

## TRAILER SCIENCE - WHAT IS BEST?

### WHY TWO-WHEEL TRAILERS ARE BETTER

Carrying a load by bike costs the cyclist energy. So how can this energy be reduced to a minimum?

**Panniers** fix the load rigidly to the bicycle, if the bike moves, the load moves. Some pannier systems mount the load low to the ground so when the bike leans the load doesn't move as much as if it had been higher on the bike.

**Mono wheel trailers** lean with the bike, and the load moves from side to side in a similar manner to low slung panniers.

**Two wheel trailers** in contrast do not lean. The trailer and the load are isolated from the bike. It is this difference that we are focusing on.

#### Energy saving of a trailer

Panniers move with their bike. Imagine a bike leaning slightly from left or right. Mono wheel trailers do the same, taking their load with them. Moving this weight costs energy. The faster the bike leans and the further the weight is moved from its original position, the more energy is used. Panniers are further away from the ground than a mono wheel trailer, hence pannier loads move more than loads on mono wheel trailers and use more energy.

#### Moving loads cost energy

Using energy to move the load when a bike leans is a waste. Worse than this the energy needed comes from you and passes through your bike frame to get to the load. This means you need a stronger/heavier bike to cope with the extra energy flowing. Think of the lazy frame angles, extra strong frames and extra spokes on touring bikes. It would be so much better if you could lean your bike without moving the load it was carrying!

#### Two wheel trailers

Consider the same load on a two wheel trailer; if the bike leans, the trailer and its load does not move. If the load does not move, no energy is used. If no energy is used then the bike does not need to be stronger to cope with the extra twisting forces and you are not wasting energy moving the load from side to side.

But how much does a bike lean during a given ride? Well, watch someone as they cycle; every time they turn their pedals, they and their bike wiggle slightly to the left then slightly to the right. That is a slight wiggle every turn of the pedals, 60 times a minute, 3600 times an hour. This is especially noticeable when the cyclist is pedalling out of the saddle, when accelerating or climbing a hill. Perfect cyclists do not wiggle but the other 99% of us do. Cyclists are also continually correcting the balance of their bike,

by leaning slightly left or slightly right. And finally as cyclists turn corners, the bike will also lean left or right.

#### Energy cost of a trailer

So because the load does not move while the bike leans, energy is saved. However, using a trailer also costs energy. There is the extra weight of a trailer that has got to be pulled up hills, the wind resistance of the trailer and the drag from the trailer's tires/wheels. Does the benefit outweigh the cost?

#### Trailer weight

A trailer might weigh 5 kg, but the bike towing it can be a few kg lighter than a touring bike, and it needs no panniers/racks, so the extra weight of the trailer needs to be compared against the savings made by using a lighter bike. We could assume that the bike can be 3 kg lighter so the net weight gain could be as low as 2 kg. Also the extra weight is not being wiggled and uses less energy. Also this extra weight is only there when a load is being carried. When you carry no load the bike weighs an extra 125 g (the weight of the hitch), this cannot be said of panniers.

#### Aerodynamic drag

About 90% of your cycling energy is used in dragging you and the bike through the air, but a trailer sits very close behind your bike in a bubble of "turbulent" air that the bike pulls along anyway. The trailer is similar to a racing cyclist who tucks in behind the leader to save energy. A rough drag coefficient can be estimated if you know an objects frontal area. Most of a trailer's frontal area is in the shadow of the rider and will certainly not add more frontal area to a bike than panniers will. Cycling with loose clothing would cost more energy than cycling with a trailer.

#### Tire Drag

A bicycle's tire drag accounts for only a few percent of a cyclist's energy. We use high quality touring tires and cartridge bearings to minimise this almost insignificant drag.

#### Conclusion

On balance we consider the energy savings of rotationally isolated loads offset the energy cost of tires and wind, so over the course of a ride two wheel trailers use less energy for a given load than panniers or mono wheel trailers. Costing less energy allows a cyclist to carry more or go further for a given input. More than this the bike needs no special adaptation or qualities to tow a trailer and it feels "normal" when being cycled.

Enjoy your trailer and the freedom it brings.