Rhythm lightens the load

Backpackers and schoolchildren have good news in a new, ergonomic way to carry loads, says S.Ananthanarayanan.

Prof Lawrence C Rome of the Univ of Penn, a biomechanics expert working with Marine Biological Laboratory, Mass, has provided elastic supports to the loads to even out the impacts of up-and-down movement, which wrecks havoc on the bones and muscles of shoulders and back, apart from the knees and ankles. It also reduces the energy needed to carry the load and helps carry more or for longer.

Double whammy

In the traditional backpack, the load is rigidly fixed to the frame, which is then suspended on the shoulders and attached to the waist. In normal walking, the carrier rises and falls some 4 to 6 centimetres at each step. The load is then lifted by this distance and stopped in a fall through the same distance, at each step. The impact of the stop and lift is many times the load itself and soreness sets in within minutes of setting out with anything but the lightest loads.

The other element is that for every pace of about 60 cms, there is a lift of 7 cms. So, if we walk 10 kms, we have lifted the load up more than a kilometer, apart from moving the load forward. There is clearly something to be said for reducing how high the load needs to rise, and fall.

The Asian coolie

Like natural systems slip into the most efficient ways all by themselves, the traditional load carriers in our own part of the world had predated Prof L C Rome of Pennsylvania.
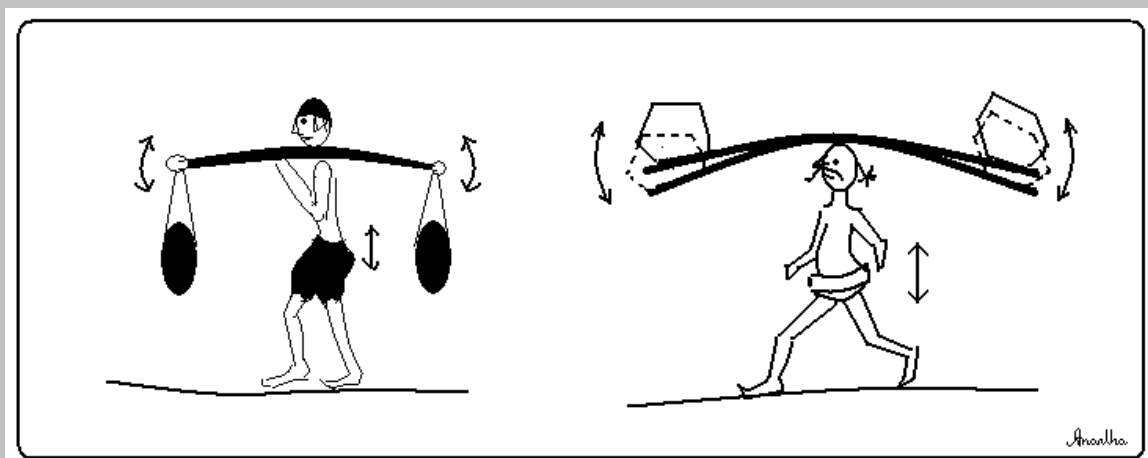
The porters and coolies and **bhishties** of India and south-east Asia suspend loads from an elastic, shoulder-carried cantilever or an elastic frame balanced on the head.

When the carrier takes a step, the lift of the shoulder/head is transferred to the load with a little delay, because of the elasticity, some of the force being taken up in bending the lever, rather than lifting the load. When the shoulder or head descends, again, the impact of the load descending is insulated. This apart, the impact is less because the load descends through a lesser distance.
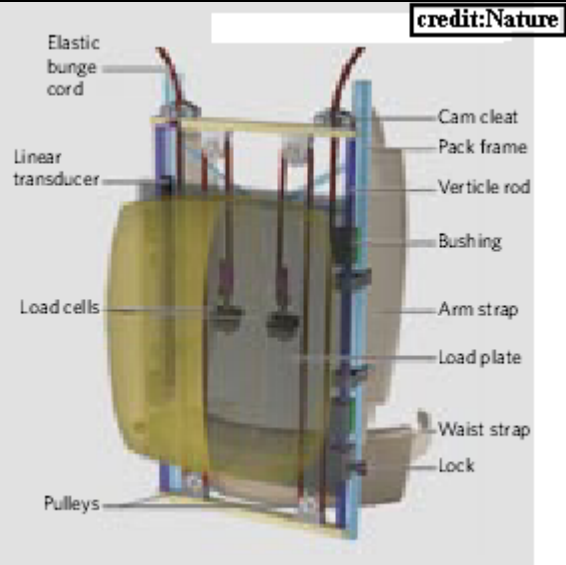
Rhythm

But the best thing is that dimensions of the support are such that the natural frequency of the rocking of the support matches the up-down movement of the carrier, so that when the carrier is at the lowest level and just rising, the load is at the highest level and ready to descend, thus reducing the effort needed. And when the carrier is highest, and the load is lowest, the carrier is descending and the deeply bent support is helping, by getting straightened, in lifting the load.

The energy for the work done by the support is also supplied, of course, by the carrier, but keeping the right rhythm evens out the effort to be exerted and reduces the impact of stopping and jerking up the load. A skilled worker can even adjust his speed and eliminate impact by keeping the load at the same level throughout!
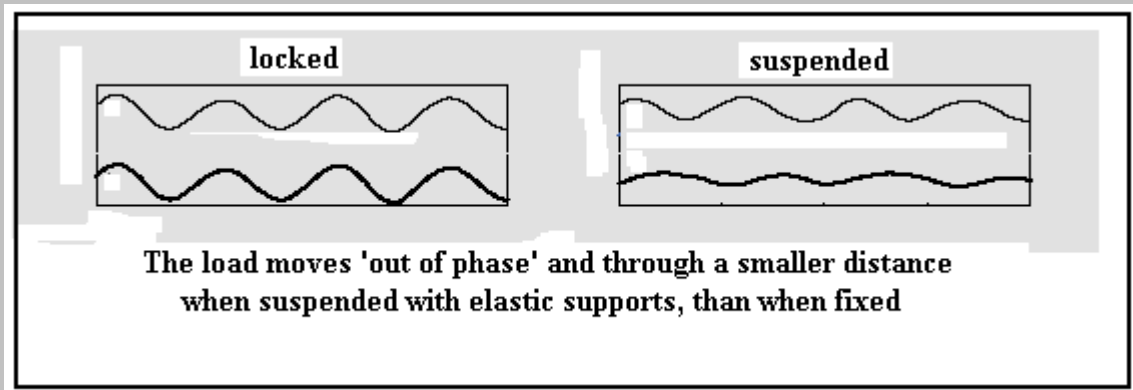

Coolie bobs up and down but the load stays at the same level
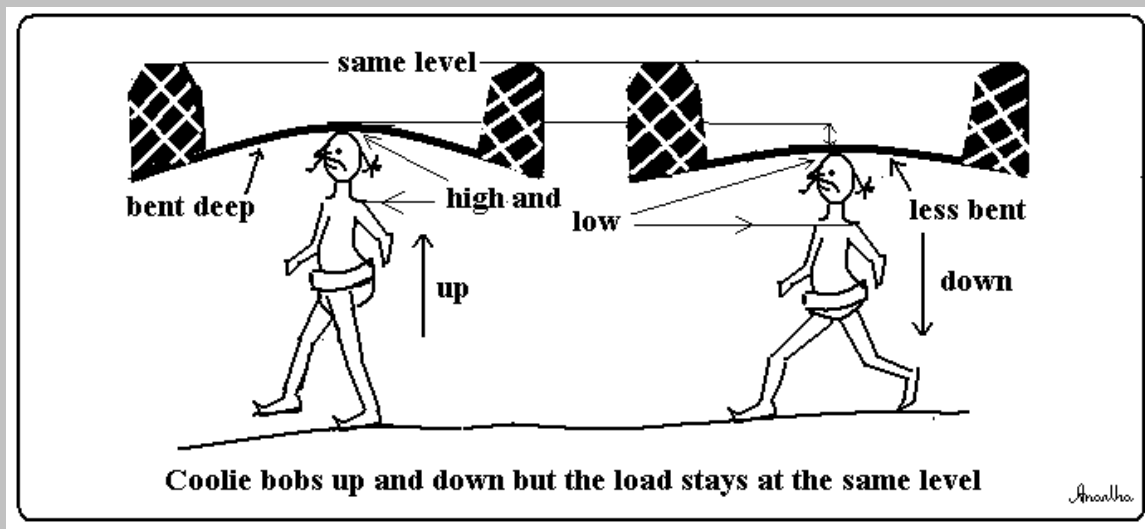
Ergonomic backpack

Prof L C Rome and MBL, Mass suspend the backpack load from the frame with elastic cords, the rope used for bungee jumping. When the hiker takes a step, the load does not rise with her, but stays put, while the rubber stretches. It eases up as she reaches the highest point and keeps going, but never reaches as high as she did. And while descending, again, the load does not come to stop with a thud, but the fall is insulated and slower. And as the hiker has started rising before the fall is complete, the load does not go down as low as the hiker.

credit:Nature

Elastic bunge cord
Linear transducer
Load cells
Pulleys
Cam cleat
Pack frame
Verticle rod
Bushing
Arm strap
Load plate
Waist strap
Lock

"While walking at 6.5 kmph, the vertical oscillation of a 27 kg load is reduced from 68.5 mm in the locked backpack to 26.5 mm in the suspended backpack", says Prof. Rome in a communication published in *Nature* this week, "The metabolic cost of walking with the load falls from 640 W for the locked backpack to 600 W", he adds.

locked   **suspended**

The load moves 'out of phase' and through a smaller distance
when suspended with elastic supports, than when fixed

This saving represents 23% saving in the extra effort required for a grown man to walk with a 27 kg load as compared to without one. And this is apart from the reduced orthopaedic and muscular trauma with the fixed load!