



Turf Compaction Comparison **REPORT**

Play golf and ride in a golf cart. It is almost a given these days. But the traffic jam caused by golf carts is getting out of control and is taking an increasing toll on turf.

There have been several good research studies in recent years documenting the impact of golf carts on turf wear, and this article will examine these effects by letting the numbers tell the story.

CART DAMAGE DEFINED

Several studies have analysed the turf damage caused by golf carts and other turf vehicles. The impacts can be broken down into two broad categories:

- **Turf injury** - The wear damage caused by vehicles is influenced by the speed of travel and the amount of stopping, starting, and turning. The tread design of tires also affects wear damage. Wear symptoms include leaf tissue matting and a subsequent exposure of underlying thatch. With additional traffic, leaf blades are bruised. Ruptured cells eventually give turf a dark, water-soaked appearance. Wilt sets in as water is lost from the leaves, eventually causing a loss of chlorophyll and cell death.
- **Soil compaction** - The soil compaction caused by carts reduces the shoot growth rate and the recuperative potential of turf grass. Compaction reduces air and water porosity within the soil as well as water movement through the soil profile. Soil compaction can impact turf growth for several weeks or months, resulting in the total loss of turf cover and chronic problems with poor drainage and the invasion of weeds that prefer compacted soil conditions.

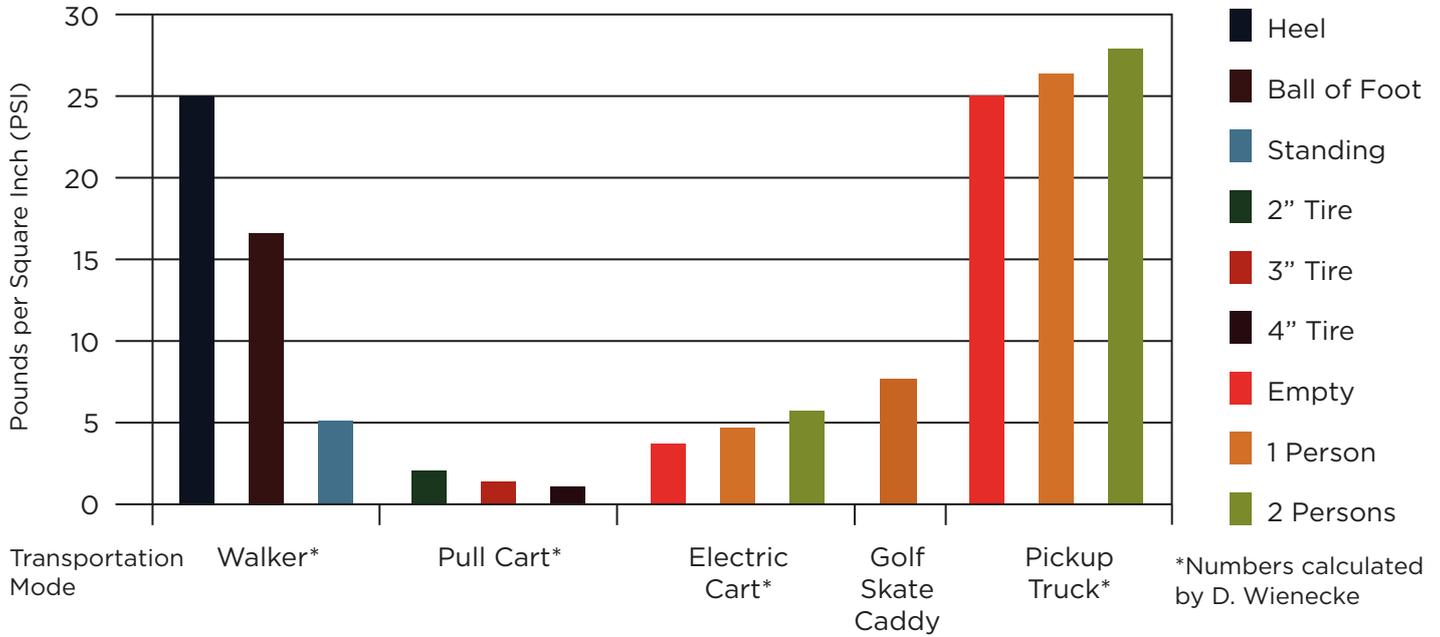
There are other variables, such as soil type and moisture levels, which further impact wear stress. Research by Carrow and Johnson noted that turf- grass growing on sandy soils and some clay soils is more prone to wear injury. Soil compaction is greatest when traffic is imposed over excessively wet soils. Any factor reducing turf growth rate, such as soil compaction, high external salt levels, and frozen soils causes a further increase in wear damage compared to a vigorously growing turf.

COMPACTION

All forms of traffic cause some degree of compaction. This is typically an indirect problem commonly resulting in a reduction in turf vigour. The forces that contribute to compaction include the weight of the golfer or golf cart spread over the turf surface. The following example illustrates the amount of pressure exerted on the turf from various sources:

Compression Pressure (PSI)

Calculations of actual compression pressure show pressure on the heel of the foot while walking is equal to pressure from a four-wheel pickup with one rider. Turf area impacted must also be considered with compression pressure to get a true picture of the cause of vehicle turf damage.



• 90kg golfer heel of foot (walking)	= 170 kPa	(25 psi)	
• 90kg golfer ball of foot (walking)	= 115 kPa	(16.6 psi)	
• 90kg golfer full foot (standing)	= 70 kPa	(10 psi)	
• 90kg golfer both feet (standing)	= 35 kPa	(5 psi)	
• Pull cart (8kg) 5cm wide tires	= 14.5 kPa	(2.1 psi)	{two tyres}
• Pull cart (8kg) 7.5cm wide tires	= 9.65 kPa	(1.4 psi)	{two tyres}
• Pull cart (8kg) 10cm wide tires	= 7.6 kPa	(1.1 psi)	{two tyres}
• Golf Skate Caddy with 90Kg rider & bag (140kg total)	= 49 kPa	(7.11 psi)	{four x 7.5cm tyres}
• Electric golf cart (empty, 430kg) with four x 20 cm wide tyres	= 25 kPa	(3.7 psi)	
• Electric golf cart with two people and gear (658 kg)	= 39.3 kPa	(5.7 psi)	
• Maintenance pickup truck (1,360 kg)	= 172 kPa	(25 psi)	(four tyres)

Based on the above compression pressure, we would expect to see walking golfers causing the most damage. In fact, the majority of wear damage observed in the field is caused by four-wheeled motorized golf carts.

Why is this true? Read on!

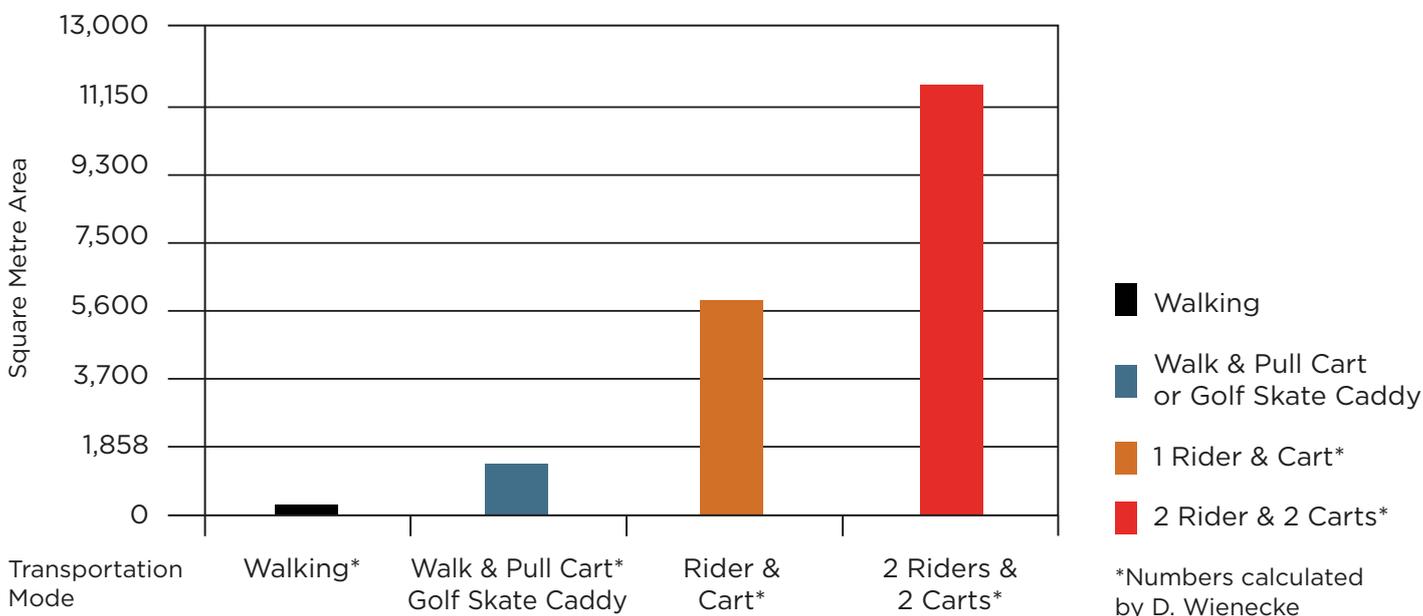
AREA IMPACTED -WHERE THE RUBBER MEETS THE TURF

The damage caused by various modes of transportation can be estimated by measuring the contact area of shoes or tyres and multiplying this over the total area covered during a round of golf. The following example illustrates the average area impacted while playing a 5,700-metre golf course:

- Walking golfer with golf bag = 120 sq metres
- Golf Skate Caddy with 7.5cm wide wheels = 1,026 sq metres*
- Walking golfer using a pull cart with 7.5cm wide wheels = 1,200 sq metres
- Self balancing 2 wheel vehicle with gyroscopic control set up for golf with large 20cm wide turf tyres = 2,200 sq metres**
- Golf cart = 5,745 sq. metres.
- Two golfers each using a golf cart =11,490 sq. metres.

18-Hole Traffic Impact Area*

Calculations of areas impacted by walking, pull carts, and riding carts show the the significant area of turf potentially damaged by carts when compared to walking golfers. One golfer per cart impacts approximately the same area as two golfers per cart. Two carts with one golfer in each cart potentially impact twice the area compared to golfers in one cart.



Looking at the numbers, it is easy to understand why four-wheel golf carts impact (and compact) the golf course so dramatically.

LESSONS LEARNED

The preceding examples paint a clearer picture of why golf carts cause significant damage to golf courses.

By analysing the numbers, we can learn the following lessons:

- All vehicles cause turf damage. This includes motorized golf carts, pull carts, and maintenance vehicles. Some of the damage may not be visible for days or even weeks as a result of the effects of soil compaction.
- Walking the golf course and carrying your clubs impacts the golf course far less than pull or motorized carts based on the total amount of area impacted.
- The Golf Skate Caddy impacts the golf course less than or equal to a pull cart based on the fact that the 2 rear wheels will follow the same pattern of the front wheels most of the time and you do not have as in a pull cart the combined surface area of the two wheels and the golfer's foot print.
- Pull carts impact the golf course less than motorized carts, but all carts impact the golf course more than walking. This is due to the smaller area contacted by foot traffic and the wheels of the pull cart.
- Vehicle traffic has the greatest impact on wear and soil compaction due to the amount of area covered and the increased damage caused by repeated traffic over a concentrated area. Damage is further increased with a greater number of turns, a higher speed of travel, and the number of traffic passes over a given area. Based on the research results, the main focus for minimizing the damage caused by golf carts should be on spreading traffic over a wider area or restricting golf carts to paths.
- There is some evidence to suggest that the newer designs of golf carts can reduce the overall impact on turf injury due to wider tires and smoother tread design.

GOLF SKATE CADDY VERSES GOLF CART IMPACT ON GOLF COURSE

From these charts and information it can be seen that the best case scenario is to walk the course carrying your bag. However in today's busy and hectic lifestyle many golfers like the convenience of using a traditional golf cart and although the Golf Skate Caddy is 1.41 psi heavier than a golf cart with 2 people, the actual impact per square metre compared to a golf cart is a massive 82% less on the surface area of the golf course and similar to or less than a golfer walking with a pull cart. Now that's amazing!

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- Vavrek, R. 2002. "How much traffic can you bear?" *USGA Green Section Record* 40(4):1-6.
- *Golf Skate Caddy Calculation for surface area estimated with the following calculation
 $2 \text{ tyres} \times 7.5 \text{ cm (0.075m)} \times 5,700 \text{ metres} + 20\% \text{ contingency} = 1,026 \text{ M/sq}$
- ** Tyre specification taken from Segway Golf x2 Turf using low pressure 20cm wide tyres. Calculation $2 \times 20 \text{ cm (.2m)} \times 5,700 \text{ metres} = 2,280 \text{ M/sq}$



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