



CREDIT: CTC

DIGITAL SIMULATION OF A FATIGUE TEST FOR SOLES

As we walk we subject the front sections of the soles of our shoes to substantial bending, especially when we place our weight on the front part of the foot. Repetition of this movement can cause the sole to split. It is this bending process that the laboratory test known as the Bennewart test reproduces.

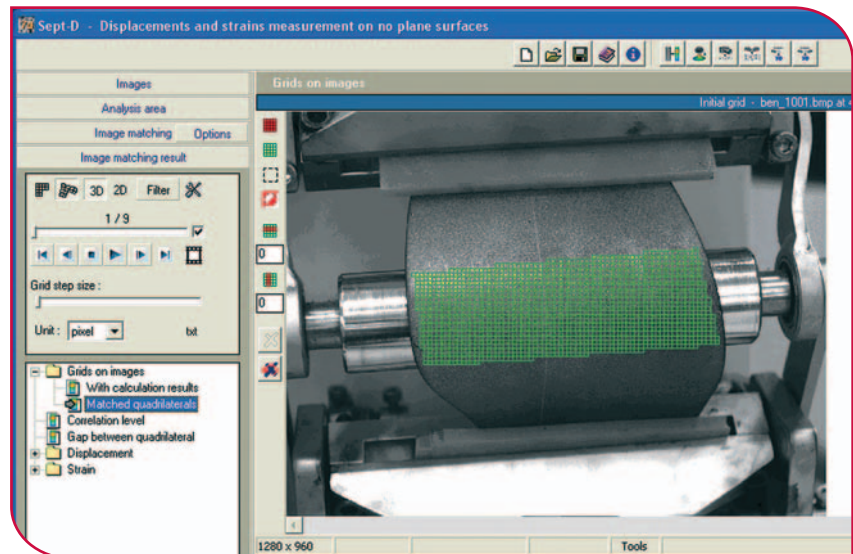
To avoid having to carry out field tests on multiple types of sole, which would be prohibitively expensive, CTC has developed a virtual test.

The sole is a component of footwear that is subject to considerable and varied mechanical constraints: bending, compression, abrasion and twisting. Soles, therefore, are components that need to withstand real wear and tear. It is essential to think about how soles will cope in the long term.

Standard tests—such as abrasion and flex (Bennewart) tests—are already in place, as is the CTC method of measuring repeated compression. The only problem with these tests is that they involve soles that have already gone into finished shoes without testing to see beforehand if they, the soles themselves, are sound enough.

PROJECT AIMS

At the moment, of all the tests that CTC carries out on footwear, the Bennewart test is one of the most effective for gauging how long a shoe will last. But, for this test, client organisations must already have fitted the sole to the final (or almost final) shoe construction, with the right mould and material.



From left to right: the multiple flex test for soles (the Bennewart test); using imaging techniques to measure damage at the end of the Bennewart test. CREDIT: CTC

This means manufacturers have to invest time and resources in a product that they cannot be sure will work.

What CTC has come up with, then, is a flex test for footwear soles, which aims to check and see if cracks appear and to see if any cracks spread from any small cuts after a large number of cycles (as many as 100,000). This number of cycles would be the equivalent of walking on the sole for 200 kilometres.

The test can stretch the sole by 250% or more and this can make any fissures caused by the test cycles worse.

It's easy to see from this that you could easily go through many different sole prototypes before coming up with one that would suffer no tears, even after 100,000 flexes. And it was because of this that CTC embarked on a project—called the Virtual Flexometer—to simulate digitally the Bennewart test.

Digital simulation tools are undeniably useful because they do not require manufacturers to produce moulds, models or other expensive prototypes. They allow producers to decide what shape and what material will work best in a sole to make it last as long as possible without any cracks.

This means, in effect, replacing the traditional Bennewart test with a digital simulation that can be carried out on a computer. But to be able to do that, it is essential to have certain data before you start in order to gauge the nature of the material for use in the sole and predict how it will perform—you can find this out beforehand by running some simple mechanical tests. You also need to have a clear idea of the shape of the sole and of where exactly the bending movement will occur.

With this information in place you will be able to simulate flex testing of the sole and be able to see from the results where and when cracks are likely to appear.

RESULTS OF THE PROJECT

CTC has been using digital simulation to test footwear for several years now and has built up a unique level of

expertise throughout the world in being able to characterise how sole materials will perform.

The project to develop the Virtual Flexometer is based on this expertise and is designed to produce long-term results. It used studies already carried out by CTC, most notably during the procedure of identifying and classifying different materials and of applying certain mathematical laws to the specific performance of elastomers.

At present, the digital simulation method has progressed since its launch to the point that CTC has been able to use it to determine how elastomer soles would perform in the Bennewart test. With the aim of comparing the digital method with the real test, the institute used a real sole-shape and statistics on real-life wear that came from a software application called 7D, which was used to reconstruct the space inside the shoe.

Analysing images that resulted from this exercise allowed CTC to map out, up to the maximum range of the Bennewart test, when and where the sole would start to lose its shape. These measurements were essential to be able to compare reliably the real test with the digital one. The next stage will be to validate digitally the different options of sole on offer.

A VIEW OF THE PROJECT

CTC still has to carry out some simple tests on the performance data it has drawn up before programming the information into the Virtual Flexometer. After this it will be necessary to simulate correctly a flex cycle with the sole, using the performance information achieved, and then extending that to multiple cycles in order to determine in the end how many flex cycles a sole will be able to withstand before any cracks appear. This will need to take real conditions into account as much as possible.

It is CTC's belief that implementing this simulation tool will allow users to improve the ability of their soles to withstand cracks while saving them time and development costs. 