FOOTWEAR TECHNOLOGY

While there is plenty of information available on the anatomy and the biomechanics of the ankle, there is no real concept of what ankle supports should do and how they should work. Because this can be an important issue in the fields of specialist footwear for sports, work or orthopaedics, Lyon-based testing and research centre CTC devised a new method for measuring and testing ankle support.

The importance of measuring a shoe’s ankle support

The ankle is a joint that operates under considerable constraints. We walk upright and the earth’s pull is downwards, so our ankles have to support all our weight. And if you look at human bone-structure, the ankle’s is not a solid-looking set-up. In fact, it looks as though the whole body sits on top of a sort of ‘pestle and mortar’ assembly, with the upturned ‘mortar’ being formed by a pincer-like bone bowl where the lower part of the fibula and tibia meet.

This coming together of the two main bones of the lower leg balances on and encases the bones that come up out of the foot, the ‘pestle’ in this analogy. There is so little interlocking in this mechanism that it cannot hold itself together. It’s precisely because the pieces interlock so little and are not bound together that we are able to move as we do.

We have ligaments going around this structure to hold the ‘mortar and pestle’ together: in other words, ligaments bind the fibula and tibia to the foot. We are talking here about the external lateral and internal lateral ligaments. They are effective because of their tautness and if they become slack, the ankle becomes too loose, making a patient or an athlete susceptible to frequent ankle-sprains.

A common complaint

Ankle-sprains are extremely common and happen to women as much as men, whether as a result of sporting activity or merely during work or leisure time.

For people who take part in sport, a sprained ankle is the most common physical problem: it happens in every sport and at every level of competition. In France alone there are thousands of cases of sprained ankles every year, around 90% of which affect the external ankle ligaments.

A number of different movements can be the cause of a sprain, but the most common is a twisting movement, often as a result landing badly on executing a jump, of missing our footing or, while running, the foot pushing towards the inside while the rest of the leg pushes towards the outside.

It is for this reason that it’s interesting, and in some cases, essential to be able to measure ankle support.
Uneven terrain puts trekkers, climbers, hikers and so on at increased risk of ankle injuries.

Footwear technology: The importance of measuring a shoe's ankle support

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In a medical context, it’s important to be able to measure ankle support offered by the ankle-foot orthotics currently in use to prevent or help heal ankle-sprains. For sports, brands and manufacturers may benefit from being able to show the levels of ankle support offered by various models of walking, hiking or climbing shoes. And it may also be a matter of interest to manufacturers of safety shoes.

**Extreme sports**

To return to sports, there can be no doubt that activities such as climbing, hiking, caving, trekking and even extreme skiing are enjoying great popularity at the moment. They all take place outdoors, which can sometimes prove to be an unstable or hostile environment, with uneven surfaces, steep slopes, banks of snow, slippery ground and so on.

This means people taking part in these sports need to have equipment that provides the maximum level of support and comfort. Adequate footwear is a central element of this equipment; the shoes people wear to carry out these activities must be comfortable and aimed entirely at protecting the foot and the ankle from the potential instability of the terrain. In this context, being able to measure the level of support for the ankle could be very relevant.

Based on its expertise in biomechanics and in developing footwear testing methods, CTC developed a laboratory test with a view to being able to analyse a shoe’s capacity for supporting the wearer’s ankle.

The aim of this test is to reproduce in the laboratory the twisting and turning movements the human ankle has to undergo. In fact, the test has shown that a restricted twisting movement allows the ankle to stabilise after sustaining the...
necessary pressure for the body to move into a vertical position as the foot goes flat onto the ground. It is at this precise moment that any imbalance at ankle level can have the most harmful effect.

CTC came up with a biomechanical foot to reproduce these twisting movements. It consists of a metal skeleton, covered in resin and a porous industrial material called Siporex. The skeleton structure has two interlocking joints, corresponding to the two main joints in the ankle: the talocrural joint and the subtalar joint. This makes it possible to carry out all the necessary movements.

Data capture
Each of the joints is connected to its own data capture device, which convert the angle of movement of the joint into electronic signals. These devices are themselves connected to a central measuring instrument by cables. During a test, the shoe that is the subject of the analysis is fitted onto the biomechanical foot.

The shoe upper is fixed into a dynamometer by means of a pulley and cables and the traction of the pulley causes the foot to move. The force applied by the dynamometer, as well as the angle of the ankle of the biomechanical foot, can vary during the test, with the measuring instrument recording the data.

The study consists of a series of five tests for each shoe, from which it is possible to work out the average force linked to the angle the shoe was subjected to during each test. This makes it possible to arrange the data in pairs, one value for the force and the second for the angle. The measuring device can then calculate what would happen if you raised these values, allowing you to calculate how much ankle support a shoe offers.

If the values in a data-pair are low, the shoe will be able to do little to prevent the ankle from moving (making sprains more likely), which is the case with soft rubber boots, for example. Alternatively, if a data-pair shows high values—as is the case with mountaineering boots, for example—it is an indication that the footwear will allow only limited ankle movement.

Conclusion
Establishing this test method makes it possible to test an aspect of footwear comfort, ankle support. The test measures the resistance levels of a shoe, in the ankle area, for a given angle, when the foot twists or turns. The data collected can be used to show how much ankle-movement a shoe will allow. This would allow consumers to make a quantitative comparison of shoes in a similar range.