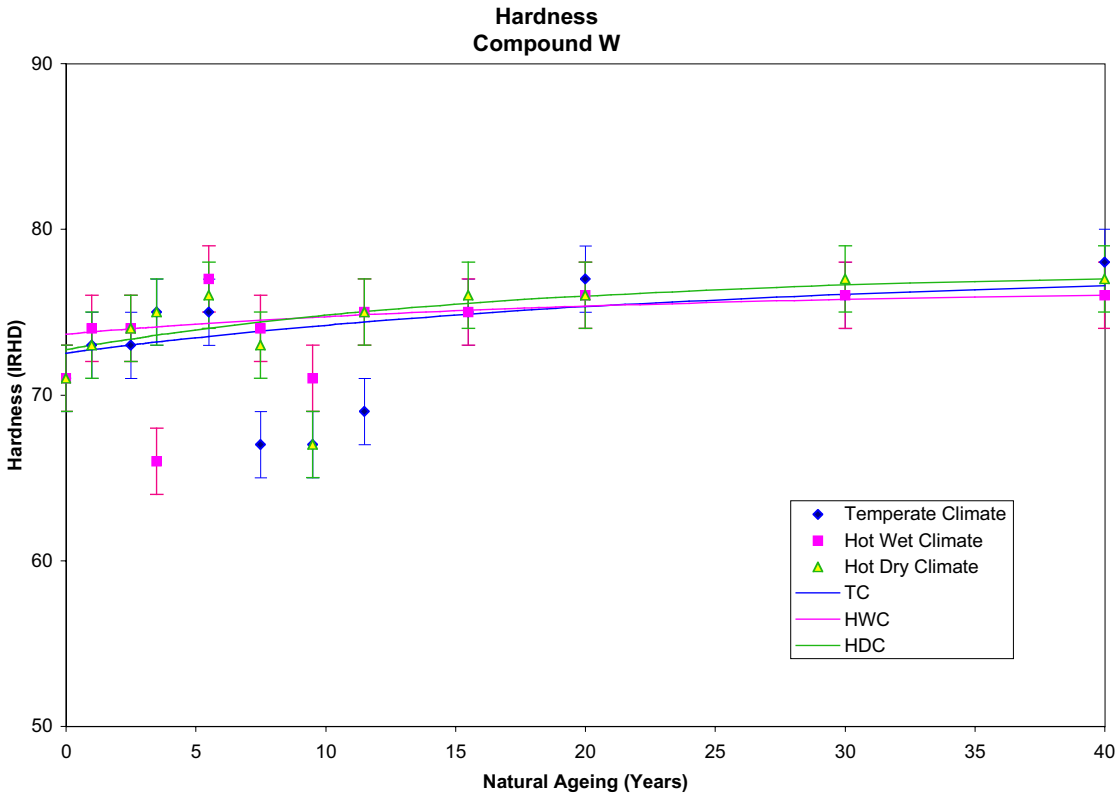

Long Term Compression Set
Compound T
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
150
100
50
0
0
5
10
15
20
25
30
35
40

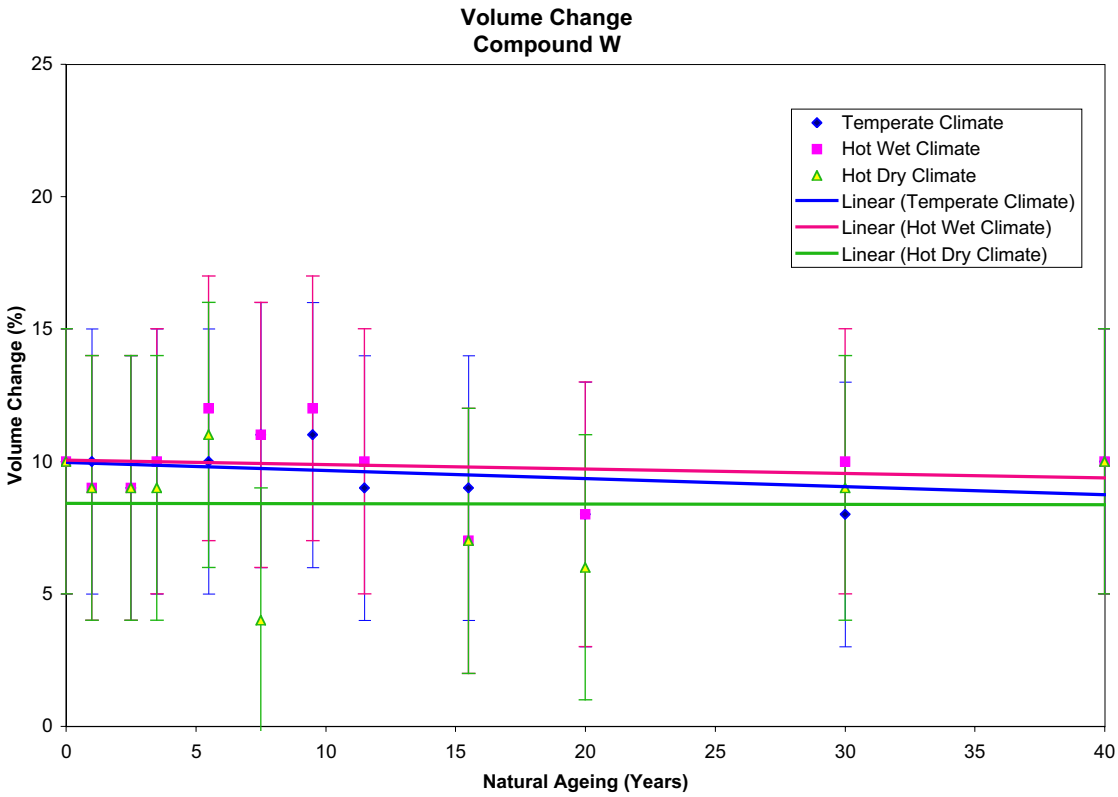


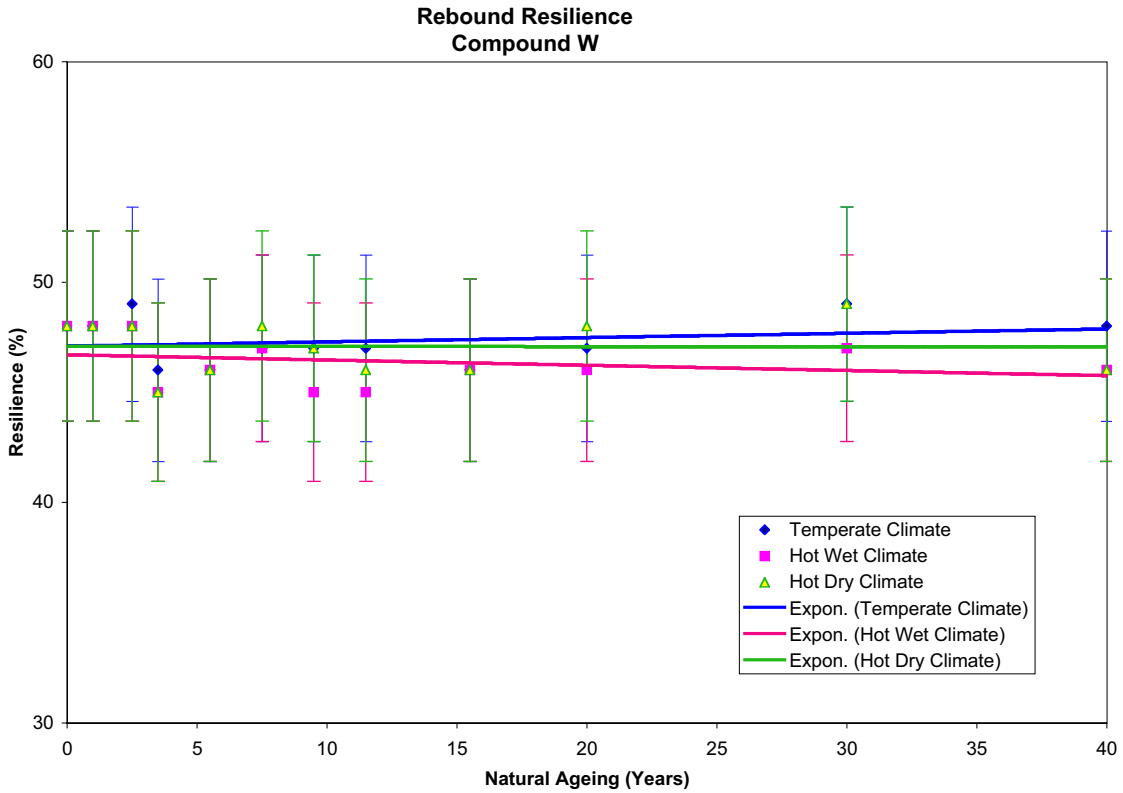


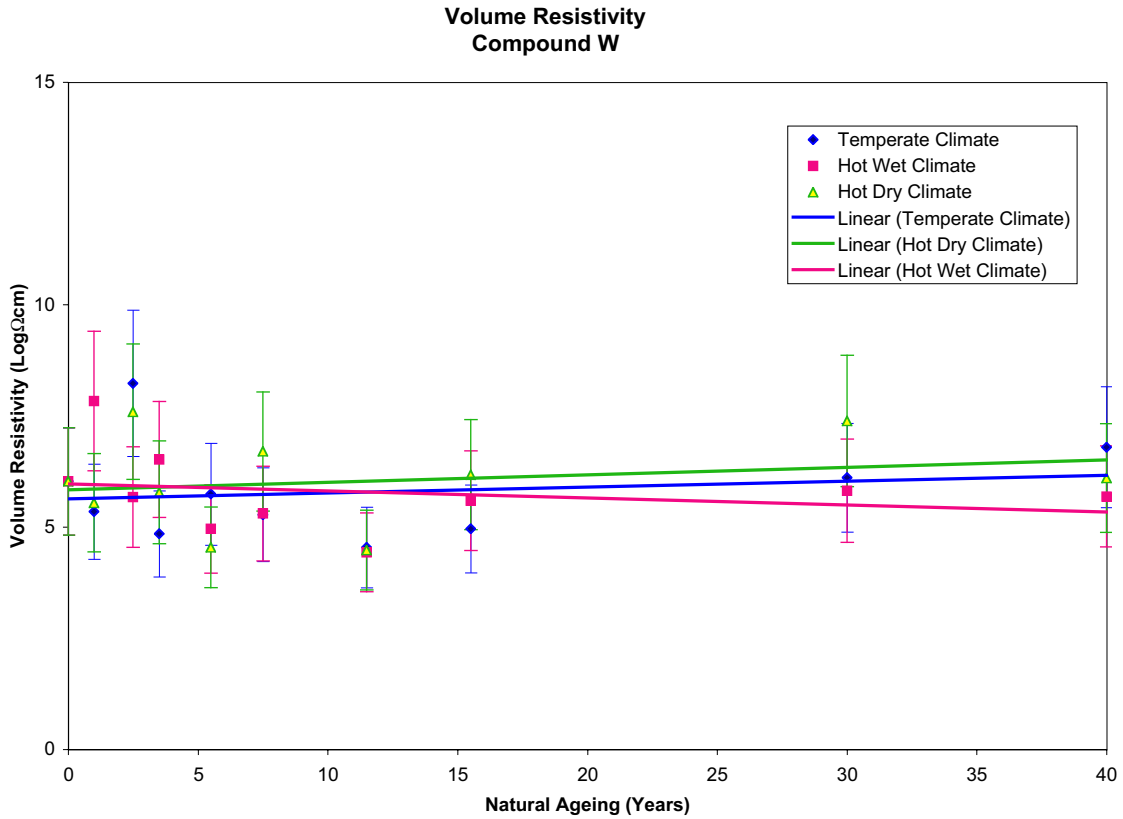
Extrapolated unaged and 40 years natural ageing data: Compound W (polysulphide rubber)

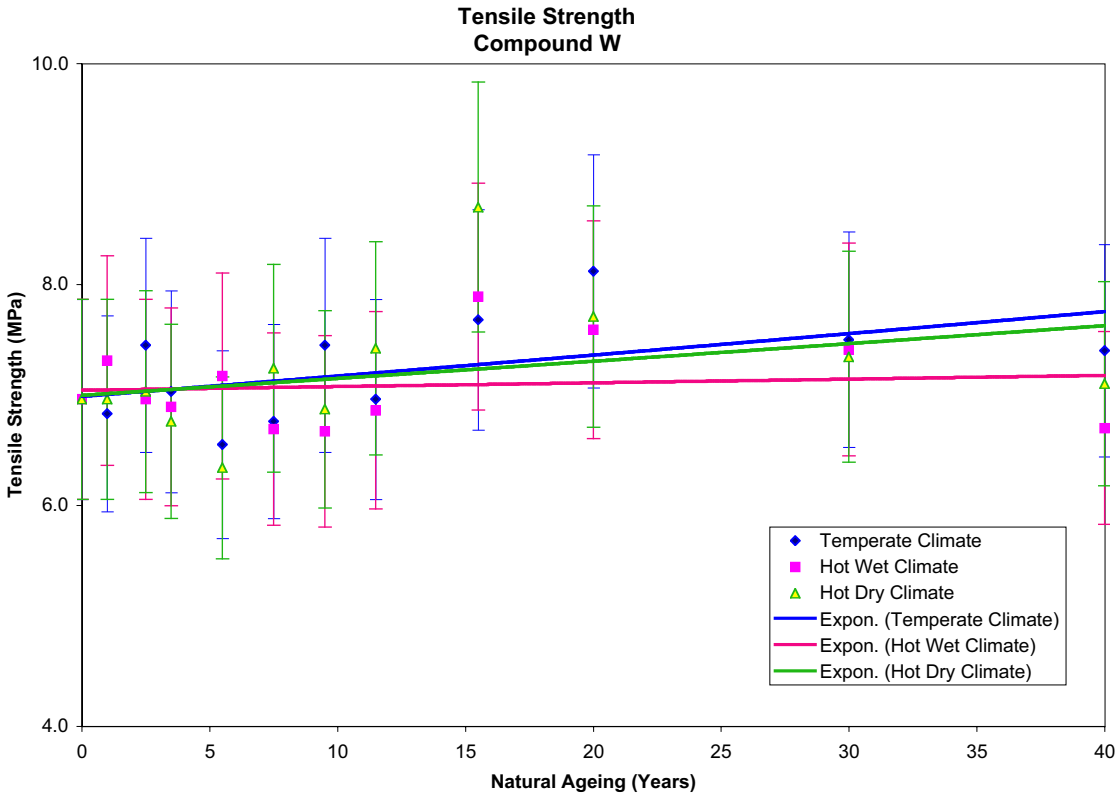
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	72.5	76.6	4.1	5.7	73.7	76.0	2.3	3.1	72.7	77.0	4.3	5.9
Volume Change (%)	10.0	8.75	-1.3	-13	10.0	9.38	-0.62	-6.2	8.44	8.39	-0.05	-0.59
Rebound Resilience (%)	47.1	48.0	0.90	1.9	46.8	45.8	-1.0	-2.1	47.1	47.1	0.0	0.0
Volume Resistivity (LogΩcm)	5.63	6.13	0.50	8.9	6.00	5.38	-0.62	-10	5.88	6.50	0.62	11
Tensile Properties												
Tensile Strength (MPa)	7.00	7.78	0.78	11	7.05	7.20	0.15	2.1	7.00	7.65	0.65	9.3
Elongation at Break (%)	200	203	3.3	1.7	203	195	-8.3	-4.1	200	213	13	6.7
Modulus at 100% (MPa)	3.35	3.75	0.40	12	3.45	3.60	0.15	4.3	3.45	3.60	0.15	4.3
Modulus at 300% (MPa)	-	-			-	-			-	-		
Compression Set												
Short Term (%)	6.55	4.80	-1.8	-27	6.40	3.60	-2.8	-44	6.30	6.20	-0.10	-1.6
Long Term (%)	0.0	85.0			0.0	104			0.0	102		
Low Temperature Properties												
T2 Value (K)	246	259	13	5.4	247	253	5.5	2.2	250	263	13	5.2
T10 Value (K)	230	226	-4.3	-1.9	229	225	-3.7	-1.6	231	228	-3.5	-1.5

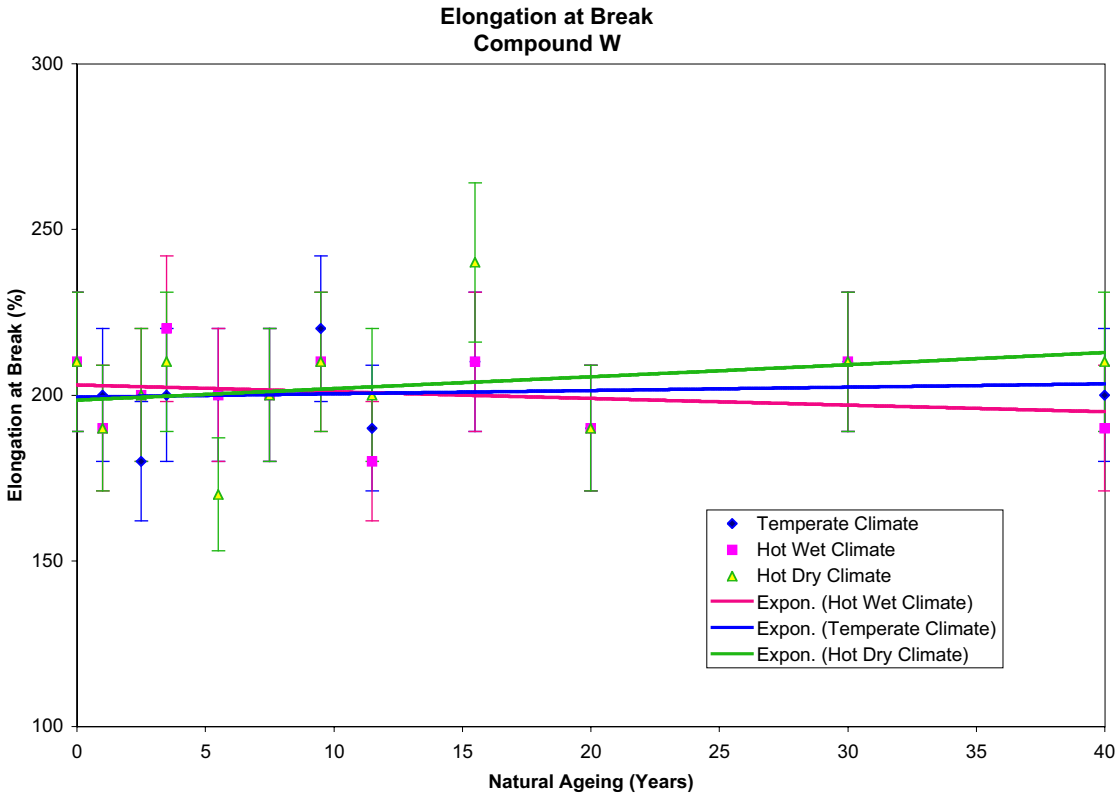

Hardness
Compound W
Hardness (IRHD)
Natural Ageing (Years)
90
80
70
60
50
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC

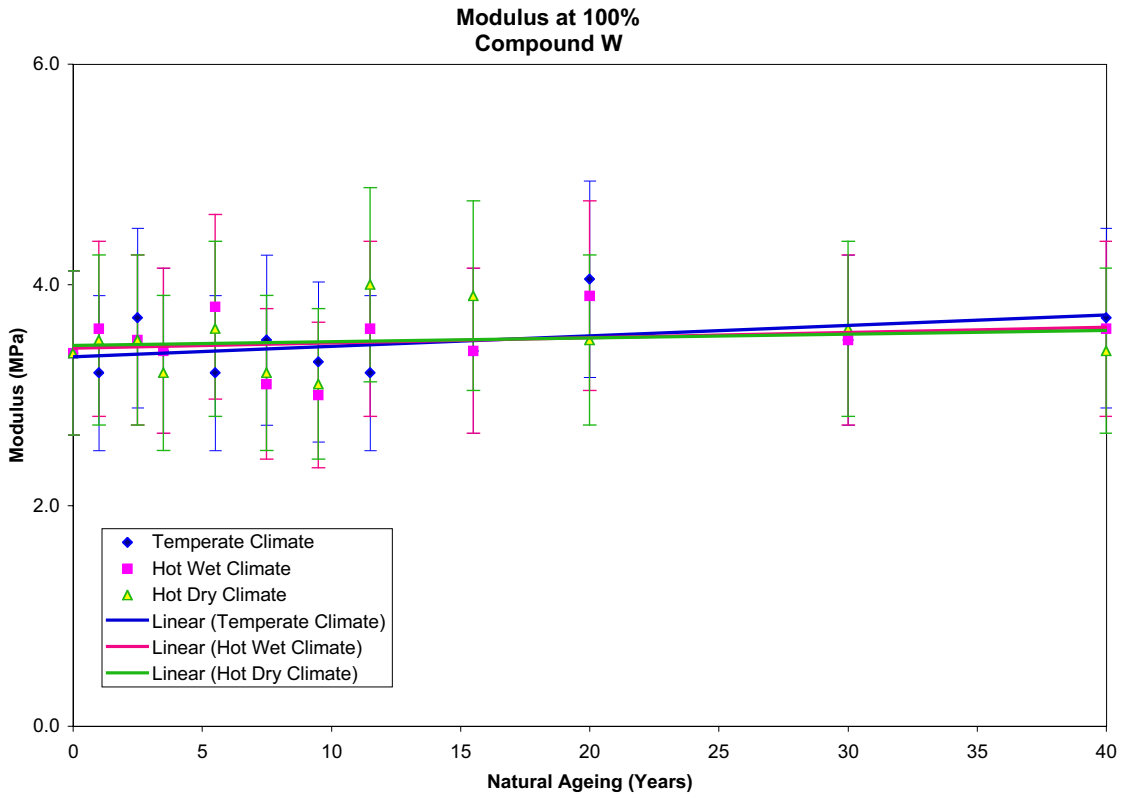

Volume Change
Compound W
Volume Change (%)
Natural Ageing (Years)
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

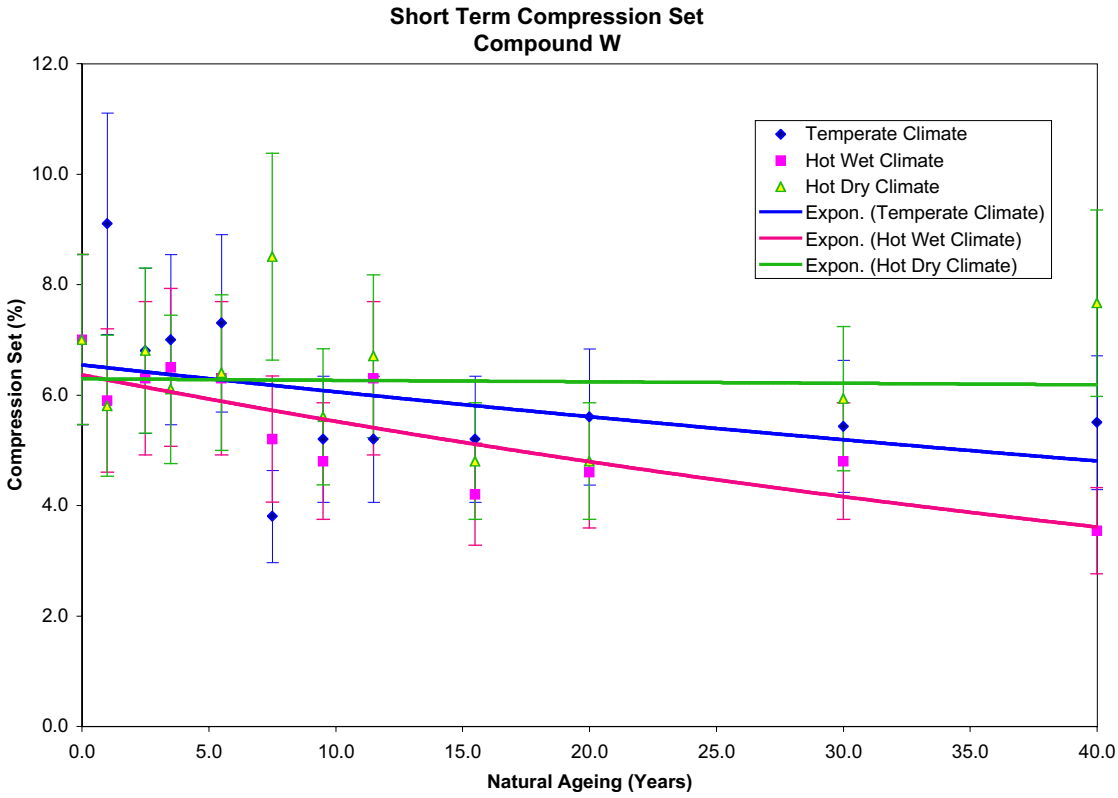


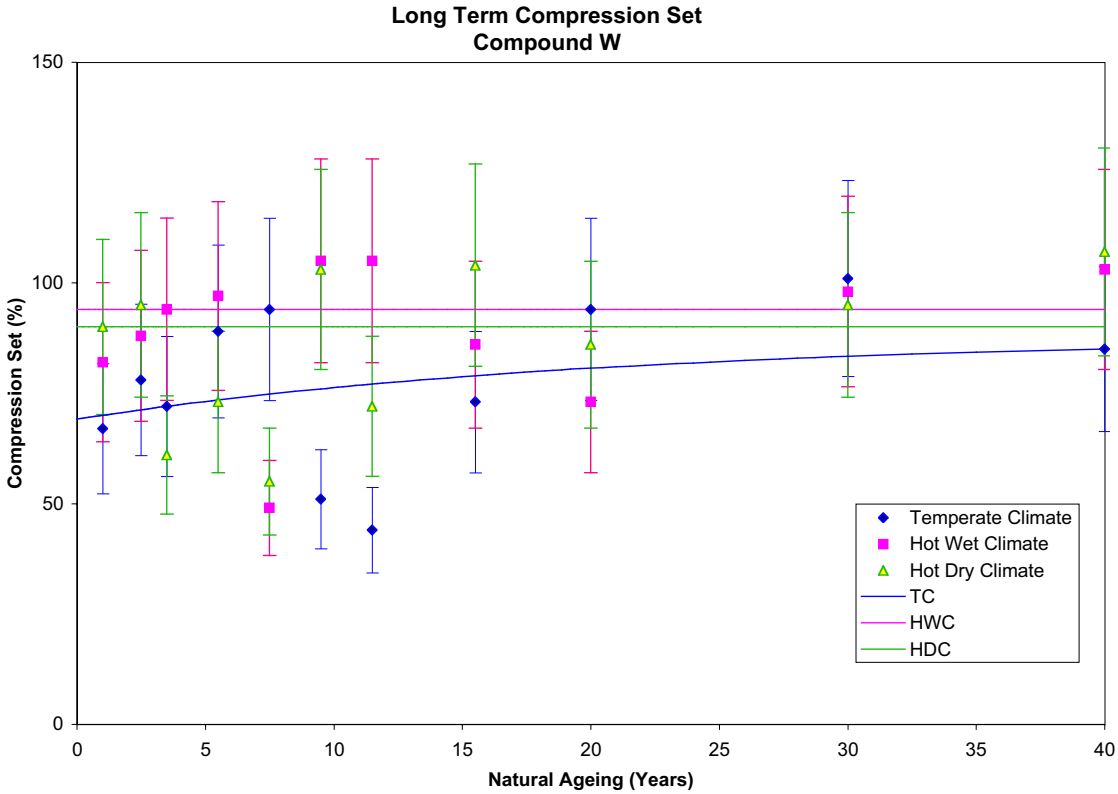


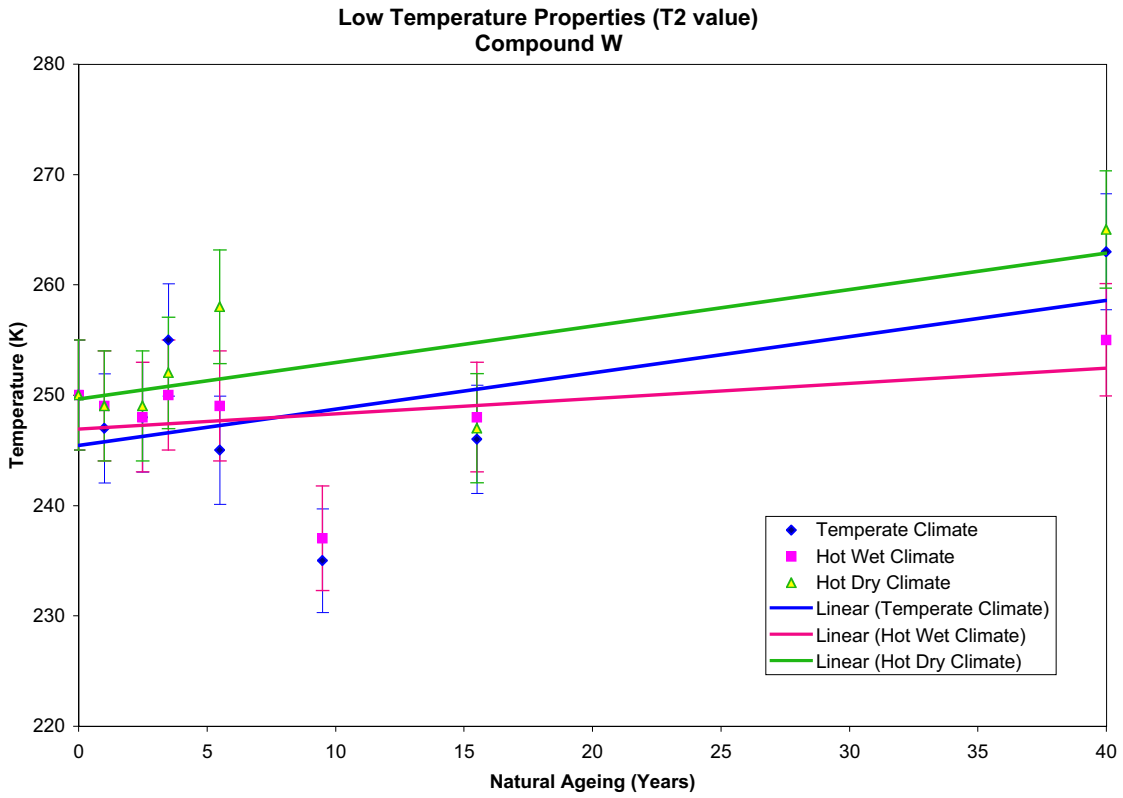

Tensile Strength
Compound W
Tensile Strength (MPa)
10.0
8.0
6.0
4.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

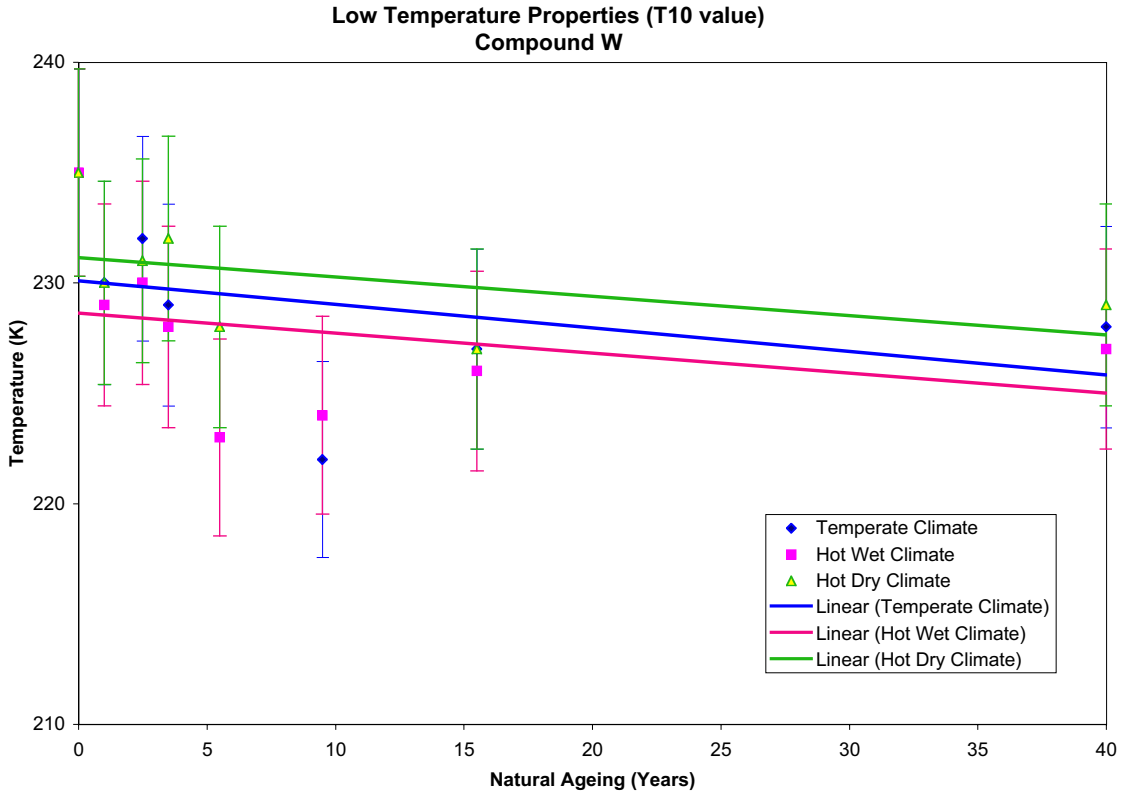

Elongation at Break
Compound W
Elongation at Break (%)
300
250
200
150
100
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)




Short Term Compression Set
Compound W
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

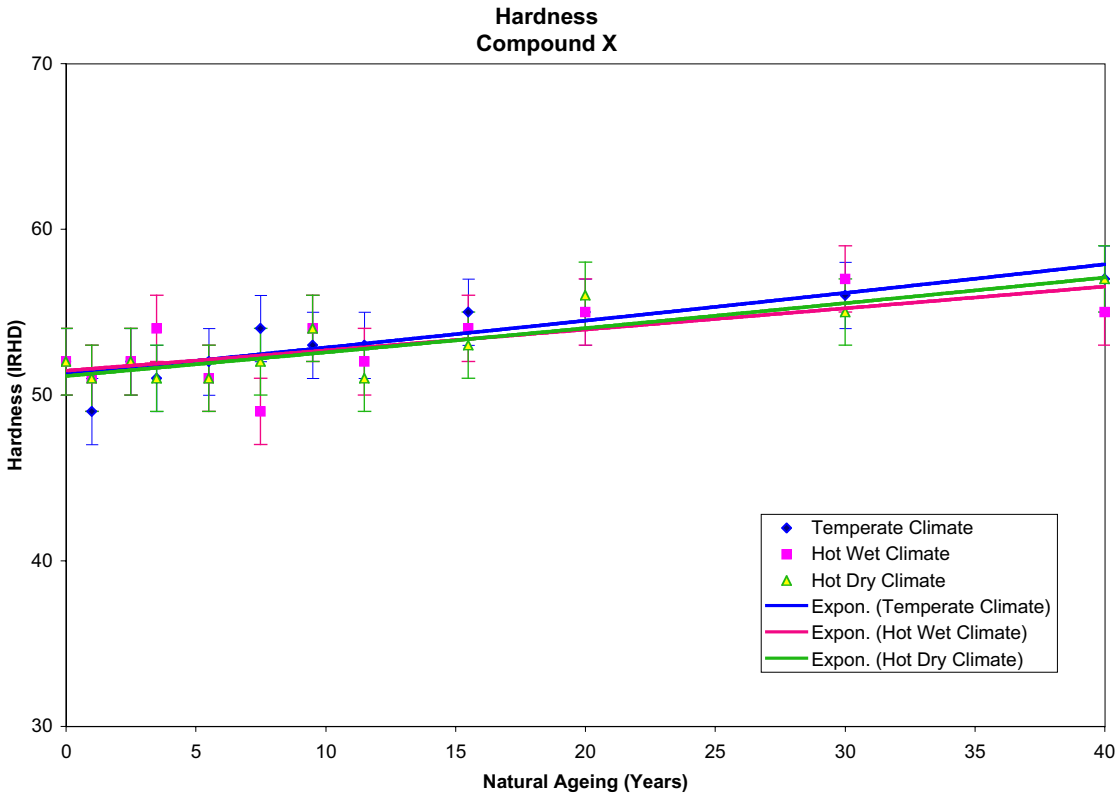

Long Term Compression Set
Compound W
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
0
50
100
150
0
5
10
15
20
25
30
35
40

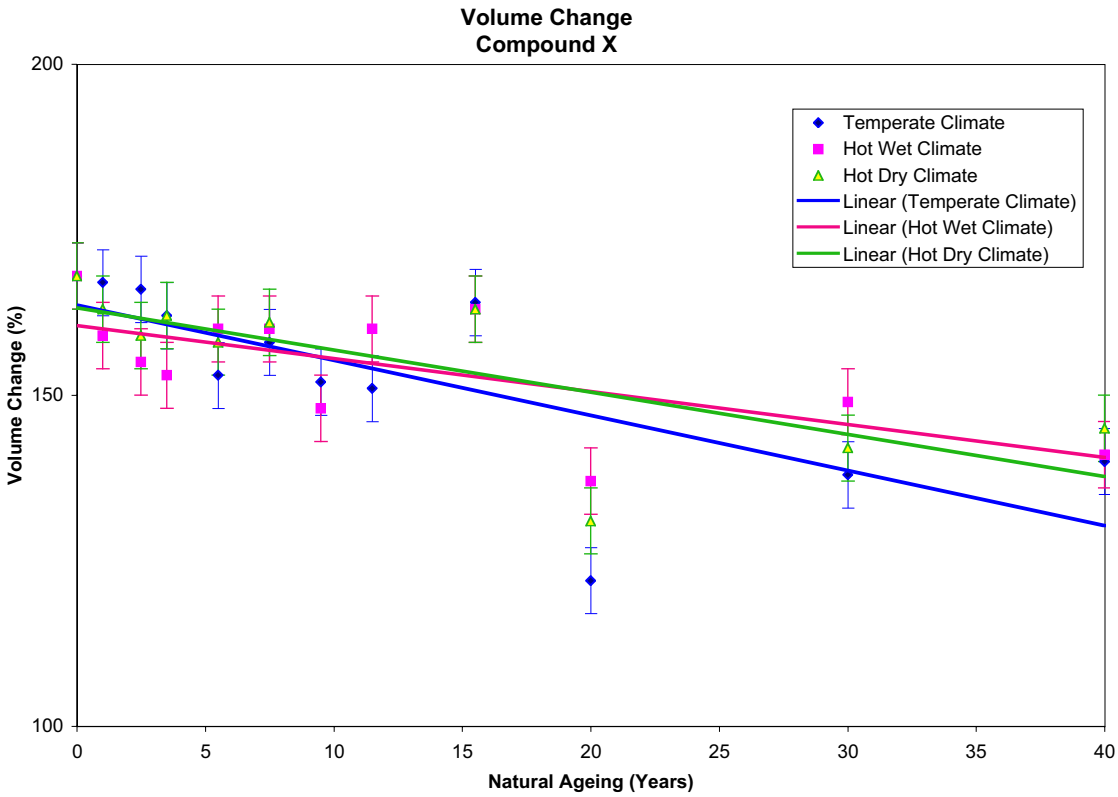


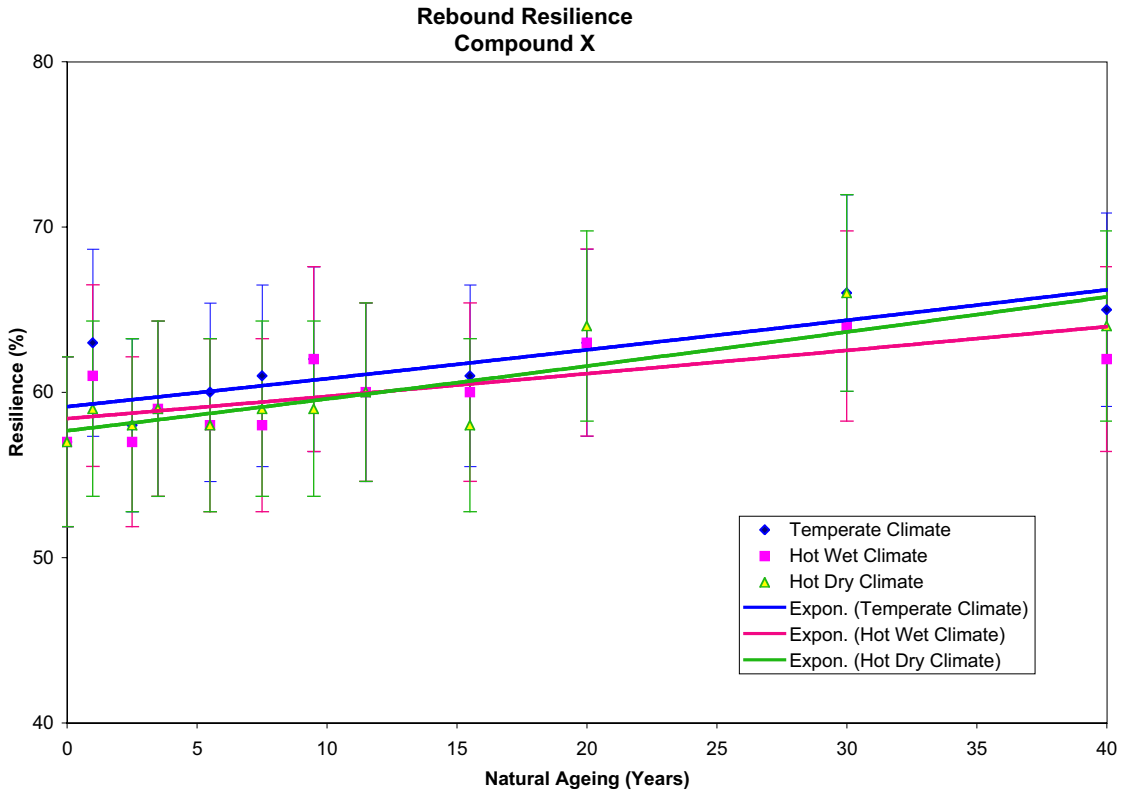


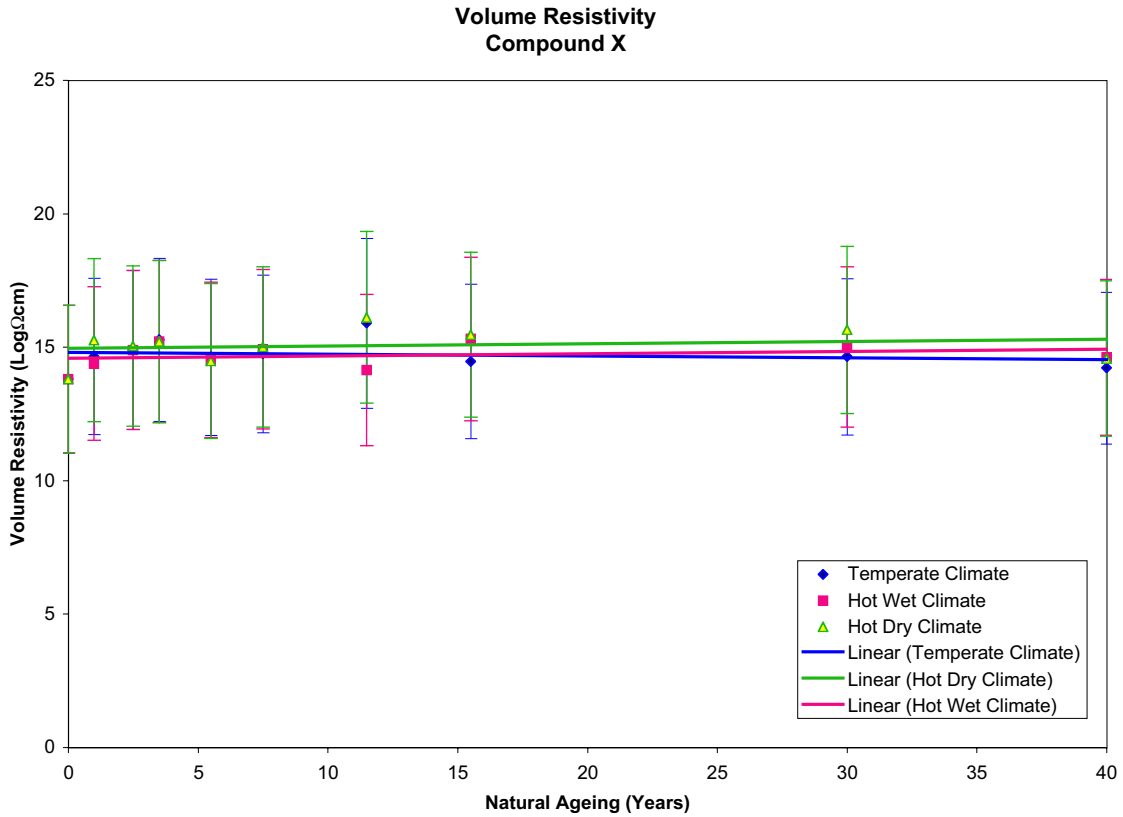
Extrapolated unaged and 40 years natural ageing data: Compound X (silicone rubber)

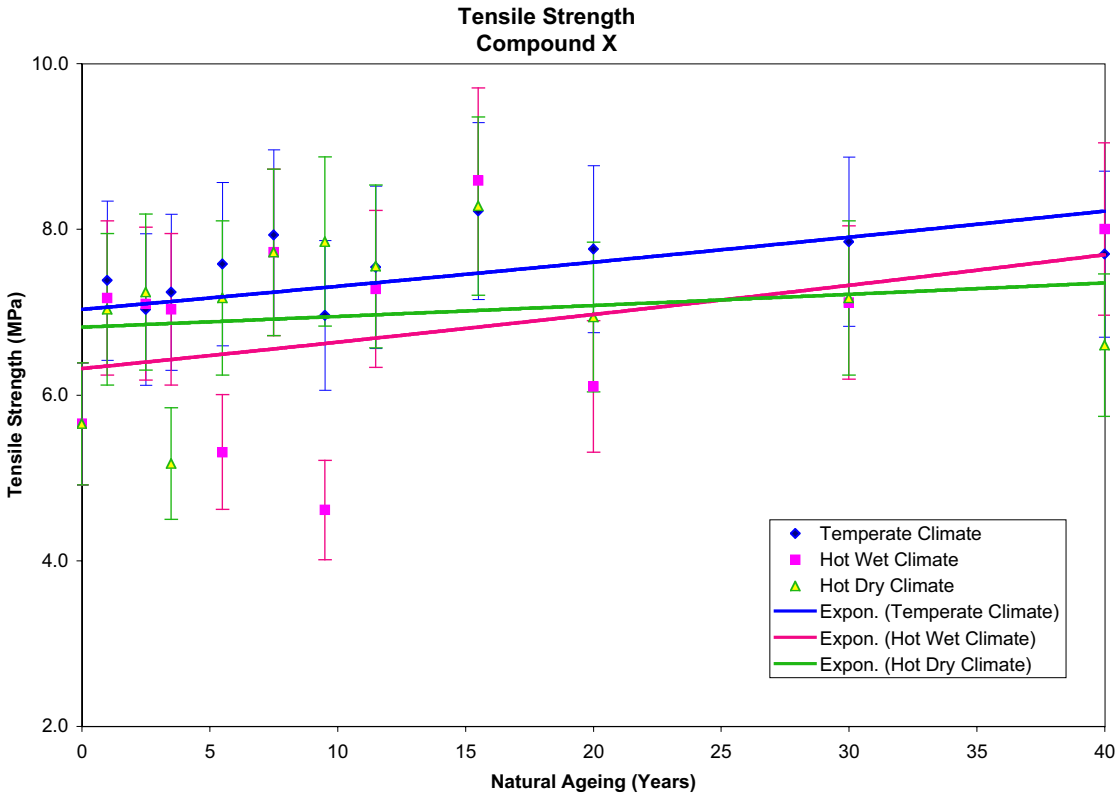
Property	Temperate Climate				Hot Wet Climate				Hot Dry Climate			
	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change	Unaged Value	40 Year Value	Difference	% Change
Hardness (IRHD)	51.3	58.0	6.7	13	51.3	56.7	5.4	11	51.3	57.2	5.9	12
Volume Change (%)	163	131	-33	-20	161	141	-20	-12	163	138	-25	-16
Rebound Resilience (%)	59.3	66.3	7.0	12	58.5	64.0	5.5	9.4	57.7	65.8	8.1	14
Volume Resistivity (LogΩcm)	14.8	14.6	-0.20	-1.4	14.6	15.0	0.40	2.7	15.0	15.4	0.40	2.7
Tensile Properties												
Tensile Strength (MPa)	7.07	8.23	1.2	16	6.33	7.70	1.4	22	6.83	7.37	0.54	7.9
Elongation at Break (%)	113	121	8.3	7.4	100	105	4.6	4.6	108	86.7	-22	-20
Modulus at 100% (MPa)	7.13	6.54	-0.59	-8.3	6.75	6.38	-0.37	-5.5	7.00	6.71	-0.29	-4.1
Modulus at 300% (MPa)	-	-			-	-			-	-		
Compression Set												
Short Term (%)	1.13	1.67	0.54	48	1.08	2.00	0.92	85	1.50	2.50	1.0	67
Long Term (%)	0.0	72.4			0.0	66.6			0.0	69.9		
Low Temperature Properties												
T2 Value (K)	228	230	2.1	0.9	230	231	0.80	0.4	231	233	1.9	0.8
T10 Value (K)	223	227	4.2	1.9	226	227	1.1	0.5	226	230	3.6	1.6

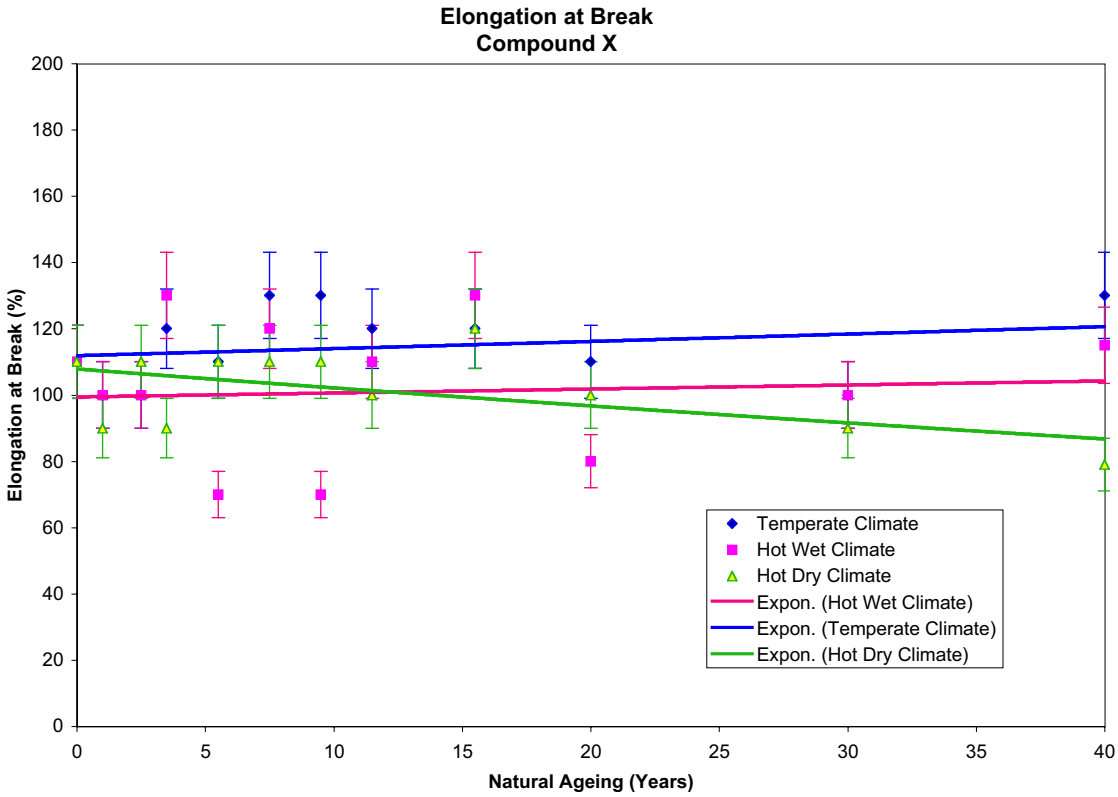

Hardness
Compound X
Hardness (IRHD)
70
60
50
40
30
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

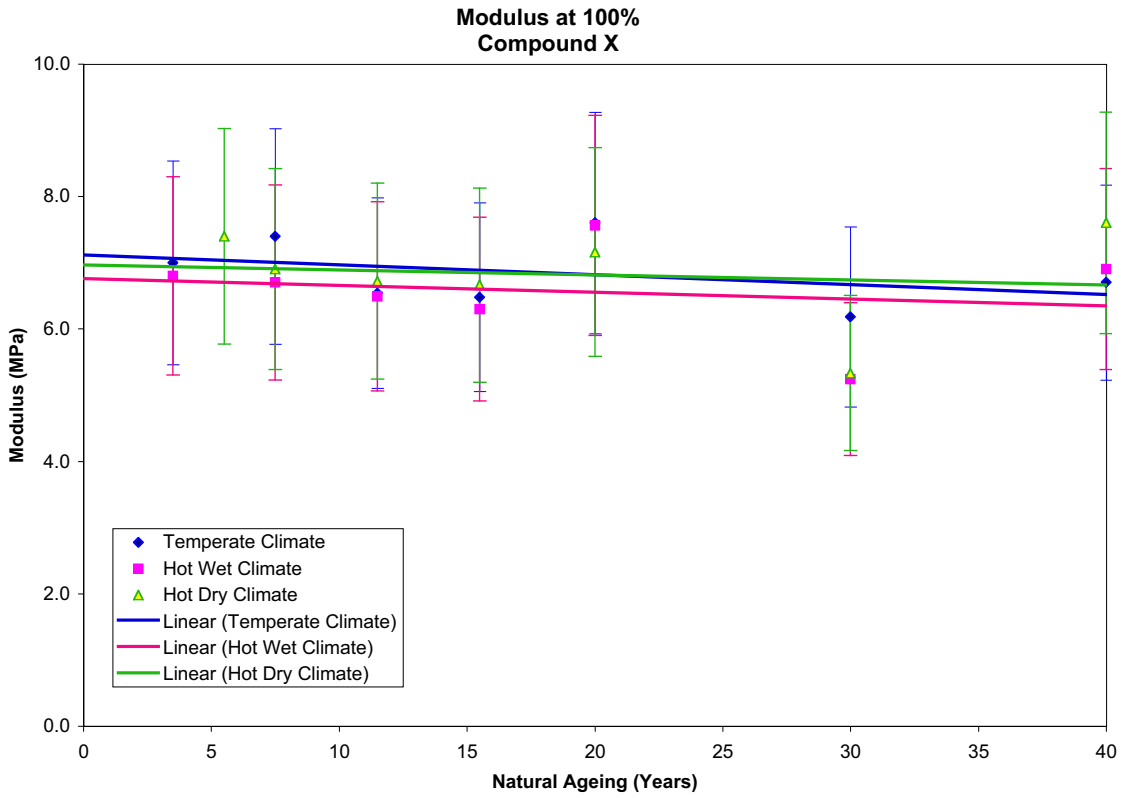

Volume Change
Compound X
Volume Change (%)
200
150
100
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Linear (Temperate Climate)
Linear (Hot Wet Climate)
Linear (Hot Dry Climate)

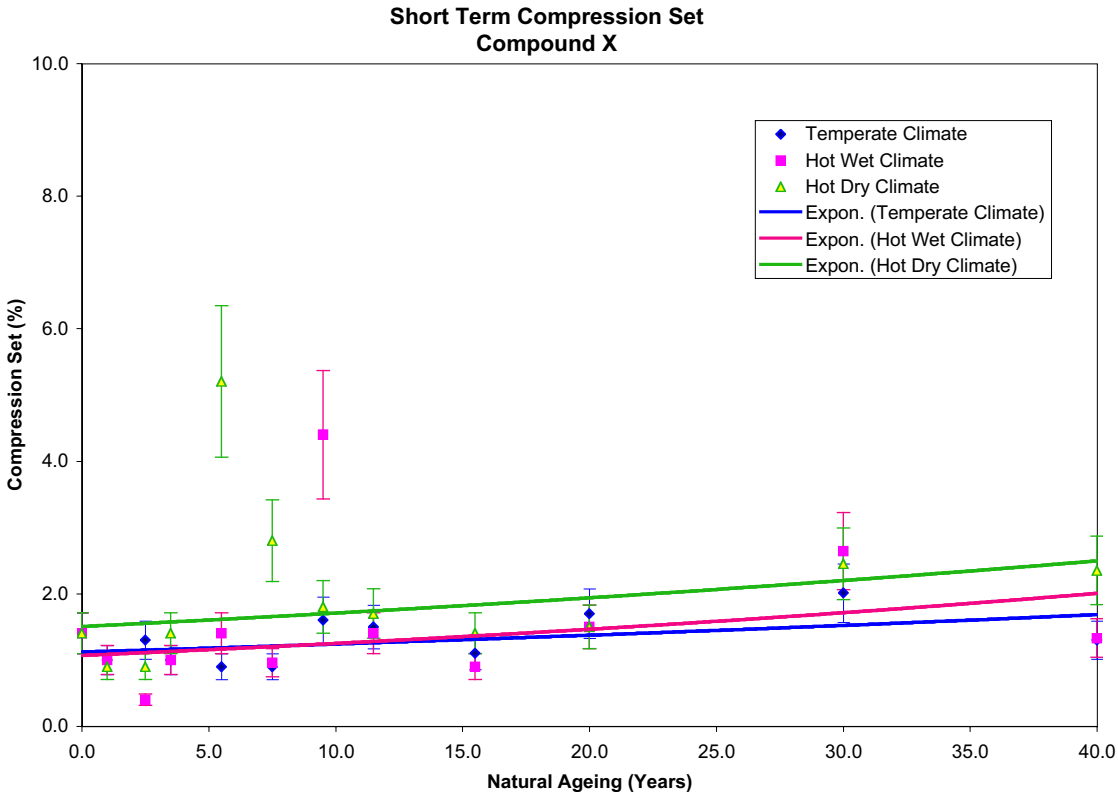


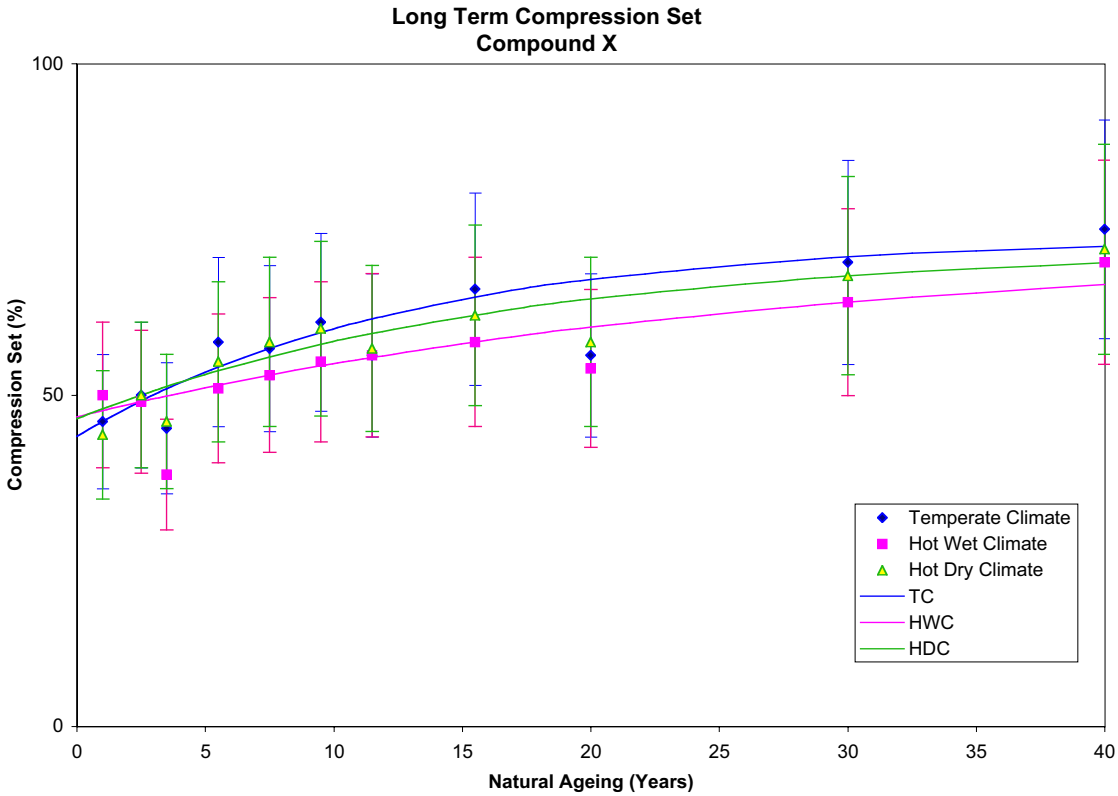


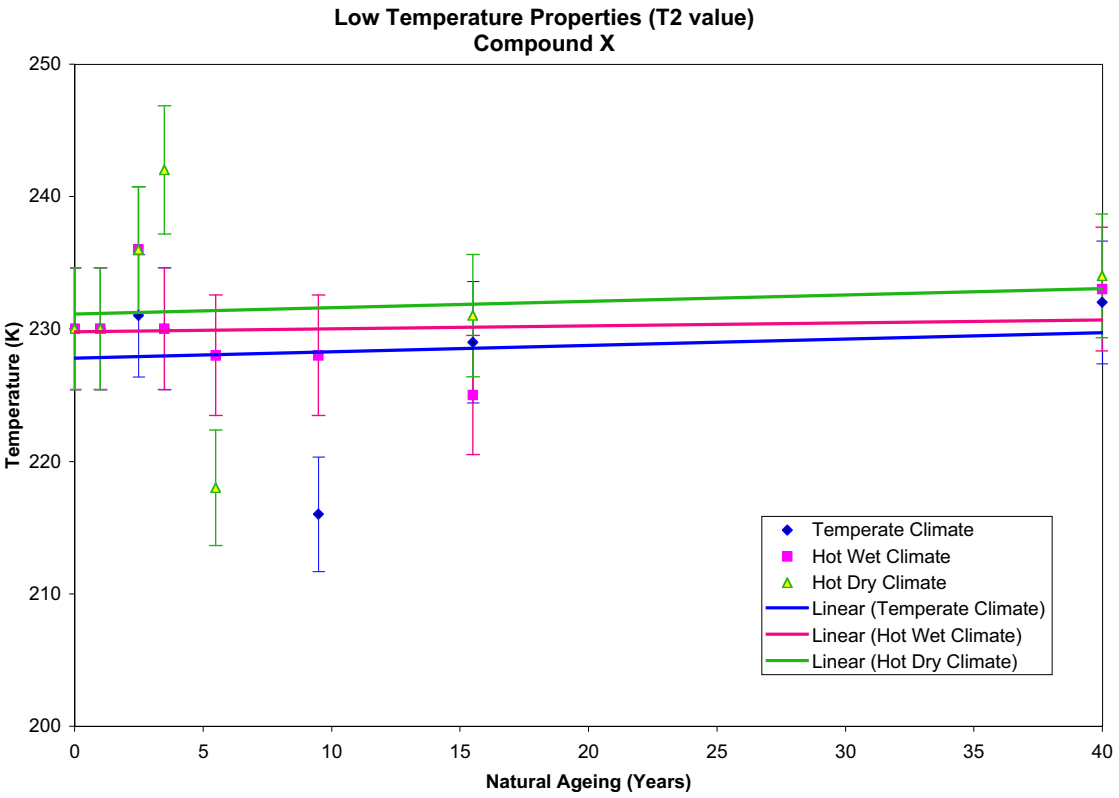

Tensile Strength
Compound X
Tensile Strength (MPa)
10.0
8.0
6.0
4.0
2.0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)

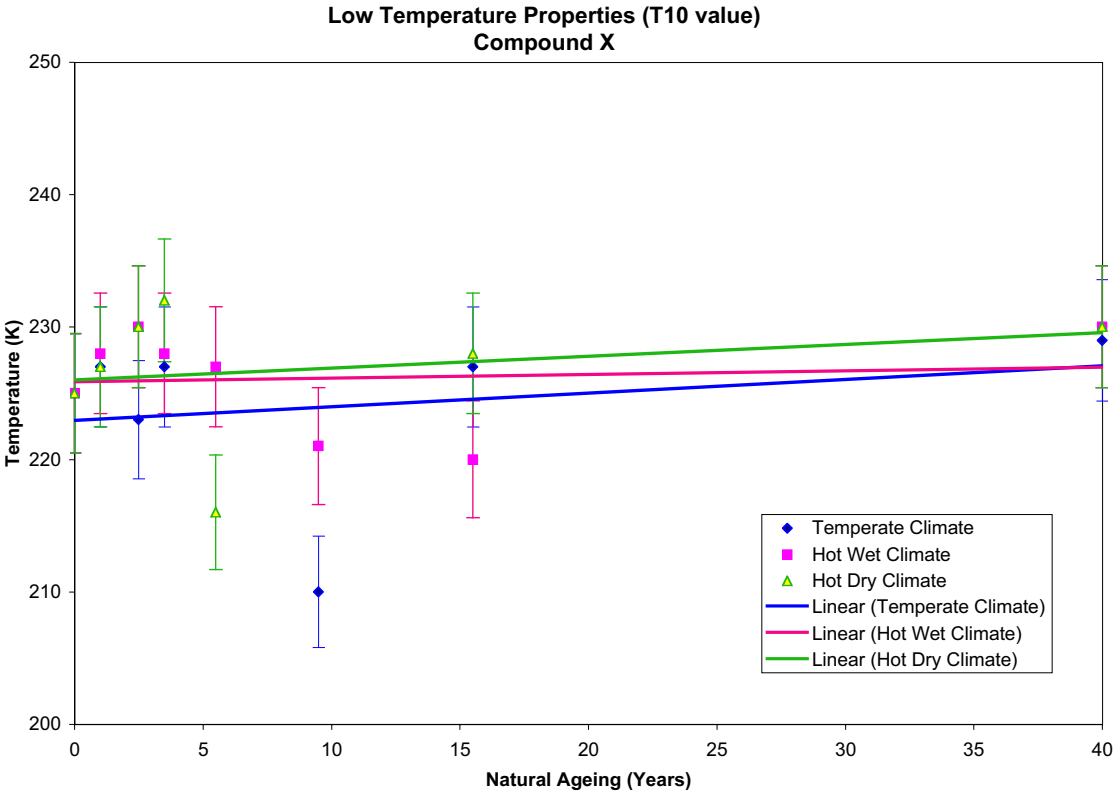

Elongation at Break
Compound X
Elongation at Break (%)
200
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Hot Wet Climate)
Expon. (Temperate Climate)
Expon. (Hot Dry Climate)




Short Term Compression Set
Compound X
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
Expon. (Temperate Climate)
Expon. (Hot Wet Climate)
Expon. (Hot Dry Climate)
10.0
8.0
6.0
4.0
2.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0


Long Term Compression Set
Compound X
Compression Set (%)
Natural Ageing (Years)
Temperate Climate
Hot Wet Climate
Hot Dry Climate
TC
HWC
HDC
100
50
0
0
5
10
15
20
25
30
35
40





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