

Scaling Calculations

Scaling calculations are best done with CAE analysis. We can determine the lifetime and weight-bearing strength of the existing design, and we also know that we can build a smaller microtractor. However, to build a larger tractor such as a bulldozer - with at least 20,000 lb. weight, we should perform CAE analysis based on the specific geometry in question. This will determine the shaft sizing, coupling, and gear reductions allowable in the system based on a 100 year design lifetime. From back-of-envelope calculations, 2.5" shafts, dually or truly wheels on the exact same drive system as now, with jackshaft gear reduction, could yield approximately 15,000 pounds of traction power by simply using 16" truck tires with 4 wheel drive. This is based on the 5000lb traction limit of an F250 truck - assuming 4 wheel drive and single tires.

Traction

The 15,000 Inch Pound Motors of LifeTrac Prototype IV produce approximately 1000 lb. of force at the 15" radius of the wheels, combining to a total of 4000 pounds of traction force in 4 wheel drive operation. Assuming 1 as the coefficient of friction for a 5000 lb. gross weight tractor, this translates to traction comparable to an F250 truck.

The motor shaft is 1.5" tapered, and the wheel shaft is 1-7/8", or an approximate good match for direct transfer of torque from wheel motor to shaft.

Traction CAE Analysis

These tests are useful:

1. Determining the shear limit of a 3/4" grade 8 bolts holding the wheel in place. This would involve 3 points of failure: the shearing of the bolt (simple pin-through with metal lock nut); ripping of the 3/4" bolt hole through the cold-rolled steel shaft; ripping of the reinforced collar holding the wheel. Test for maximum safe torque with a safety factor resulting in 30 years of continuous operation (equivalent to 8 hours per day for 100 years).
2. Determining the wheel mounting strategy (multiple bolts, key, or spline that would achieve the above lifetime). If practical considerations require replacement as the only lifetime design option, that may be the outcome.

Load Tests

1. Test for maximum weight bearing capacity of 1-7/8" shaft based on wheel geometry of Quick Attach Wheel.
2. Test of weight bearing capacity of Quick Attach Wheels system.
3. Weight holding capacity of frame assuming point load on 2 upper horizontal long members for

a deflection of 1/2" or until bolt failure, whichever is earlier.

4. Shock absorbing capacity of frame using Grade 2 bolts prior to bolt shearing, and same with Grade 5 and 8 bolts. This is used to determine if Grade 2 bolts are satisfactory for lifetime design.

5. Scaling frame 2x to determine weight bearing capacity of tractor with a larger frame. This is used to determine whether the tractor can be weighed down with concrete or other weights, height being scaled to about 10x16 feet - or the size required for a bulldozer of 20,000 lb. minimum weight.

6. Using 2.5" bearings, determining the maximum weight bearing capacity for a jack-shaft drive system, 4 wheel drive, for a bulldozer - using all-steel wheels like in old steam traction engines from about 100 years ago.

