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THE Y

Trailer Science

Carrying load by bike costs the cyclist energy. However some methods of carrying cost more energy than others. We consider three representative ways of carrying load, panniers, mono wheel trailers, and two wheel trailers. We seek to demonstrate that two wheel trailers are frequently the most efficient way to carry loads.

Panniers fix the load rigidly to the bicycle, if the bike moves, the load moves. Some pannier systems mount the load low, so when the bike leans the load doesn't move as much as when it is higher on the bike. Mono wheel trailers are almost as rigidly attached to the bike, so if the bike leans the load moves from side to side in a similar manner to low slung panniers. Two wheel trailers and the load on them, do not lean essentially stay still as the bike leans. It is this difference between panniers/mono wheel trailers and two wheel trailers that is what we are focusing on.

ENERGY SAVING OF A TRAILER

Panniers move with their bike. Imagine a bike leaning slightly from vertical to the left or right. Panniers or mono wheel trailers and their load also move as the bike leans. Moving this weight costs energy. The faster the bike leans the more energy is used, 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 mono wheel trailers loads for the same angle/speed of lean, and hence they 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 needs come from you, and pass through your bike frame to get to the load. This means so 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. Wouldn't it be great 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 hence 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 a load from side to side.

But how much and how often does a bike lean during a given ride? Quiet a lot actually. Watch someone as they cycle; every time they turn their pedals they and their bike wiggles, slightly to the left then slightly to the right. That's 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, again the bike will 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's got to be lifted up hills, the wind resistance of the trailer, and the drag from the trailers 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, uses less energy than the same weight were it on the bike or you. Also this extra weight is only there when a load is being carried. When you carry no load the bike weighs an extra 120 g (the weight of the hitch bracket) 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 guessed at if you know an objects frontal area. Most of a trailers 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 bicycles tire drag accounts for only a few percent of a cyclists energy. We use high quality touring tires, and cartridge bearings to minimise this almost insignificant drag.

ELECTRIC POWER ASSISTED BIKES

The same principles apply even more to Electric Bikes. Power assist gives more carrying capability and range. Carrying heavy loads becomes even easier and a combination E Bike - Carry Freedom Trailer, is a big step forward to a sustainable modern transport system, without cars.

CONCLUSION

On balance we consider the energy savings of rotationally isolated loads offset the energy cost of tire's 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. Using 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.
Bob - 2020

Carry Freedom, we create innovative high quality solutions tailored for people living in the real world.

For more information go to www.carryfreedom.com