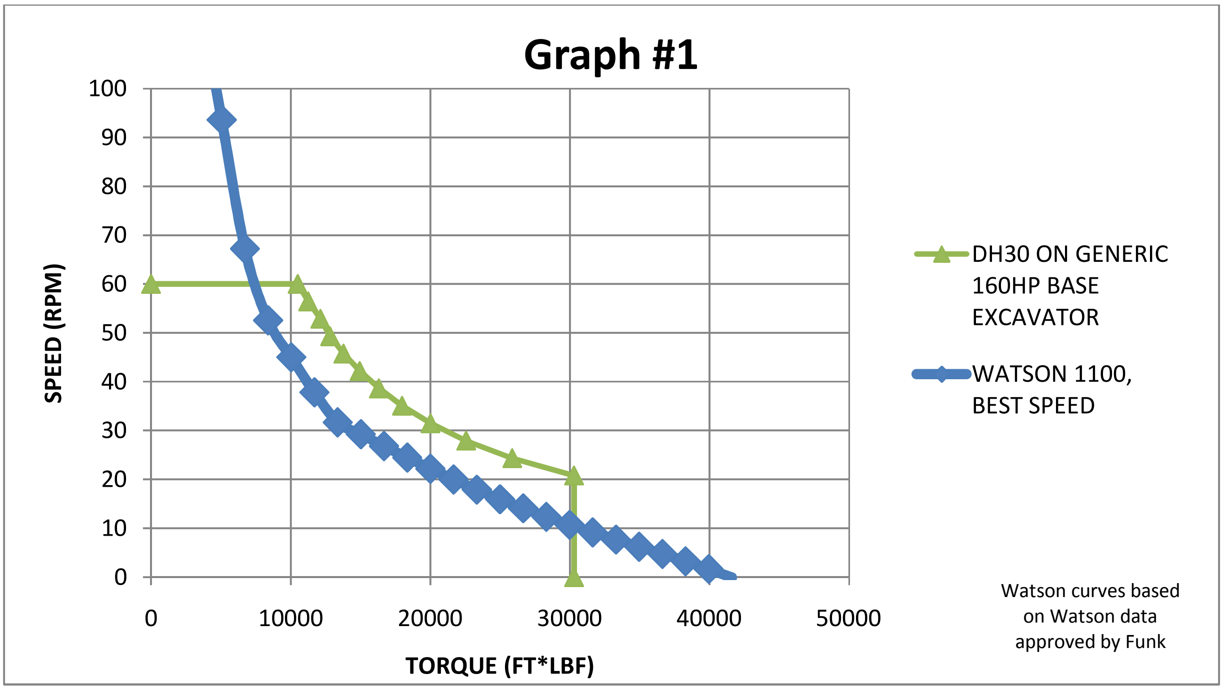
Torque vs. Torque

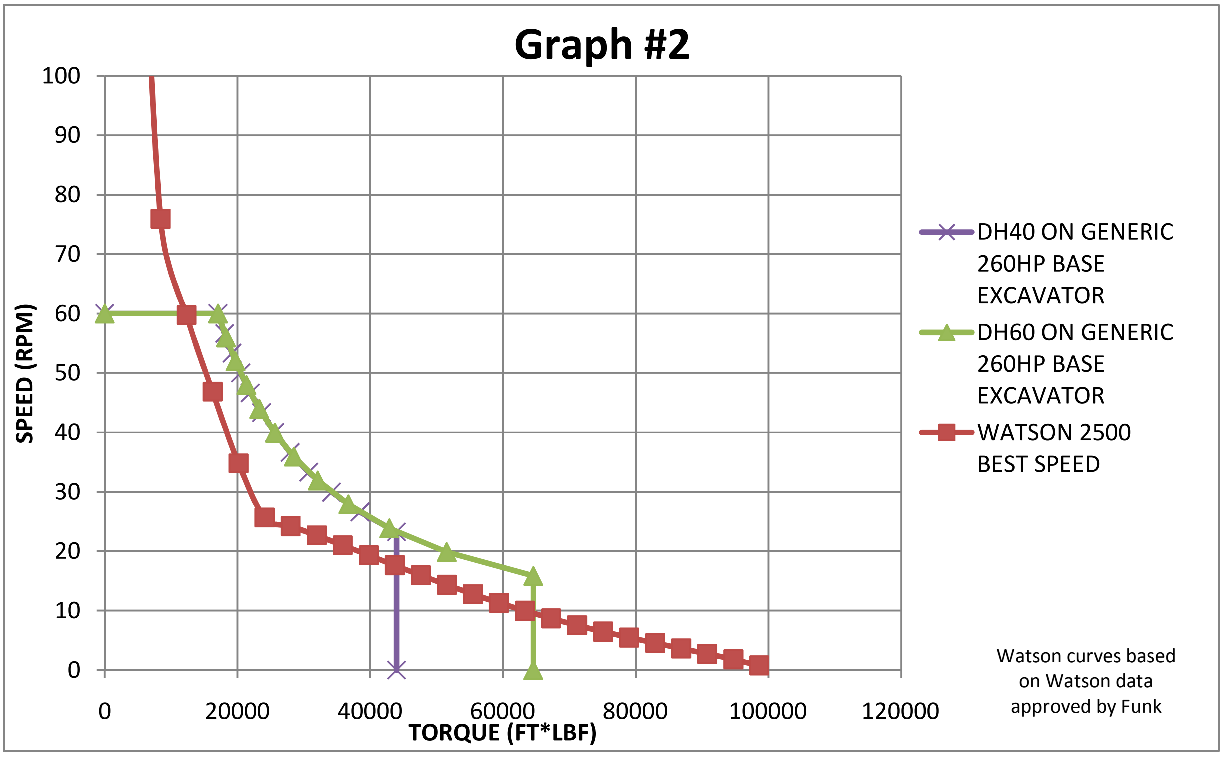
The drilling industry is unique to many quirky terms, methods, and specifications. Torque is one of these areas. Our industry is the only industry to focus so highly on torque. When you look at other heavy construction and mining applications, horsepower and weight are the two dominating factors. In this white paper, I will compare our equipment to equipment of some of our competitors while focusing on torque, HP, and weight.

Most people already know the difference between mechanical torque and hydraulic torque. The general rule is to divide the mechanical torque in half to equal hydraulic torque. While this practice has become standard, a lot of people do not know the reason. The way a mechanical drill works is very much like a manually shifted automatic transmission on a car. You have an engine, transmission, torque converter, and final drive.

Dividing mechanical torque in half is not 100% accurate, as these machines will generate their rated torque; however, the rated torque is produced at or near zero RPM. Most holes do not get drilled at zero RPM; they commonly get drilled between 20 and 60 RPM.

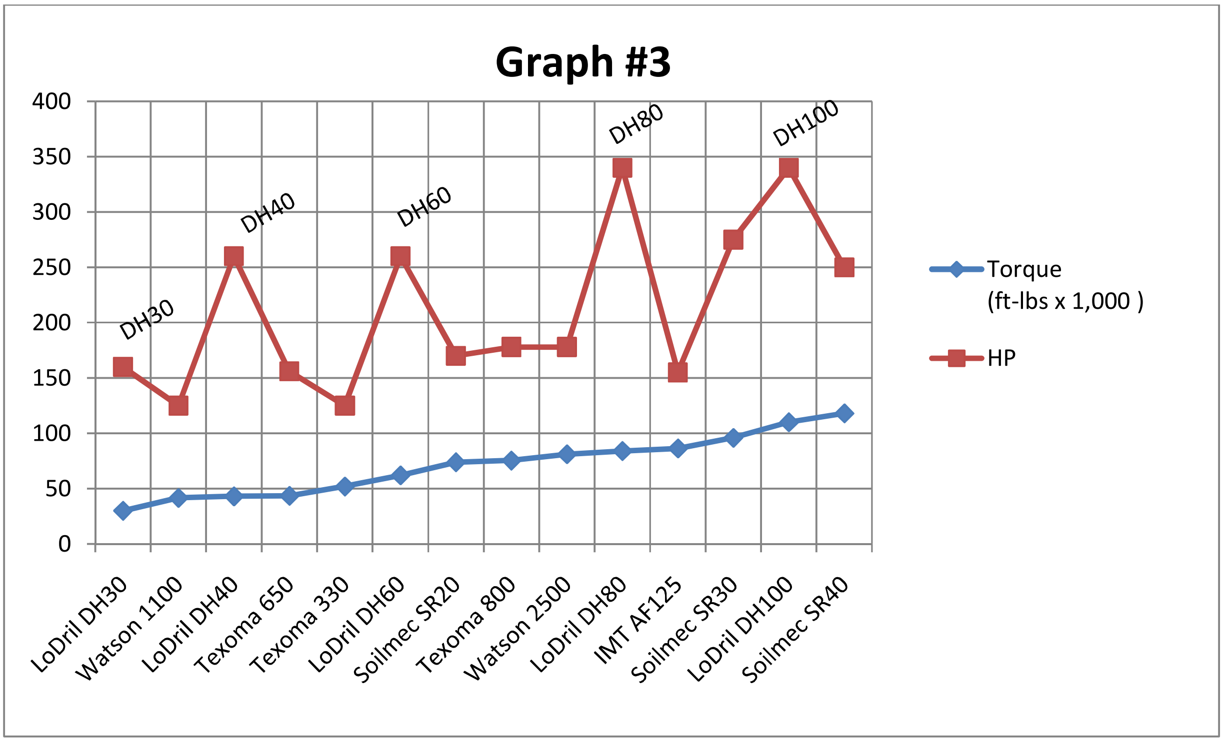
If we look at graph #1 we can see the comparison between a Watson 1100 and a LoDril DH30. The graph shows the best speed curve for the Watson, which is the most efficient speed, and torque ranges for each gear and the DH30 assumed on a 160 HP (120 kW) base excavator. As you can see, the DH30 has a definite speed and torque advantage in the 12-60 RPM range. If we assume that the most common drilling speed used by drillers is 25 RPM, we can see that the 1100 peaks out in 1st gear at approximately 17,500 ft-lbs (24 kN-m) and the DH30 at 25,000 ft-lbs (34 kN-m). Similar data is shown on Graph #2, which compares a Watson 2500 to a LoDril DH40 and DH60.



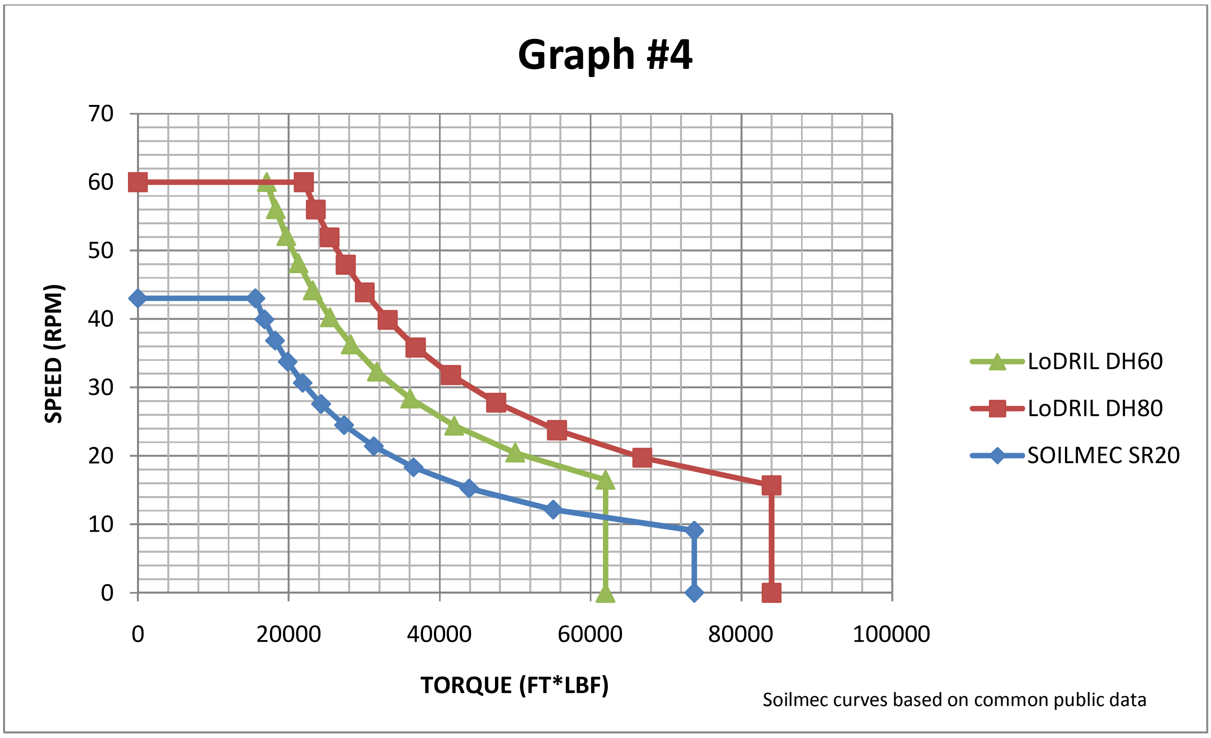


Another industry trend when using mechanical rigs is that it is forbidden to use 1st gear. This is primarily because something on a mechanical rig will break when full torque is reached in 1st gear.

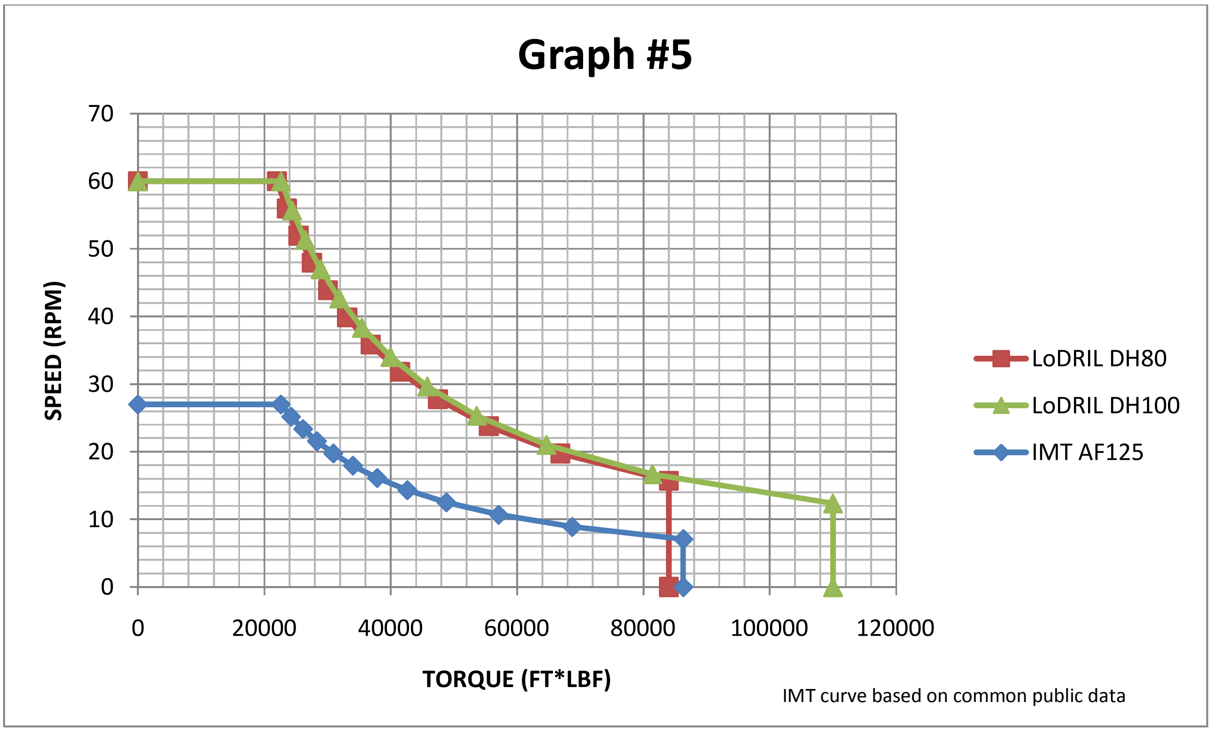
The data and graphs for mechanical machines speaks for itself. Next, I would like to focus on comparing equivalent torque machines with differing engine power ratings. There is a very simple equation that you can use to determine the relation between HP, torque, and speed: HP = (ft-lbs * RPM) / 5252. Graph #3 shows a series of drill rigs with their listed HP and torque. The LoDrils clearly have the torque-to-HP advantage. Taking the data from the chart and graph, we can use the equation above to solve for the variable, which is RPM. Rearranging the equation gives us: RPM = (HP * 5252) / ft-lbs. Clearly, more HP and less torque will result in a higher RPM.

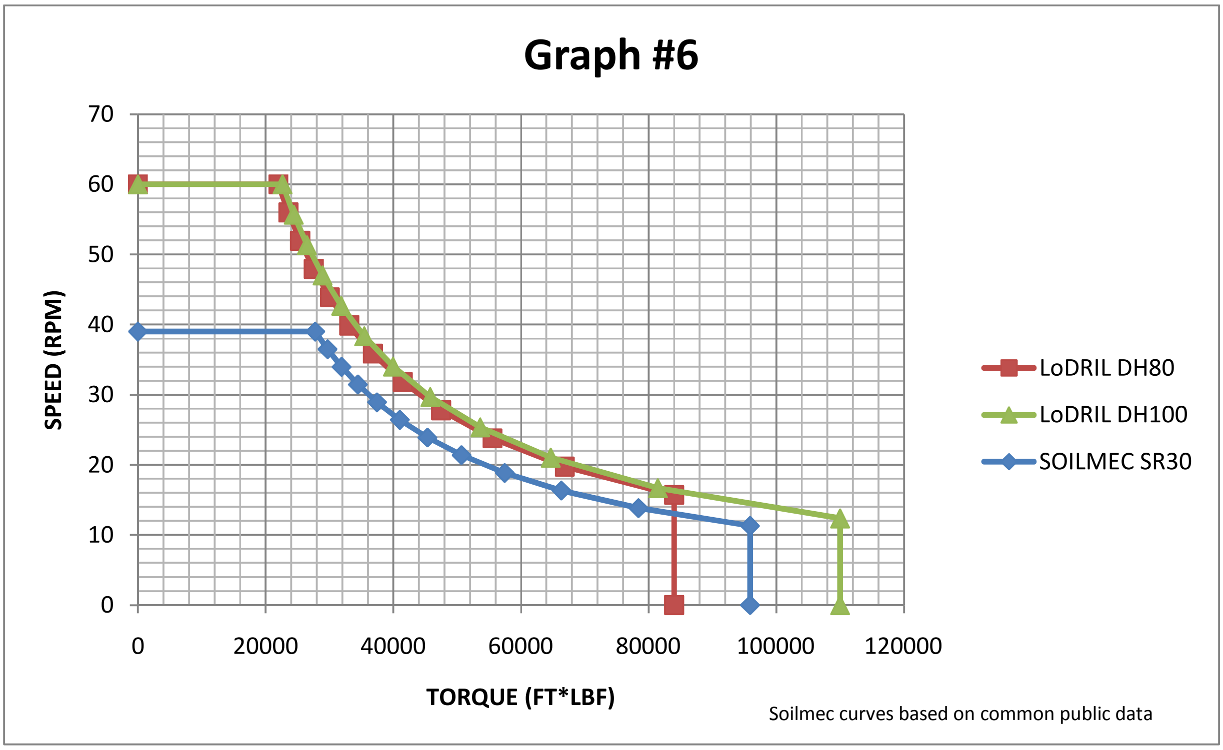


To further this explanation and to make it more visual, graphs #4 through #7 can be consulted. LoDril models DH60, DH80, and DH100 have been compared to a Soilmec SR20, IMT AF125, Soilmec SR30, and Soilmec SR40. On every graph, the LoDrils have a definite speed advantage at a given torque.

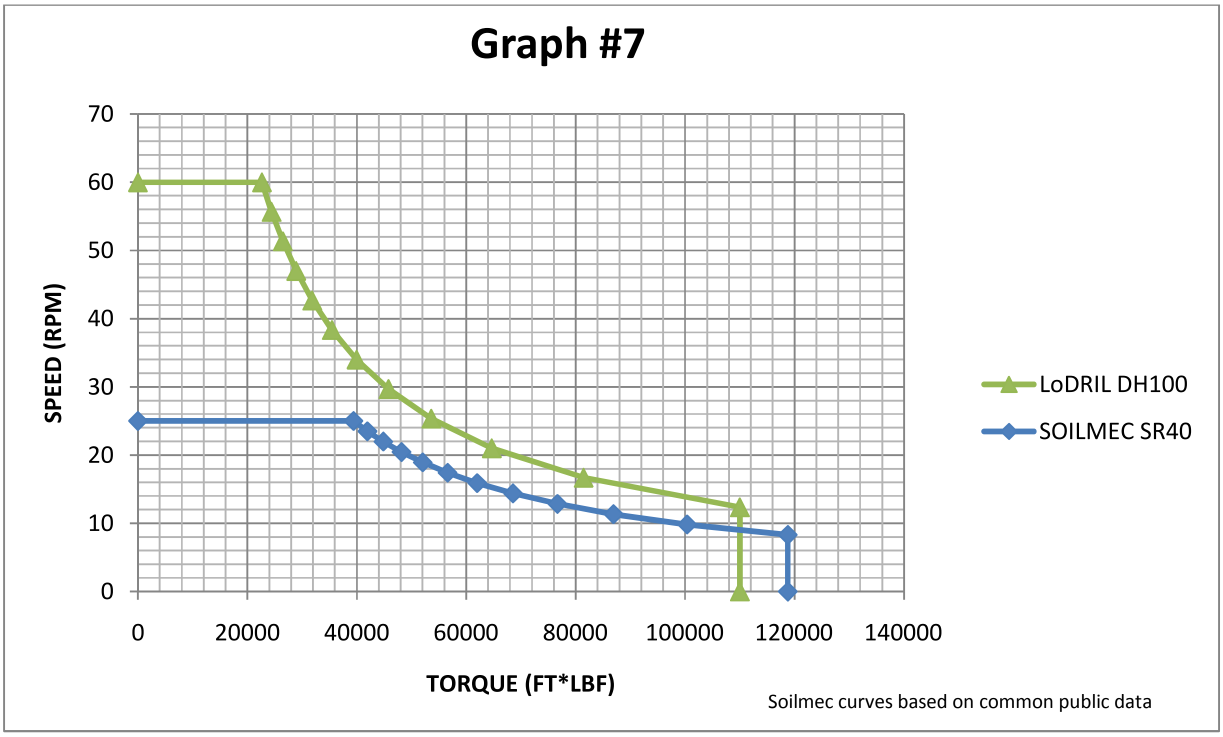


This leads into one of my theories about why so many contractors have such high-torque drill rigs. For no particular reason, let's focus on the IMT AF125. I have no doubt that this machine will achieve their rated 86,000 ft-lbs (116 kN-m) of torque, but it is achieved at approximately 7 RPM. Just like in the mechanical torque comparison, if we look at 25 RPM the IMT only produces approximately 25,000 ft-lbs (34 kN-m) of torque, while the DH80 and DH100 LoDril produce over 50,000 ft-lbs (68 kN-m) of torque. If a contractor wants to generate similar LoDril torque, 50,000 ft-lbs at 25 RPM, they would need to look at a much larger European style machine.



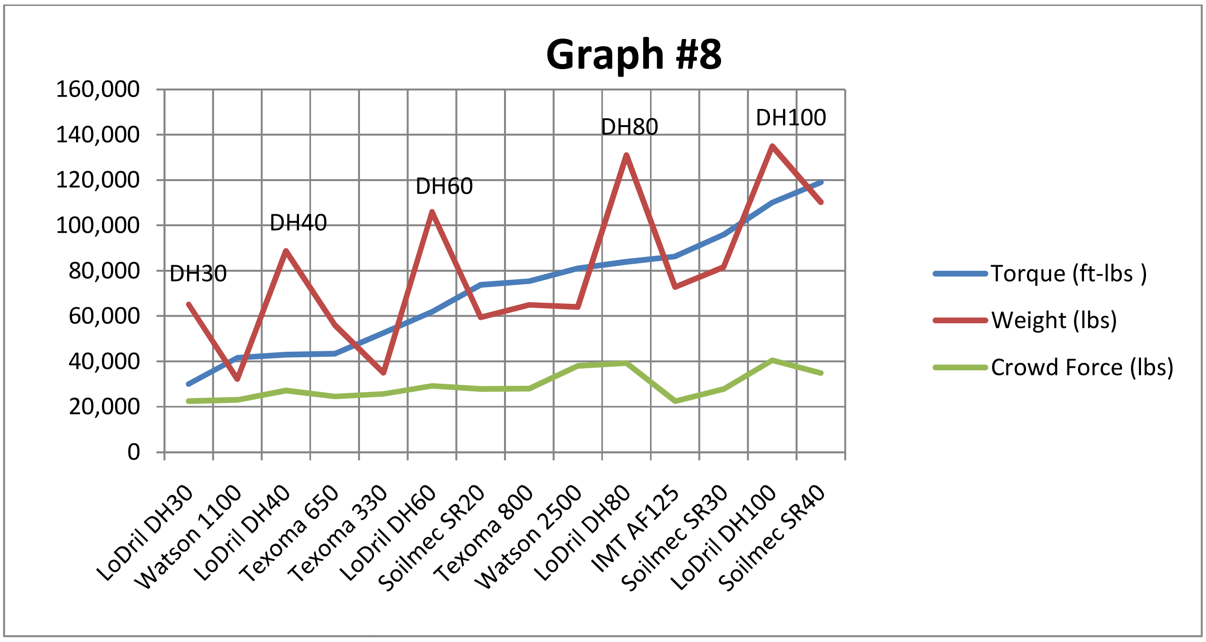


Also, looking at the comparison between the Soilmec SR30 and SR40 is very interesting. The SR40 actually has less HP than the SR30 based on the specifications on Soilmec's Website; therefore, comparing the curves, the SR30 will outperform the SR40 until you get below 10 RPM.



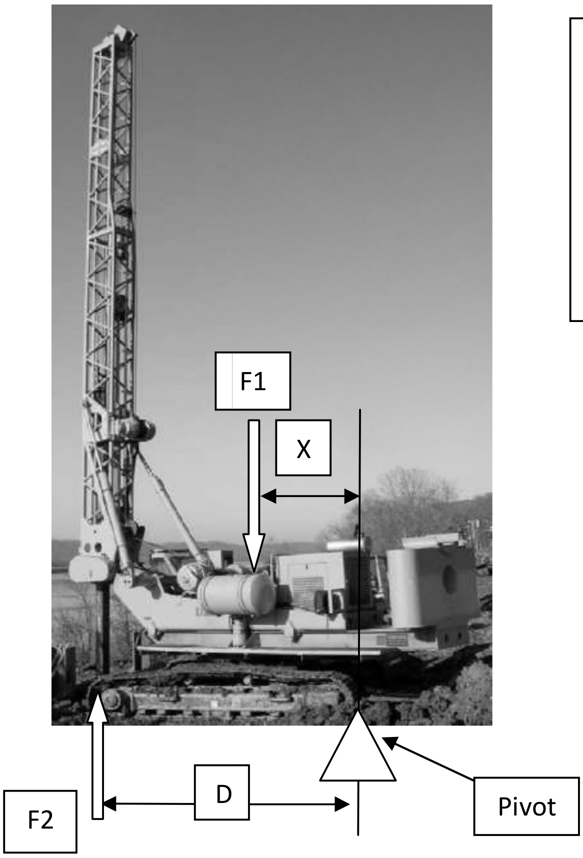
I hope these explanations and graphs have been able to show just how important HP is. At the end of the day, we could create 100,000 ft-lbs (135 kN-m) of torque with a 5 HP (4 kW) lawnmower engine. What would be the disadvantage of doing this? Plug it into the equation above and you will see that you would be turning an auger at 0.26 RPM assuming 100% efficiency. Looking at this from the other end, let's assume we want 100,000 ft-lbs (135 kN-m) and 60 RPM drill speed, what HP would we need? We would need over 1100 HP (820 kW)! Even a Bauer BG48 doesn't have that kind of power.

The last point I would like to focus on is the weight of the equipment. Weight gives you several key requirements when drilling: Rigidity, stability, and crowd force to name a few. Graph #8 shows a relationship between torque, weight and crowd force. The LoDrils have the advantage of weight vs. crowd.



As a general rule, we build LoDrils to maintain a 30% - 35% ratio between crowd and weight. Other machines, such as the Watson 1100, have a ratio of over 70%. This means that the Watson 1100 can apply over 70% of its weight to crowd, the Watson 2500 almost 60% and a Soilmec SR20 almost 50%. A simple statics equation and calculation will show how valid these specified crowd forces are.

Looking at the Watson 1100:



F1 = Watson 1100 weight
- 32,310 lbs (14,655 kg)

F2 = Crowd force
- 23,000 lbs (102 kN)

X = Distance from pivot to calculated center of gravity (calculated below)

D = Distance from pivot to center line of kelly bar (assumed from scaling a photo)

ΣM = 0

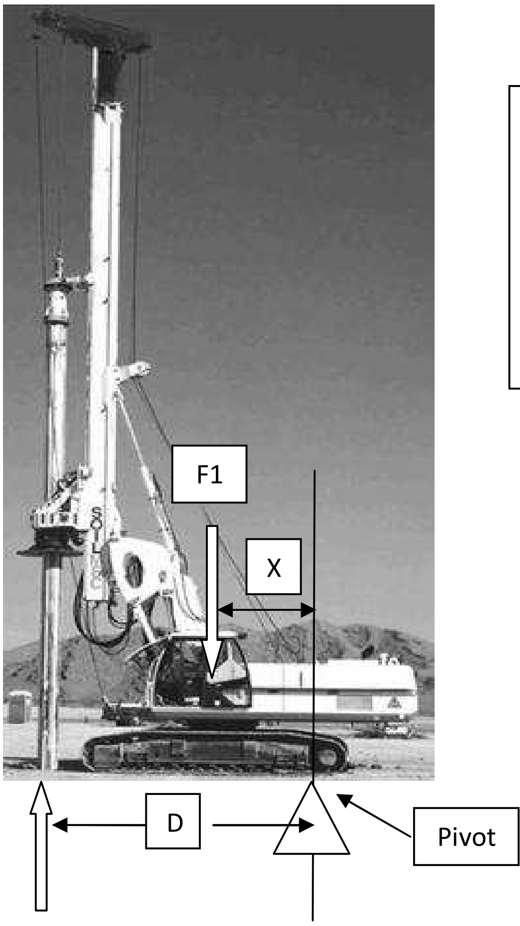
32,310 lbs (X) = 23,000 lbs (14’)

X = 10’ (3 m)

This means that the center of gravity is 10’ (3 m) in front of the pivot point, which I have assumed is at the back of the tracks. This scenario is ideal and, therefore, unrealistic. Looking from the other direction, this means that there is only approximately 3’ (0.9 m) from the Kelly bar to center of gravity. If this weight and crowd force were true, the machine would be too unstable to move and have virtually no capacity to lift an auger out of the hole.

To summarize, it can be determined that the Watson may have the ability to crowd 23,000 lbs but it does not have enough to react all of this force. Putting the weight through the centerline puts the available crowd from between 16,000 and 18,000 lbs.

Looking at the Soilmec SR20:



F1 = SR 20 weight
- 59,500 lbs (27,000 kg)

F2 = Crowd force
- 27,875 lbs (124 kN)

X = Distance from pivot to calculated center of gravity (calculated below)

D = Distance from pivot to center line of kelly bar (from SR 20 brochure dimensions)

ΣM = 0

59,500 lbs (X) = 27,875 lbs (16’ 11”)

X = 8’ (2.4 m)

The summary of the SR20 gets complicated. In the brochure there are two crowd forces listed, 68 kN and 124 kN (15,400 lbs and 28,150 lbs). Which to use? Considering a crowd force in the up position, or retract, is unneeded we will assume that the higher number is the down crowd force. Also, since the SR20 has a parallelogram the center of gravity can move unlike the Watson. Assuming the max and min reach point with the 124 kN crowd force the center of gravity will be approximately 13” – 21” (325 mm – 540 mm) in front of the center line of the machine or 4’6” – 5’ behind the front of the track. This seems very practical.

So, what is the other 68 kN (15,400 lb) crowd force listed for? Is this the actual crowd force? If so then the center of gravity would move behind the centerline of the machine by approximately 24” (600 mm). This seems very unrealistic. I will say again, why list two crowd forces?

In conclusion, we have seen the differences in hydraulic vs. mechanical torque, hydraulic vs. hydraulic torque based on horsepower, and how weight is directly related to crowd force. I am not trying to discredit any of the drill rigs or manufacturers mentioned in this paper, I am just presenting the facts. I urge you to seek all the facts about the equipment you own or plan to own. Bay Shore Systems is here to help you make the most educated decision.