

Outdoor Lockable Skateboard Rack

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Abstract & Project Purpose

- In the large campus community, one preferred mode of transportation is the skateboard. The university has not implemented a means of storing or securing skateboards. Storing skateboards in classroom aisles (Fig. 1) poses an inconvenience and a hazard to students and faculty, and violates Fire Safety Codes.
- The 2007 California Building Code 1025.9.6 prohibits the obstruction of aisles in assembly halls.
- The purpose of this design project is to offer a secure and universal outdoor storage rack for skateboards in a campus or university setting.



Figure 1. Storing skateboards in classrooms creates hazards.

Benchmark

Trilary, Inc. Madrax Division offers a floor-mounted, lockable rack with a capacity of six skateboards (Fig. 2).

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| <p>Pros</p> <ul style="list-style-type: none"> •Lockable cable •Floor-mounted •All-weather capable for outdoor use | <p>Cons</p> <ul style="list-style-type: none"> •Is not wide enough to accept all board sizes. •The rack limits use to one user at a time. •Small locks are ineffective. |
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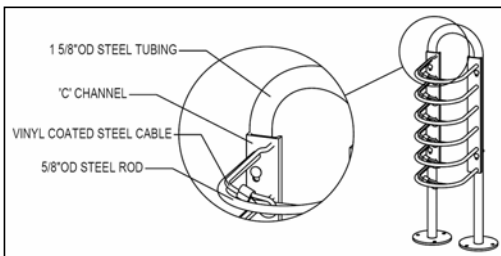


Figure 2. Benchmark: MADRAX model SBR-SNG-6-SF. ©2007 Trilary, Inc. All Proprietary Rights Reserved.

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- Jerry Wojpak, MADRAX Representative

Market Research

•A survey of the UCSB campus discovered (Fig. 3) a variety of skateboards based on wheels, trucks, and deck lengths. This necessitated a locking device with universal acceptance of skateboards. The nearest universally constant dimension among all skateboards is the deck thickness. Thus, deck thickness was the key constraint for the rack design.

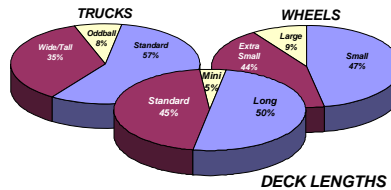


Figure 3. Survey results of skateboard use on campus.

Design Development

•Multiple designs were proposed in brainstorming sessions. •Based on market research, benchmark analysis, and patent reviews (Ref. 2) the following were determined to be important features for the final design shown in Fig. 4:

- Secure and lockable
- Accepts all types of skateboards
- Sturdy, robust outdoor frame
- Many people can use the rack at once due to limited time between classes
- No moving parts to increase lifespan

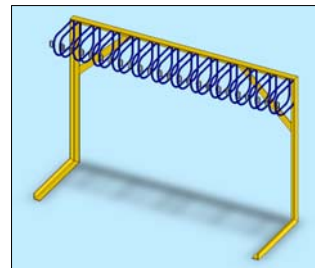


Figure 4. SolidWorks model.

Modeling

•Finite element modeling (Fig. 5) was used to test both typical and extreme loading conditions on the rack.

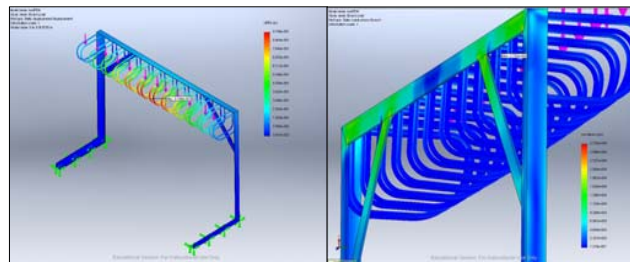


Figure 5. Finite Element Model using COSMOS with twelve concentrated 20 lb. loads. (a) Maximum displacement is 0.916 in. (b) Maximum von Mises stress is 27,920 psi.

Testing

- The unloading area in front of the racks was calculated (Table 1) using a uniform thickness as a measure of how many persons may use the rack at a time
- Failure testing (Fig 6.) was performed on the locking devices of both the benchmark and the improved design to verify that the improved design is more secure. Three varieties of theft tools were used to measure the time to break either the cable (*benchmark*) or chain (*improved design*) (see Table 1).
- Initially, the benchmark cable appeared to be more resistive to bolt cutters than the chain. However, a weak point in the cable was discovered at the aluminum coupling (Fig 6c).



Figure 6. Testing the locking device of the improved design against the benchmark with (a) a hacksaw, (b) a pneumatic grinder, and (c) bolt cutters.

Feature	Benchmark	Improved Design
Unloading Access Area (with a 2 ft thickness)	1.75 ft ²	12 ft ²
Estimated time to unload entire rack (~30 sec/board)	~180 sec	~60 sec
Unit Weight	43 lbs.	112 lbs.
Time to cut cable or chain (mm:ss)	Hacksaw	1:30
	Pneumatic grinder	0:45
	Bolt cutters	0:47 (cable) 0:04 (coupling)

Table 1. Performance comparison to benchmark

Conclusion

- The testing results verified that the improved design is more secure and more time-efficient than the benchmark.
- Once the testing and modeling results verified that the model met the design specifications, a functioning - but not market ready - prototype was fabricated. This prototype expressed the validity of the design by demonstrating that the performance requirements were met.
- This design process concluded at prototyping, but the continued process would include forming a consistent manufacturing procedure, as well as optimizing the use of materials.

References

1. Trilary, Inc., Madrax Division website. <http://www.madrax.com>
2. U.S. Patents 6481581 B2, 6293412 B1, 5301818.