Deflection versus Indentation

The sections 4.4 and 4.5 of ISO 12636 standard define compressibility test conditions respectively for deflection and indentation.

Moving head speed is 1 mm / minute for both methods. According to the standard, the use of the compressibility-deflection or the compressibility-indentation method is the choice of the manufacturer.

Test results obtained with one or the other methods are not to be considered comparable.

Compressibility-deflection method uses a 700 sq. mm circular sample, its full area being subject to five compression cycles between two parallel flat surfaces of the compression apparatus.

Compression test pressure is 2,000 kPa.

As per the standard, deflection test values are to be recorded both at 1,000 kPa and 2,000 kPa.

But if results at 1,000 kPa are important, an alternate compression test up to 1,000 kPa should be run instead as to different maximum pressure values correspond different test cycles.

Equipment and software noise introduced in the deflection test, although still quite visible on the graphs, does not influence test results as much as it happens in the indentation test.

In fact compressed area on the deflection test is seven times as big and the maximum load is twice as large when compared to the indentation test.

The deflection test does afford hysteresis-related results that are easy to interpret, its use looking promising as a powerful designer's tool in the study of blankets for particular uses.

Reassuring as these findings may be one should not hastily conclude that one test does provide better blanket performance evaluation than the other.

Freeing the hysteresis concept from the well known and useful hysteresis-cycle-introductory-tool, may help its study as just another characteristic of the planetary-system structure of matter.

Compressibility-indentation method uses a 100 sq. mm circular load disk that is applied atop the centre of the rubber surface of a 700 sq. mm blanket sample. That assembly is to be subject to five compression cycles between two parallel flat surfaces of the compression apparatus.

The remainder 600 sq. mm sample area is not subject to compression.

Indentation test values are to be recorded at 1,000 kPa.

However, the ring-shaped blanket area immediately adjacent to the edge of the load disk will become subject mainly to tension as the sample area under the load disk is being compressed.

This means not only that the compression load required by this test method for the same blanket deformation is likely to be proportionately higher than in the compressibility-deflection method but also that blanket stress gradient will be maximum under the edge of the load disk.

During the test, when at every cycle the upper compression limit is reached the moving head of the test equipment starts moving away and the blanket starts regaining thickness.

Rubber compound characteristics are largely responsible for the blanket reaction fashion.

But, unlike with the deflection method, in the indentation method compression load has to equal the sum of the reactions from 100 sq. mm of compressed blanket area plus ~20 sq. mm of tensioned blanket ring area.

Reaction of rubber to tension - also dependant of rubber compound characteristics - is likely to be different from the reaction to compression.

And in fact during the indentation test most blankets exhibit a “whip” reaction at the higher compression cycle limit, clearly visible on the respective dynamic hysteresis graphs.

“Hiwip” and “Hiwhip” marks were added on the graphs signalling the borders of that reaction.

During the indentation test and at its high compression cycle limits, tension energy stored by most blanket models assists a comparatively large blanket gauge recovery as test equipment moving head inverts the direction of its movement and an initial load reduction occurs.

In a similar way, as the moving head starts compressing after the lower compression limit is reached the rate of blankets’ compressive load increase is much smaller than during the remainder of the hysteresis cycle.

A Lowhip mark was also added on the graph.

In the absence of (or at low) load an even small load increase will cause in most blanket models a comparatively large blanket gauge reduction.

Thus, one should fairly expect maximum blanket gauge uncertainty - or not directly measurable hysteresis effect - to be reached at rest and at very low compression stress values.

Relative value of compression and tension reactions will vary with the respective area’s ratio.

Tests have shown that the “whip” reaction does significantly increase with test speed and it is believed that higher compression stress values will also lead to a stronger “whip” reaction.

Although exhibiting quite different characteristics both “whip” reactions add negative areas to the hysteresis cycle. Thus hysteresis related results obtained by the compressibility-indentation method, such as gauge uncertainty, hysteresis and elastic (or stored) energies, or damping capacity, will lose their meaning for most blanket models prior to “whip” reaction compensation.

Indentation test results show that “whip” reaction is higher the lower the damping capacity is.

Blankets using compounds with high damping capacity have a comparatively slow gauge recovery and may even hardly exhibit a “whip” reaction at all.

But blanket indentation and similar border circumstances do usually occur during the printing process.

NOTE:

Energy storage in a rubber component may be achieved by distortion of its natural shape and distortion means matter movement.

During the compressibility-indentation test, rubber under the edge of the load disk will swing outwards during blanket compression, in its contribution to the tensioning condition of the ring-shaped blanket area adjacent to the load disk and back inwards during blanket decompression.