



**Gravitational  
Systems  
Engineering, inc**

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## **Gravitational Systems Engineering:**

### **Speed Sponges**

#### **Crash Mitigation Technology**

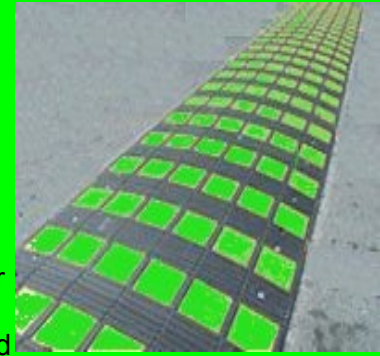
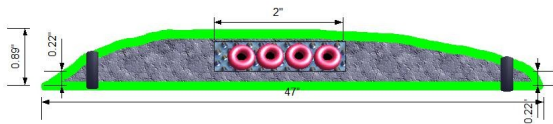
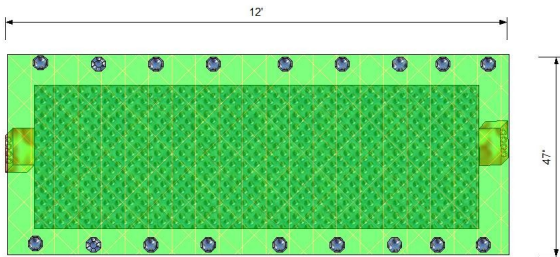


A speed sponge is a horizontally emplaced application that removes forward momentum, and therefore speed from a moving vehicle, or process. Speed sponges are engineered to target specific speed/mass processes, up to or exceeding K-12, by implementing an exponential decay function. The device can be engineered to have a minimum impact on vehicles traveling below the targeted speed/mass, while having maximum impact on all other vehicles.

Unlike other speed absorption technologies based upon engineered materials, speed sponges <sup>tm</sup> have a number of operational advantages. Speed sponges <sup>tm</sup> are automatically reset to optimal as soon as the mass of the targeted vehicle, or process, passes over the device. Speed sponges <sup>tm</sup> can be engineered within a wide variety of fixed, or operator controlled, capacities. These devices can be designed to operate effectively on vehicles ranging from bicycles to jumbo jets. Targetable vehicles include wheeled, tracked, and rail based vehicles.

A speed sponges redirects the energy from the targeted process into either gas compression or fluid pressure. Sufficient quantities of energy re-directed from the targeted vehicle to operate other ancillary systems such as pneumatic or hydraulic barriers, flame suppression, and diversion systems.

Speed sponges are constructed of durable, recycled materials and will provide many years of service even under high demands or in-hospitable environmental conditions.



An above ground speed sponge, can be retrofitted to existing roadways, or used as a temporary device. Above ground speed sponges come in widths ranging from 2 to 6 feet, and can be configured to span road surfaces of almost any length.

Embedded speed sponges<sup>tm</sup> are built into the roadway as either retrofit or new construction. Embedded speed sponges are custom designed and can be built to almost any width and length.

By implementing an exponential decay function, these devices have applications far beyond crash mitigation. When implemented as a residential speed table vehicles below the targeted mass/velocity will barely notice its existence.

This means that cars traveling below a selected speed will encounter the speed sponge<sup>tm</sup> as a high friction road surface. However, heavier or faster moving vehicles will experience the device with the resistance of 8 inch deep mud or wet sand.

GSE RVSS are based upon PEC [Pressure to Energy Conversion] a force redirection or vector modification technology. The technology conserves intermittent pressure and momentum energy as heat and gas compression. The energy conserved as heated compressed gas is then channeled perpendicular to momentum as exhaust or storage.

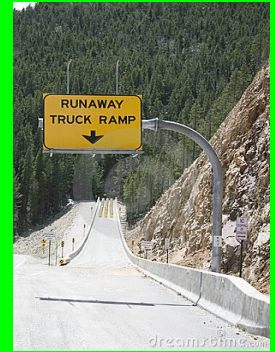
RVSS technology represents a dramatic new approach to handling excessive vehicle speed, or loss of control.

RVSS Speed Sponges<sup>tm</sup> have the external appearance of large speed bumps. However, unlike a speed bump, which reflects energy back into the vehicle. RVSS systems absorb the impacts and convert them into gas compression and heat. RVSS units can be deployed in harsh environmental conditions, including extreme cold, or un-paved roadways.



RVSS technology has many advantages over traditional physical attenuation methods, such as guard rails, crushable gravel, nets, or entanglements.

RVSS are naturally regenerative, and can be retrofitted to existing structures. RVSS can easily be relocated as conditions require.



Naturally regenerative RVSS can remove energy from a targeted process, and within seconds return to 100% capacity. The regenerative nature of the RVSS makes it ideal for a much wider variety of recurring or non-emergency physical attenuation applications.

R-series vehicle safety systems [RVSS] are available in both horizontal and vertical orientations.

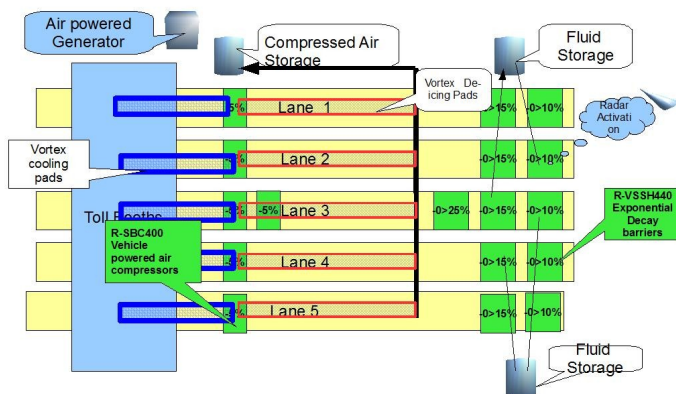
### Horizontal RVSS: applications

Horizontal RVSS are alternatives or adjuncts to runaway truck ramps, crushable resistance systems, and entanglement stoppage systems. The units are either retrofitted or constructed into targeted vehicle surfaces, such as roadways, runways, or ramps. RVSS are engineered to impede vehicle momentum in safe low impact steps.

A 40 ton vehicle traveling at 80 mph, would be slowed to 70 mph by the initial RVSS, 55 mph by the second, 40 mph by the third. This stepped velocity reduction allows the operator to regain control, due to the reduced speed and increased traction.

Each stepped reduction, while sudden, is not a threat to the integrity of the vehicle, its operator, or its load. The effect for the operator of the targeted vehicle is very similar in feel and action, to driving in deep sand.

The automatic regeneration of the RVSS requires no power not contained in the initial impact. Each RVSS can provide years of service with no maintenance, and a light inspection regime.



**Performance Specifications: GSE: Percentage of energy removed based upon weight & velocity**

| Model           | Vehicle GWT | 5-15 Mph | 16-25 Mph | 25-45 Mph | 45-60 Mph | 60-90 Mph | >90 Mph |
|-----------------|-------------|----------|-----------|-----------|-----------|-----------|---------|
|                 | >3 ton      | 0        | 0         | 0         | 1         | 10        | 8       |
| Dimensions      | 3-6 ton     | 0        | 0         | 1         | 2         | 8         | 6       |
| 12' x 3' x 1.5" | 6-15 ton    | 0        | 1         | 2         | 7         | 6         | 5       |
| PSI Trigger     | 15-30 ton   | 1        | 2         | 6         | 5         | 4         | 3       |
|                 | >40 ton     | 2        | 3         | 5         | 4         | 3         | 2       |
|                 | <40 ton     | 3        | 4         | 3         | 3         | 2         | 2       |



**Traffic calming:**

Horizontal RVSS are designed for permanent placement on roadways; vehicle ramps, such as cloverleafs and emergency stoppage ramps. RVSS units when employed on sharp or irregular curves, guarantee that drivers maintain optimal operating speeds.

**Emergency stoppage:**

When employed on emergency ramps, RVSS units can effectively reduce both grade and length required for a given amount of slowdown potential. When RVSS units are applied to existing ramps, the ramps' engineered limits are effectively upgraded. RVSS can transform wide shoulders into stoppage ramps, minimizing overall construction costs.

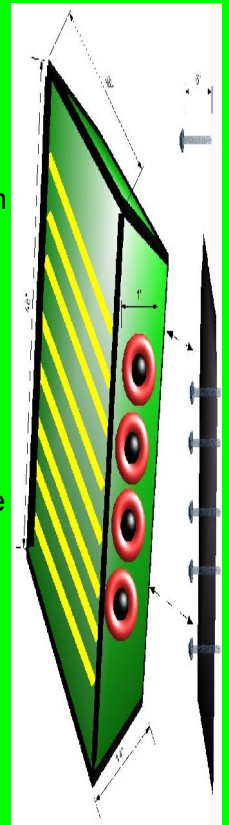
**Security perimeters:**

RVSSH can also be employed as a key component of security perimeters, to slow approaching vehicles. When employed for security purposes a series of RVSSH units can effectively prevent vehicles from gaining sufficient momentum to compromise security barricades.

## Vertical RVSS

Vertical RVSS models are designed for wall mounting. Vertical RVSS can mitigate damage to vehicles and passengers at significantly higher impacts than conventional methods. RVSS automatically regenerate crash resistance, within seconds of impact, mitigating maintenance costs, and maximizing the availability of protection. GSE vertical RVSS comply with containment level N2 in accordance with EN 1317-2.

Vertically mounted RVSS can replace or adjunct existing crash barriers, such as guardrails, retaining walls, and structural voids. The units are either bolted to existing structures, or integrated during new construction.

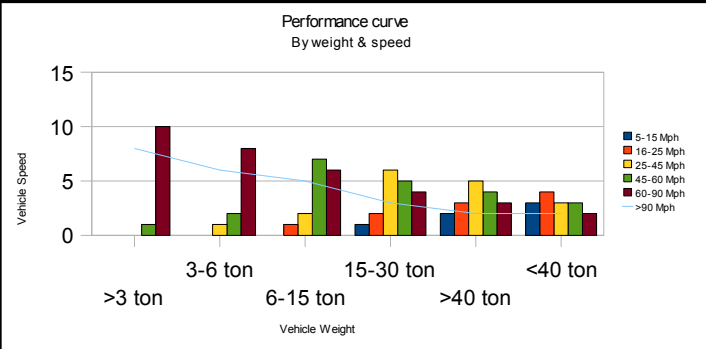
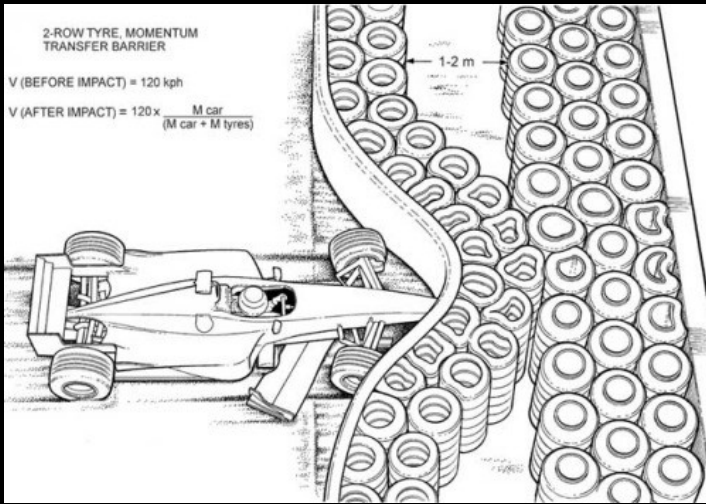


RVSS-V are naturally regenerative, providing the highest level of effectiveness when compared to alternative methods. RVSS-V are generally composed of recycled tires, and can be engineered to a wide variety of cosmetic requirements, including advertising backboards. GSE RVSS convert velocity (impacts or inertia) into air or gas compression and heat.

RVSS are maintenance free, and self regenerating. Each unit is engineered to absorb a fixed amount of energy from impacts, safely reducing vehicle inertia with minimum passenger jarring or vehicle damage. Horizontal RVSS also increase control traction.

The energy absorbed by the RVSS is converted into heat and gas compression. The compressed gas can be discarded, stored for future usage, or employed immediately in a wide variety of applications, such as barrier activation.

Another byproduct of the RVSS is heat, which can also be employed in a variety of applications.





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