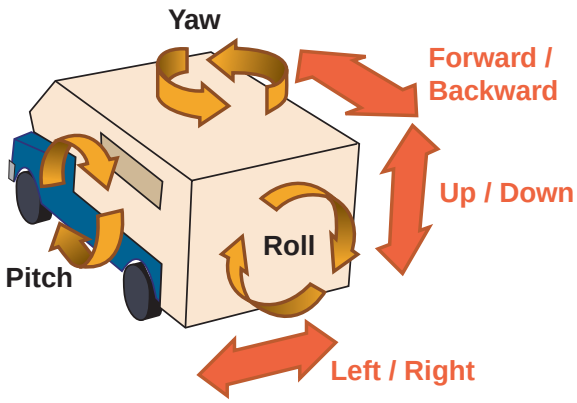
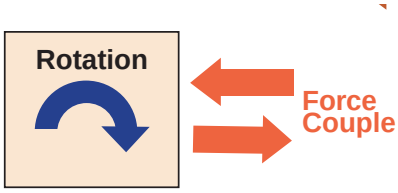
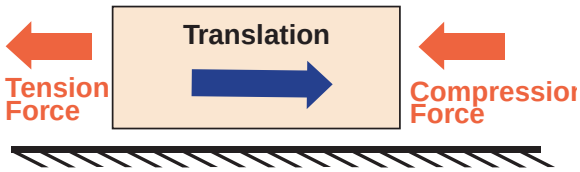
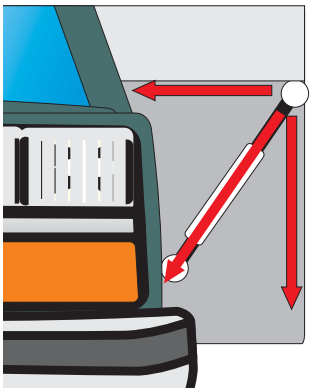
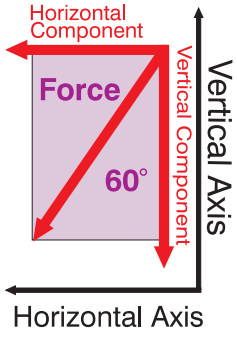
What everyone should know about restraining camper movement











There are six possible camper movements that any tie-down system must address in order to be effective.

In an independent "Analysis of Restraining Requirements for Truck-Mounted Slide-in Campers"**, Dr Spencer Magleby PhD, a Mechanical and Structural Design specialist and Associate Professor of Mechanical Engineering at Brigham Young University, identifies the six possible movements of a camper. Dr Magleby reports that,**

"Drawing from standard rigid-body movement nomenclature, there are exactly six possible movements for a camper. Each of these movements is defined relative to the truck...Three of the movements are rotations and three are translations. For each of the movements there are two directions, yielding a total of 12 possible ways that the camper could move relative to the truck." **Bearing this fact in mind, Dr. Magleby goes on to point out that** "each of these movements can occur independently of the other. An effective tie-down system must address each of these potential movements."

Adequate resisting forces are required for each possible camper movement in an effective tiedown system.

Because each possible camper movement is unique, sufficient restraining forces must be created that address each individual movement.

"In order to minimize each of the movements outlined above, the tie-down system must create a set of appropriate resisting forces. The nature of the required resisting forces is different for translations and rotations...Translations can be resisted by a single force acting in a direction opposite to the translation...Rotations are resisted by either an opposing moment (a twisting force), or by two forces that act in parallel, but opposite directions...creating parallel, opposing forces, called a couple, is the most practical approach."

Appropriate angles between mount points as well as rigidity are the key to creating effective restraining forces.

"Tie-down system components such as chains and turnbuckles can only support forces in a direction between their end points. If a tie-down is exerting a force in a general direction, this force can be broken into components at the endpoints that act along the three directions of the coordinate axes."

"Achieving these forces efficiently and without damaging the truck or camper should be the objective of any tie-down system. Key to the design is creating the appropriate mount points and resulting angles for the tie-downs, and assuring that the mounts can handle the required loads."

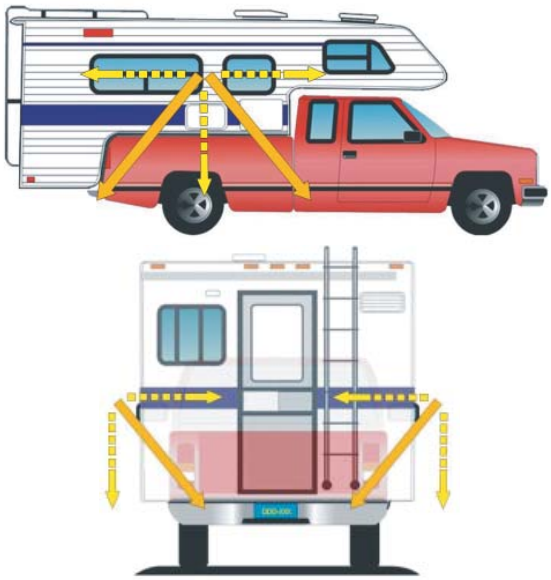
For complete copies of Dr. Magleby's reports call or visit us online.

800.231.7440 www.happijac.com

HAPPIJAC®
A Division of Lippert Components Inc.

The only tiedown system that effectively controls camper movement in all directions

In a recently completed study, Dr. Spencer Magleby PhD evaluated the Happijac Frame Mount Tiedown System. Dr. Magleby found that Happijac delivers the physical efficiency, stiffness and redundant resisting forces that address all six independent camper movements. "This efficiency allows for the lowest possible tension forces in the tie-downs themselves, while maintaining sufficient force components to resist movements." Here are some of the key findings in Dr. Magleby's "Analysis of the Restraint Sufficiency of the Happijac Tie-Down System for Truck-Mounted Slide-In Campers"



Happijac creates efficient angles of resisting forces supported through optimal anchor point locations.

"Critical to the efficient operation of the (Happijac) tie-down system are the angles of the turnbuckles relative to a vertical and horizontal plane, and the stiffness of the tie-down locations on the truck. The Happijac system cleverly addresses both of these issues by providing front tie-down locations that are as far forward on the truck bed as possible, and rigidly attached to the bed box and frame...The rear anchor mount points are at the ends of the bumpers. This location allows for efficient angles of the tie-downs for producing force components that hold the camper down in the back and resist left-right movement."

Happijac's stiff mounting points and spring loaded turnbuckles provide optimal rigidity.

"The system design also results in very stiff mount points on the truck (stiff meaning that they are not easily deflected), especially in the front where they are most critical. The stiffness of the mount points, combined with high stiffness of the turnbuckles results in very little relative movement of the truck and camper."

Happijac anchor points prevent truck bed deformation.

"In addition to the analysis of restraints it is interesting to examine the ability of the tie-down system to accommodate twisting deformation of the truck bed. The Happijac system ties into the front panel of the truck bed and through the frame in this area. This is an optimal location for locking the camper and truck bed together due to the front panel acting as a large shear panel to resist twisting deformation."

No other competing system meets the physical requirements necessary to control all possible camper movement.

"The most commonly discussed competitors to the Happijac system use tie-down locations that are created by extending cantilevered bars attached to the vehicle frame under the truck bed. While these systems have a number of strengths, the design concept generally does not allow for the types of efficiency and stiffness that the Happijac system enjoys...With this orientation it is not possible to generate large force components in the horizontal plane (required to prevent yaw and fore-aft/left-right translations) unless there are extremely high forces in the tie-down chain/cable. The stiffness of such systems generally suffers due to the large length of the cantilevered bars. These essentially act like large springs."

Happijac Products that Prevent Translations

Product	Forward / backward	Up / Down	Left / Right
Front Tiedown	✔	✔	✔
Anchor bolt and rear Coupler	✔	✔	✔
Turnbuckles	✔	✔	✔

Happijac Products that Prevent Rotations

Product	Yaw	Pitch	Roll
Front Tiedown	✔	✔	✔
Anchor bolt and rear Coupler	✔	✔	✔
Turnbuckles	✔	✔	✔

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