**Ergonomics, Casters and Wheels**

In our experience, it is difficult to predict caster/wheel push pull forces. We have not found rolling resistance formulas – based on wheel diameter – to provide particularly useful predictive data. In most applications for casters, many environmental and application variables are in place – and formulas may provide a false sense of precision. Attempting to predict push/pull also doesn’t take into account the design intent for a cart, tool or work stand.

However, in an attempt to provide some assistance with ergonomics, casters and wheels, following are a few thoughts on the ergonomic impact of key caster components:

Wheels:

In general – if we assume 95A polyurethane-tired wheels on smooth concrete – and wheel diameters between 6” and 10” – using 3% of the load on the caster as the max startup force – and 1% of load on the wheel as the steady state force for a continuous roll – is fairly safe.

For hard wheel materials such as steel, nylon or phenolic – and harder polyurethane-tired wheels – these percentages will drop. And, for softer polyurethane and rubber-tired wheels – these percentages will increase.

While hard wheels do initially roll easier, they do have a tendency to pick up foreign object debris (FOD) – so that over time, their rollability can become compromised – resulting in diminished ergonomic advantage vs. polyurethane wheels. And, some high-performing, softer 85A durometer urethane-tired wheels – with high elasticity and rebound properties – will actually perform better than harder 95A polyurethanes wheels.

Using split-tread, ergonomic wheels – such as Twergo or Swivel-EAZ – can further reduce the max force at startup to about 2% of the applied load – or even 1.5%, depending upon the load applied to the wheel and caster.

Caster Yoke/Chassis and Main Swivel Bearing:

The design of the caster’s main swivel bearing can also impact caster ergonomics. Our general industry consensus is that kingpinless main swivel bearings provide ergonomic advantage over kingpin-style swivel bearings. A kinpinless race essentially increases the kingpin size to the diameter of the swivel race – and distributes the axial loads accordingly. For example, a standard industrial kingpin-style caster commonly has a 5/8” diameter kingpin – the equivalent kingpinless caster has a 2-1/8” diameter swivel race.

In recent years, ergonomic casters have begun using precision ball bearing swivel races. Industry consensus is that this style swivel bearing provides ergonomic advantage over kingpinless – but generally does not offer the same impact resistance as compared to kingpinless or kingpin-style casters.

If ergonomics is the primary concern then using a precision ball bearing swivel section is the best choice. If impact loading and high stress durability is more important, then a kingless caster tends to perform the best.

Swivel Offset:

Increasing/extending the swivel offset/swivel lead – which is the distance from the center of the caster kingpin to the center of the wheel axle – can offer ergonomic advantage. Because casters are generally opposed to the direction of travel at startup, a greater swivel lead creates a larger moment arm, requiring less force from the caster user to initiate motion at startup, resulting in greater ergonomic advantage.

It is important to note, however, that swivel lead must incorporate wheel diameter – and that a balance should be maintained. If the swivel lead is increased beyond the optimal amount, ergonomic advantage can actually be lost. When it comes to swivel lead – too little or too much can have equal and opposite negative effects – with the correct solution residing in the middle range.

In power towing applications, a caster with an extended swivel lead can travel at a higher speed while resulting in better tracking and less swivel caster “flutter.” The drawback of an increased swivel lead is generally a corresponding reduction in caster capacity.

Wheel Bearings:

Historically, caster wheels have used straight roller and tapered roller bearings. In recent years, precision sealed ball bearings are displacing roller and tapered bearings to provide greater ergonomic advantage – with the added benefit of being maintenance-free.

Summary:

We find the casters and wheels provide the best ergonomic advantage when they are subject to loads at about 50% of their rated capacity – and that wheel selection has the biggest impact on ergonomics. In all cases, the best ergonomic push/pull data is supplied through drawbar testing – either in the lab or in the field.