

Go-kart Track Safety Barriers and Modern Track Design

By Peter F. Olesen, P.E.

Kart occupant safety is the single most important consideration in the design of any go-kart track. As track designers, we have a responsibility to design barrier systems that keep karts on the track and provide the greatest impact reduction provided by any safety barrier system on the market today. This entails checking out modern innovations in barrier design that claim superior safety.

A real challenge exists in the lack of published serious testing research into the comparative advantages and disadvantages of the various systems on the market today. Go-karting is a niche industry, far too small to attract the attention of any consumer or government testing agencies that would put the various systems through rigorous testing. As a result there has a wide range of barrier systems developed by small companies with limited research capabilities, all proclaiming to be better than the rest. Some have failed miserably and left the scene almost as quickly as they arrived. There are many examples number of stories on various system failures floating around the industry. Some may be false or exaggerated descriptions, while others may be completely true.

The bottom line is there is no solid data base on which to reach or identify unbiased conclusions. As a result, each manufacturer, owner, developer or designer makes a decision based on his or her own thought processes and experience. Some have worked out great, while others may have ranged from mediocre to dangerous.

Steel Rail/Automobile Tire/Barrier Curb Track Safety Barrier System:

To date we have not come across a barrier system that provides both energy absorption, return to original configuration and having reasonable costs that better meets these requirements than the steel rail/automobile tire/backing curb system we've been using since 1990 on all the concession go-kart tracks designed by our firm, Entertainment Concepts, Inc. (formerly Peter F. Olesen and Associates, Inc.).

Our first track barrier system was a modification of a design being used by others which fastened the tires to a steel rod or post. Our observations at the time indicated that when the tires were forced back against the post, the tires actually collapsed and folded around the post, resulting in a double impact on hard hits. Our change to a continuous backing curb eliminated the collapse problem of the earlier design as well as maintaining straight barrier alignment.

The system is composed of automobile tires backed by a poured concrete barrier curb or steel anchor plate for outdoor installations and steel anchor plates for indoor operations, and faced with a vertical steel barrier rail. This system provides by far, the greatest energy absorption of any system on the market. The steel barrier rail has sufficient weight to resist rising of the barrier during kart contact, which is not the case if a "plastic" rail were used. Tires with diameters of 26 inches permit a compressibility of 20 inches or more upon solid hits. The currently available commercial barrier systems on the market provide only a small fraction of the compressibility provided by the barrier anchor/tire/barrier rail system we use for all of our track barrier systems.

Beginning with our first track design all of our firm's track designs have utilized automobile tires as the primary impact attenuation component of our barrier curb/automobile tire/ steel plate barrier system. By using tires the barrier system can be compressed over a greater distance. As a result, the "G" forces experienced by both the driver and the kart are more gradually reduced during impact than would be the experience with any current competing track barrier system. The superior energy absorbing capacity has protected countless victims of impacts against this barrier system from serious injuries.

In the 90s most track barrier system used automobile tires with 24 to 26 inch diameters and tread widths ranging from 6.5 inches to 7.5 inches. These were among the most readily available used tires to be found. They were normally used with barrier rails ranging from 6" x 1/2" to 8" x 1/2". Most track barrier rails were mounted on 1" to 2" high skid plates.

Over the past 10 years many karts increased in weight and karts speeds at many tracks have crept up, resulting in some karts driving under the barrier rails. To eliminate this problem many tracks are being designed with 8" x 1/2" to 8 1/2" x 5/8" rails and the track clearance being reduced to 1/2" skid plates.

Keep in mind that most modern electric go karts weigh in from 600 lb. to 800 lb. (with batteries) without anyone being seated in the kart. The combination of greater weight with higher operating speeds, kart/barrier impacts results in greater "G" forces being transmitted to the driver, kart and barrier system. ECI's current barrier system uses tires with tread widths of 8 1/2" to more than 9" coupled with vertical steel barrier rails at least 8" x 1/2" mounted on 1/2" thick skid plates, to provide a vertical surface tall enough to keep karts from riding up and over the barrier.

Steel barrier rails are used to provide sufficient barrier weight to resist karts from running under the barrier rail. Other systems using composite or "plastic" rails are often designed with tie-down cable systems which in themselves restrict horizontal compression.

Automobile manufacturers have been increasing the diameters and tread widths over the past 15 years, resulting in smaller diameter tires becoming very difficult to locate. As a result, we now specify tires with diameters ranging from 26" to 28" and tread widths ranging from 8 1/2" to 9 1/2".

We do not recommend low profile tires because of the smaller sidewalls which have less compression resistance and rebound performance than conventional tires. While we have utilized used NASCAR at the request of several clients, they do not have the resistance on compression and less rebounding capabilities than the performance obtained with conventional automobile tires due to their two-ply sidewalls.

Proper Tire Preparation:

Another major improvement in the steel rail/automobile tire/barrier curb system has been the introduction of our universal tire drilling pattern. We realized there was a strong need for proper tire drainage when tires were lying flat on the ground to prevent water lying in the tires from splashing out when karts hit the barrier, as well as removing standing water mosquito breeding sites. At the time, a few tracks slashed sidewalls, which in most cases actually sealed up when the tires were installed. We created a universal drilling pattern to assure tires would drain whether the tires were flat on the ground, facing uphill or down, on the high side or low side of a banked turn. This was accomplished by first drilling mounting holes into the tire treads 180 degrees apart for fastening the tires to the rail and curb. We then specified drilling four one inch diameter holes into the center of the sidewalls to be installed face down, on a 90 degree spacing pattern, with two drain holes aligned with the two tread face mounting bolt holes.

Over the years new tire companies come on the scene and they as well as the older more known manufacturers constantly modify their tread and sidewall patterns, the result is a wide range of final diameters within the same size designations. This makes it important that the barrier installation team take the time to sort out similar diameters into separate stacks of similar outside diameters (hole side face down) to permit maintaining a straight alignment of the barrier rail after installation. The tires of a similar diameter should be placed consecutively along a straight section, changing diameters in the curves.

Operating Track Widths:

Overall track capacity and safety performance is a combination of the design of the safety barrier system and the proper track pavement width (face of rail to face of barrier rail) of the track driving lane. We never design a track width that will not have sufficient width to allow karts to drive by a single kart spun out on the track regardless of its position or angle facing oncoming traffic.

The specific width of a given track must take into consideration the type of track, specific kart width and length and the anticipated peak hour ride demand. A track width of 20 feet face to face will work effectively for the majority of the tracks. Certain track operations may require widths of 22 to 24 feet to accommodate anticipated heavy rat traffic. Adult slick road courses and skid track ovals may require width of 26 feet or more to function efficiently.

Development of Modern Track Pavement Design:

Not all go-kart tracks are entertaining and exciting. There is a wide difference in go-kart track designs and the designers that create them. Many follow concepts developed 30 years ago with little creativity. Traditional go-kart track designs include long straight sections and sweeping turns. This concept permitted tracks to be paved with bituminous concrete (asphalt or blacktop) using basic roadway construction equipment, a reasonably economical construction method. Unfortunately it didn't meet the needs of modern go-kart track design.

Our initial research combined with many years of designing freeways and toll roads led us to develop a paving process that eliminated the requirement of reinforcing steel in go-kart track pavements. This consists of a controlled pavement concrete mix, specific placement, finishing and timely sawing of contraction joints in a specified pattern. Tracks designed using our design (minus steel reinforcing) have been in operation for up to 27 years in northern heavy frost region in the U.S. and Canada without pavement slab cracking.

Asphalt Pavement – Yesterday's Solution:

While the asphalt tracks worked, the system has numerous shortcomings, including the surface being up to 40 degrees warmer in the summer and resulting in up to 40% greater tire wear than that experienced when using Portland Cement Concrete (PCC) pavement.

Asphalt pavement has several other features that become maintenance issues. One is that it is a live pavement and reacts to traffic. As it softens in warm weather, it can develop small depressions in the pavement surface that can hold water on the surface after a rainfall. With go-kart tires having smooth treads this can result in unwanted hydroplaning.

When there is no ongoing traffic, the asphalt pavement weathers (oxidizes, and after a time begins to crack and crumble. A good example is the outer reaches of shopping mall parking lots that have little ongoing traffic. These pavements weather and fail because of the lack of ongoing traffic. Keeping the pavement in good condition requires a regular periodic sealing or resurfacing program in order to keep the pavement usable.

Portland Cement Concrete Pavement – The Pavement of Choice:

The introduction of PCC Pavement permitted tighter, banked turns, rapid use of the track after rainfalls, lower tire wear, extremely longer pavement life, the ability to maximize the performance of barrier rail systems (hot, soft asphalt resists the sliding of the barrier rail system upon kart impact.

Creating Excitement and Entertainment Value:

With the introduction of PCC pavement, the era of modern go-kart track design began. PCC Concrete permitted the use of tight banked turns, improved track geometry and grades, better pavement design control, improved drainage, effective use of rail/tire/curb safety barriers and related improvements have all contributed to the constantly evolving track design concepts which are raising guest expectations for more entertaining and exciting track experiences.

The incorporation of left hand and right hand banked turns with varying angles, short straight sections and a fluctuating profile all add to guest entertainment and excitement. This improvement of guest experience is the foundation for success. The more fun, the more rides purchased and the more return visits per year.

Creation of reverse operations with a different driving experience allows a facility to create additional incentives to return on days when the track operates in the opposite direction.

“Adult” slick road course and rookie road course tracks offer additional guest attraction where space and funding is available.

Special Market Tracks:

Special designs have been developed for tourism markets with their heavy concentration of people with both disposable time and money. In major tourism markets the “bigger is better” mentality takes over as the best way to outdo competitors in the quest for maximum attendance. This probably is best exemplified by the development of elevated wooden tracks which began in the Wisconsin Dells almost 30 years ago and spread to most of the major tourism areas around the country about 25 years ago and is now evolving into elevated steel and concrete structures.

As the costs involved in creating these structures (\$1Million + not counting the karts) is far higher than the ground level facilities found across the country, they can only be feasible in markets where the concentration of guests with disposable time and income is very high.

Electric (Battery Powered) Go-Karts:

Electric (battery powered) go-karts came on the market in the mid 1990s. In the early years there was a fair amount of experimentation with batteries, types of motors and kart charging systems. One option available on electric karts is the capability to operate with multiple speed range with the push of a button on the track supervisor’s hand held remote control. This permitted the kart fleet to be able to serve birthday parties, the middle school crowd, family and adult groups and the testosterone crowd using the same karts and track facility.

It took until around 1999 to see real progress in-kart batteries and charging systems. Batteries were able to hold charges longer and with proper charging practices battery life was greatly extended. Floor charging systems offered an improved method of recharging batteries. The routine of providing two sets of karts (one set on the track while the other set was in the pits being recharged). Assuming a four minute “race” and dual pitting, dual pitting increased the rides per hour to increase by approximately 60%. Having two sets of karts resulted in a sizable equipment cost increase but at the same time greatly reduced the ventilation system cost by not having to remove kart generated carbon monoxide laden exhaust.

For outdoor use, electric karts remove the need for fuel tanks and refueling operations. While this holds appeal, at the present time most outdoor track operators are staying with gasoline powered karts.

Get Ready for the Future:

Now is the time to consider developing an FEC with go-karts whether you are a newcomer or owner of a facility without go-karts (assuming you have space). Done properly (sound design couple with modern geometrics) go-karts will become your magnet attraction for a major segment of your target market. They have a broad demographic and provide a high through-put, which helps hold guests at the facility during peak attendance periods.

Once constructed the go-kart track and pit canopy can remain in good condition for 30 years or more with little maintenance other than the periodic replacement of weathered tires. The karts have varying longevity, almost completely dependent on a sound preventative maintenance program. This writer is aware of kart fleets still functioning at a high level of performance after 18 years of use.

Choose your track designer carefully, as not all have the same creativity, knowledge, experience or capabilities. Compare finished projects and previous client experiences, for there is a wide range of qualifications and finished products. The same applies to the design of your overall facility. Work with experienced industry specialists with proven track records. This applies to the selection of qualified Contractors as well.

No facility can be successful without being operated by a qualified management team and well trained staff. Take the time to carefully assemble your entire team. In this industry, your youngest and least experienced employees become the face of your operation that your guests see.

Planned and executed properly, your inclusion of go-karts into your attraction mix will prove to be one of your best decisions.

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