RES-Q-JACK®

STABILIZATION SYSTEMS

TRAINING PRESENTATION

2021-2022

Compressed Buttress and Tensioned Restraint Stabilization/Lifting

Objective

- To understand struts and their proper use.
- To increase the student's knowledge in the use of Res-Q-Jack struts for stabilization and lifting in motor vehicle accidents or other applications.
- To understand the physics of stabilization in relation to shapes, movements, weights and forces and to see how they apply in stabilization and lifting operations.

Table of Contents

Part I:

Basic Strut Information

What is a strut?

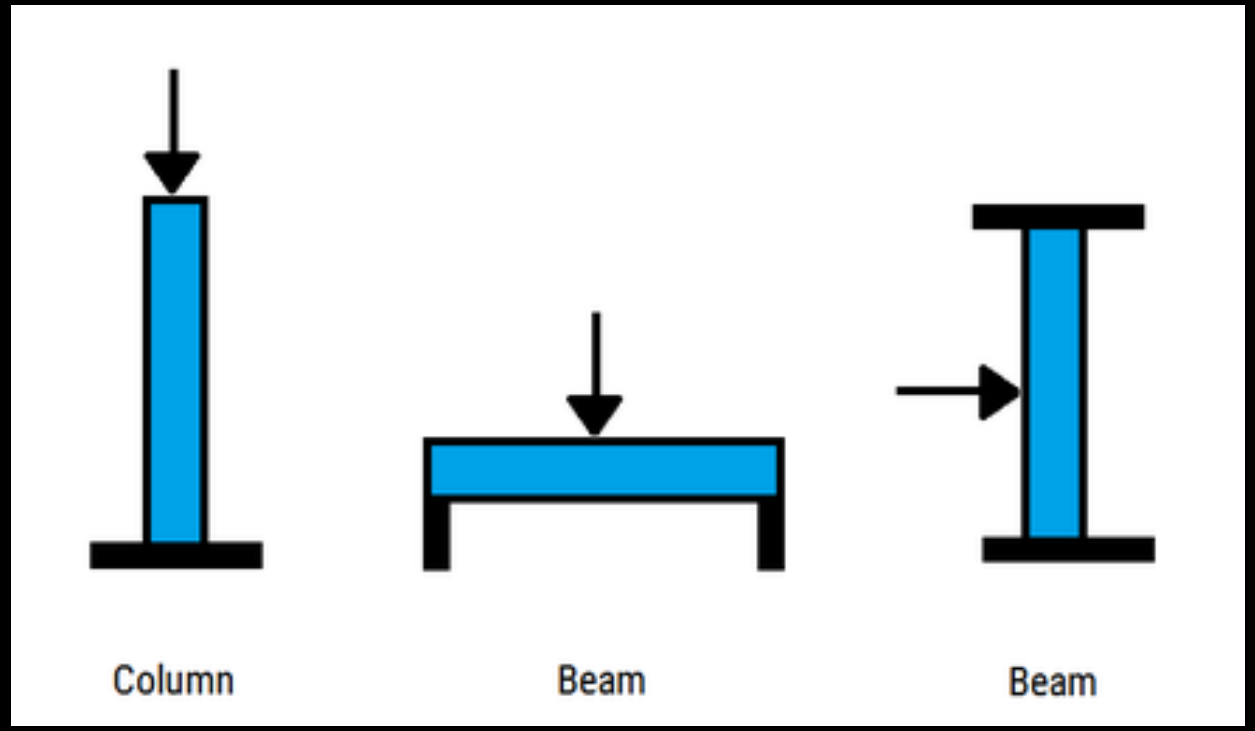
- A strut is a rod or bar designed to resist compression
- We further define a strut as a “system” consisting of tubing, extensions, base and head/end fitting
- Each time you add a component you change the capacity of the system/strut
- When comparing struts and working load limits (WLL), be sure you know what each manufacturer defines as a strut and how they test it
- Some refer to a strut as the tubing only, not including the head and base

Strut Design Factors

- Material and Properties
- Diameter
- Hollow vs. Solid Inner Tube
- Telescopic vs. Fixed Length (i.e. Wood 4x4)
- Number of Joints and Fit Clearance
- Overlap Between Joints
- Base/End Fitting Design, Fixed vs. Pivoting

Strut Loading

- Struts are loaded axially at the two ends, unlike beams which are transversely loaded on the side
- A column is one example of a strut. We often interchange the words strut and column, even though a column generally refers to a vertical support.



Warning: DO **NOT** Side-Load Struts

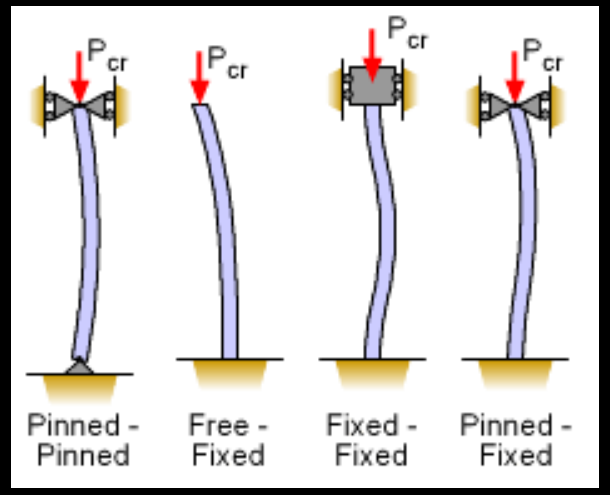
- We refer to beam loading a strut as side-loading. There should always be space between the strut and the object you're stabilizing or lifting.
- Certainly a strut will have some strength as a beam, however, we do not test or characterize a strut with regards to transverse loads. There are far too many variables involved to adequately determine the load.
- RQJ strut working load limits refer to column load capacity.
- Side-loading your strut will cause damage to your equipment or lead to injury.

Strut Testing

- How a strut is tested is critical
- A strut should be tested as it is used in the field with all components involved in the system
- A “strut” tested without a head or base will have a much greater test capacity than one with them
- A strut with a pivoting head has a much lower capacity than a strut with a fixed head

Strut Testing

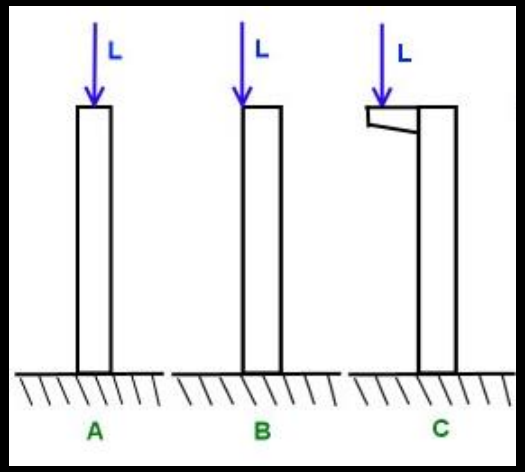
- A strut's boundary or end conditions/freedoms/restrictions play a big role in a strut's capacity
- These conditions are determined by the end fitting/head/base used on the ends of the strut where the loading occurs
- A pivoting end will allow the strut end to freely rotate, where a fixed end restricts strut end rotation
- The more freedom a strut end has to rotate, the lower the column working load limit, thus a strut with fixed ends will hold more than a strut with pivoting ends

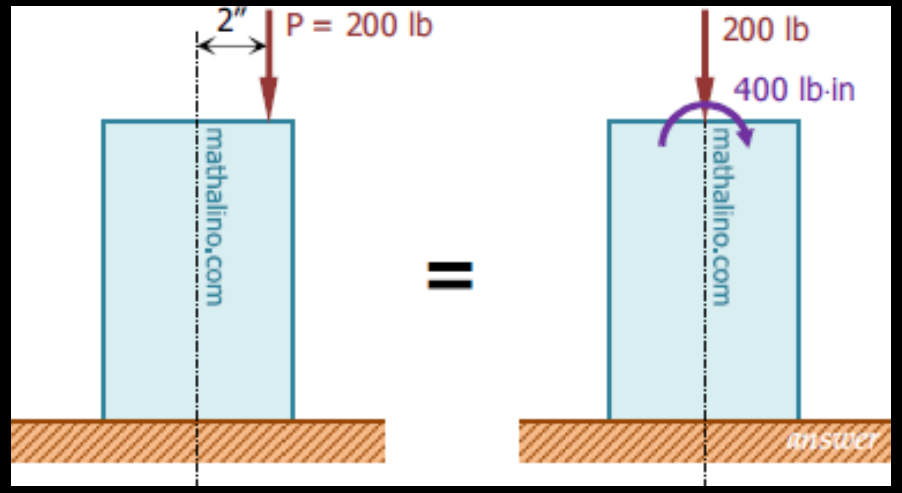


Reference: https://www.ecourses.ou.edu/cgi-bin/ebook.cgi?doc=&topic=me&chap_sec=09.2&page=theory

Offset Loading

- Where the load is positioned on the strut head is also very critical
- Be sure to know the impact of offset loading
- A strut with a centered column load has a much greater capacity than a strut loaded eccentrically/offset
- A concentric (centered) column load is a compression problem. An eccentric (offset) column load is both a compression and bending problem





Reference: https://www.tapatalk.com/groups/the911forum/ozeco41-s-response-to-a-challenge-to-explain-initi-t779-s15.html
https://www.mathalino.com/reviewer/engineering-mechanics/255-equivalent-loads-compression-member-eccentric-load

Strut Loading—

Concentric vs. Eccentric (Column Center vs. Offset)

TECHNICAL DATA SHEET

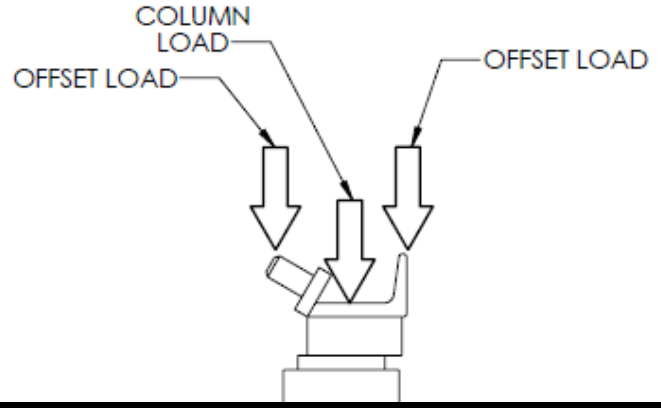
DATE UPDATED: 10/15/2018 | REV: C

TITLE: LONG APEX STRUT | PART NO.: APX-LSTRT

RES-Q-JACK STABILIZATION ELEVATED

LOAD RATING (2:1 SAFETY FACTOR)

	HEIGHT (in)	HEIGHT (cm)	COLUMN (lbs)	OFFSET (lbs)	COLUMN (kgs)	OFFSET (kgs)
SHORT STRUT: COLLAPSED - EXTENDED	45.17-62.75	114.62-159.39	12,500	6,900	5,669	3,129
SHORT STRUT: EXTENDED WITH 12" EXTENSION	74.75	189.87	9,400	5,400	4,263	2,449
SHORT STRUT: EXTENDED WITH 24" EXTENSION	86.75	220.34	7,360	3,790	3,338	1,719.11
SHORT STRUT: EXTENDED WITH 36" EXTENSION	98.75	250.82	5,800	2,900	2,630	1,315
LONG STRUT: COLLAPSED - EXTENDED	58.75-91.5	149.23-232.41	7,750	5,200	3,515	2,358
LONG STRUT: EXTENDED WITH 12" EXTENSION	103.5	262.89	5,400	3,700	2,449	1,678
LONG STRUT: EXTENDED WITH 24" EXTENSION	115.5	293.37	3,900	2,760	1,769	1,251.91
LONG STRUT: EXTENDED WITH 36" EXTENSION	127.5	323.85	3,270	2,630	1,483.24	1,192.94



A good rule of thumb is to assume you lose 50% of your strut's concentric column capacity by moving the load 1.5" off center

Comparing Apples and Oranges

- Some struts are rated at 4:1 safety factors with very high WLL's
- Be sure you know how these numbers were developed
- Did they only test the tubing without heads and bases? Would you ever use a strut that way?
- What type of heads were used—fixed or pivoting?
- Does the labeled capacity of your strut indicate load position—concentric or eccentric?

Part II:

Strut Stabilization Concepts

Why Do We Stabilize?

- To ensure vehicles/objects are safe to work around
- To ensure the safety of not only the patient, but the first responders!

Stabilization Assessment

- What do we need to consider?
  - How stable is the vehicle?
  - How much stabilization is required?
  - What equipment is needed?
  - Is lifting necessary?

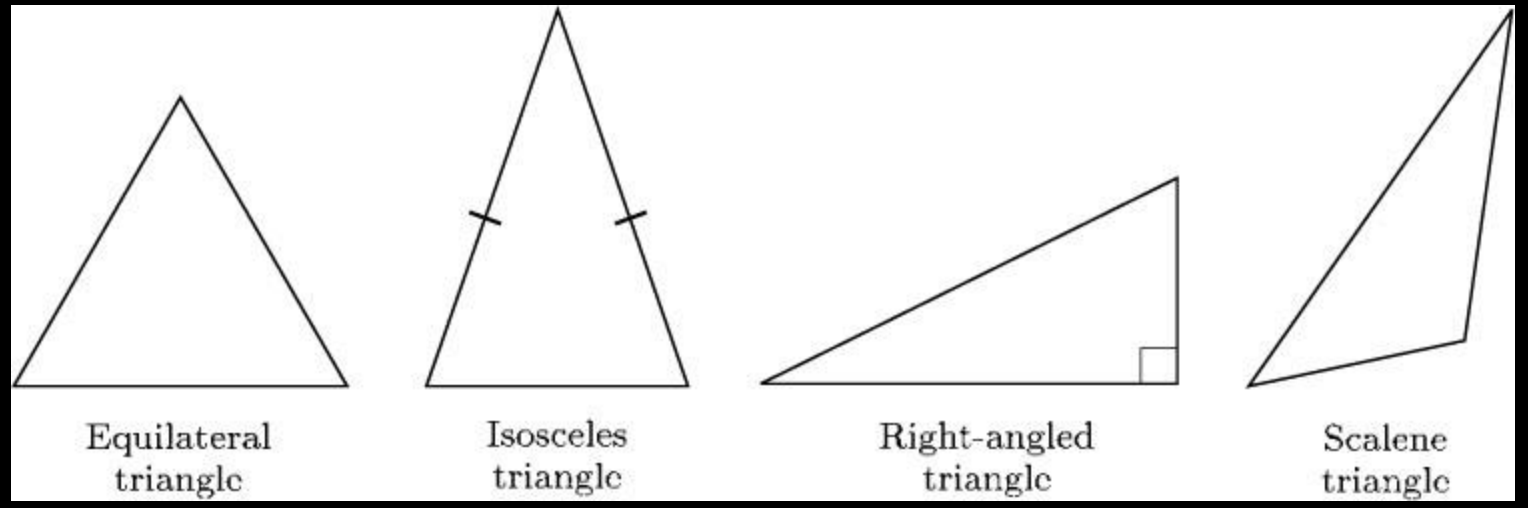
Shapes and Geometry: Why They Matter

- We need to recognize the different shapes we're creating with straps, chains, struts, objects, etc.
- Start seeing things as simple shapes
- Eliminate the background noise
- Geometry matters because it determines the restriction or freedom an object has to move

Triangles 101

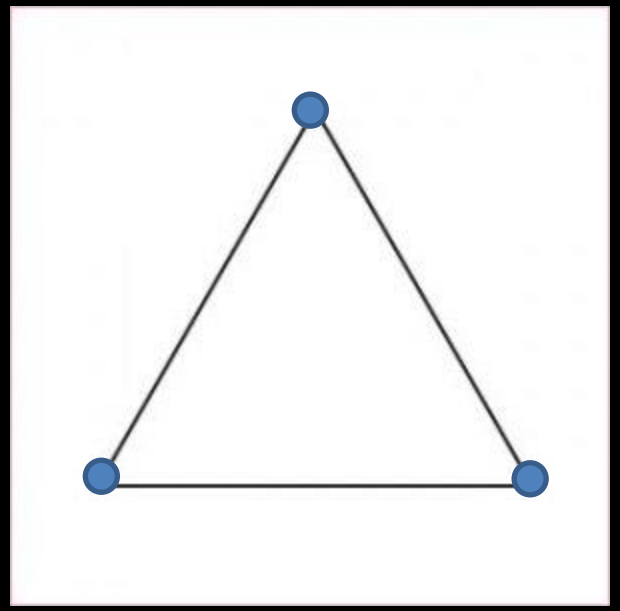
Triangles are the basic foundation for stabilization

- 3 sides
- Triangles are unique in that they are the only rigid 2D shape making them the strongest and simplest 2D shape
- All other shapes can be deformed with a simple push



Conventional Triangles

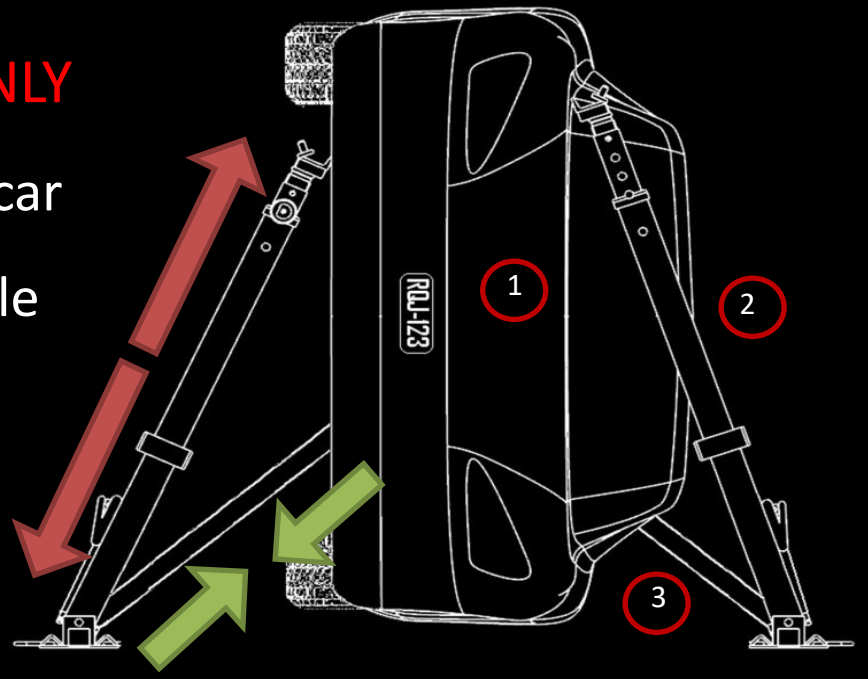
- Rigid 3 bar shape
- All parts move/rotate together
- All parts will handle compression or tension
- All segments are fastened to each other
- They will not separate at the joints
- However, we're not typically working with a conventional triangle…



Conventional Triangle

Unconventional Triangles

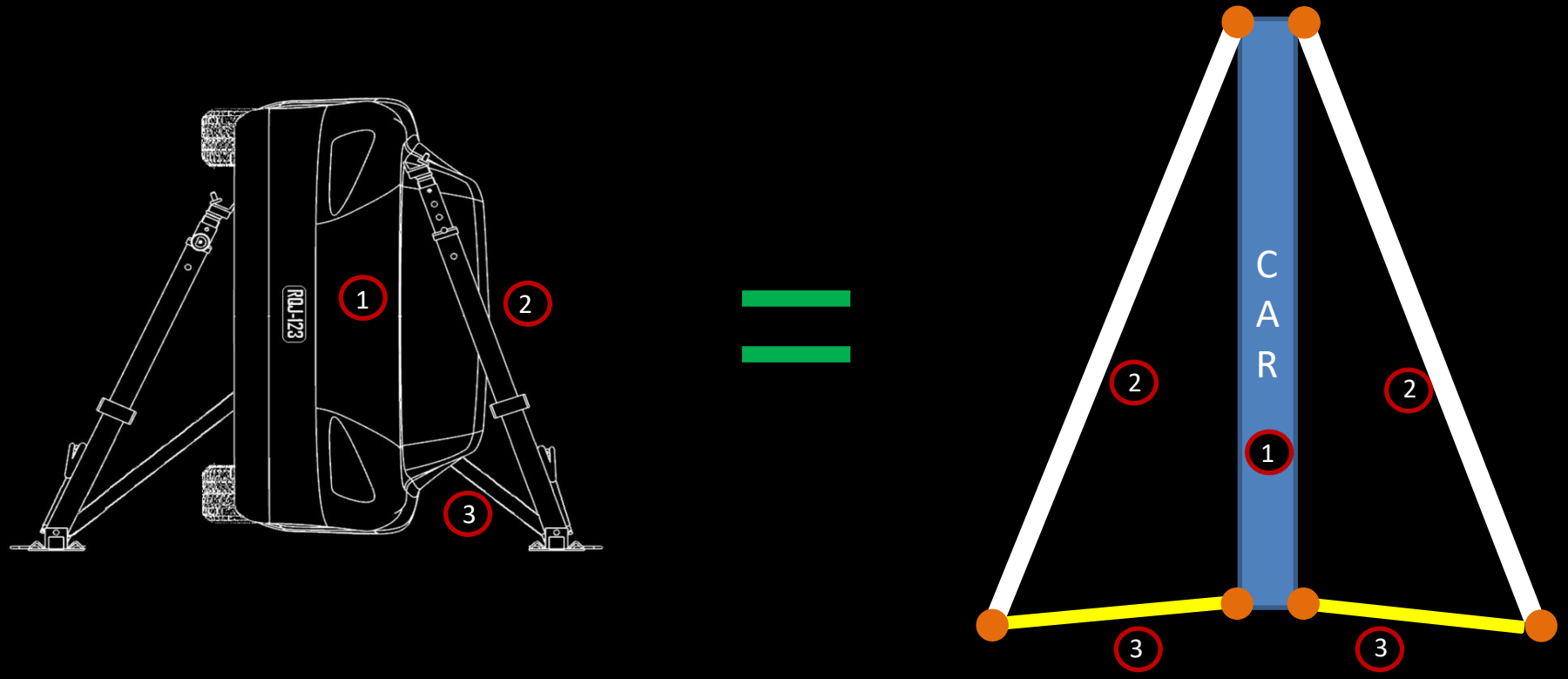
- STRUTS work in COMPRESSION ONLY
  - The strut head is not fixed to the car
  - The strut can separate from vehicle



- STRAPS work in TENSION ONLY
  - STRAP will collapse or fold in compression

1. Vehicle
2. Strut
3. Strap

Visualize the Triangles



- As long as the vehicle or object is solid then we can assume a straight line between a strut and its base strap connection.

1. Vehicle
2. Strut
3. Strap

Visualize the Triangles

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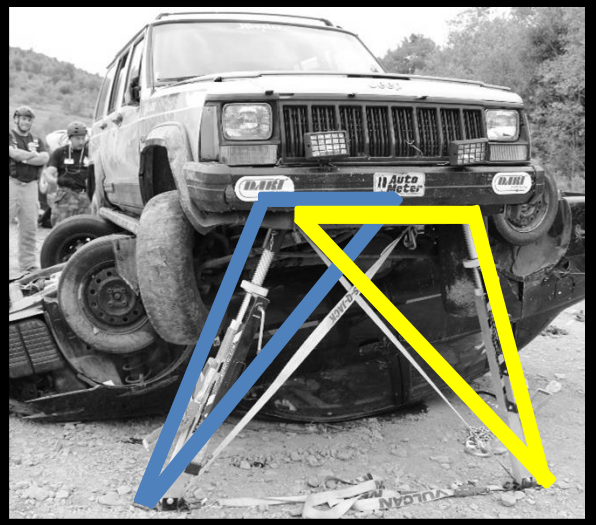
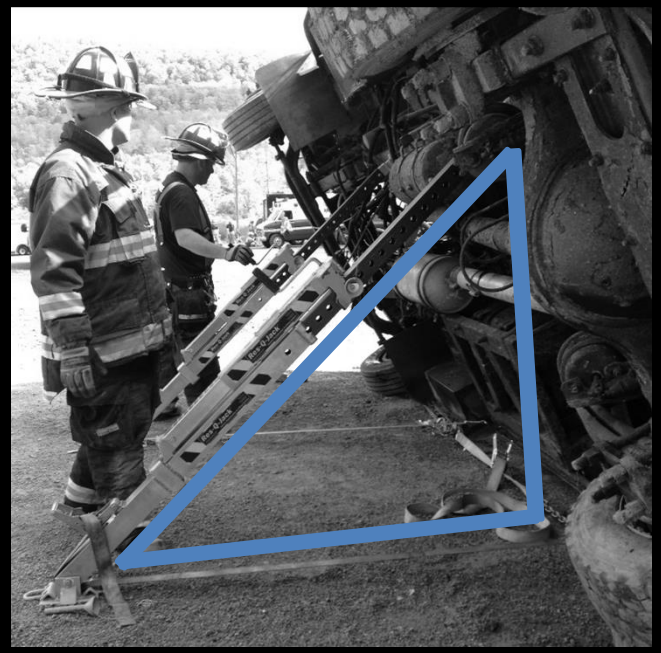
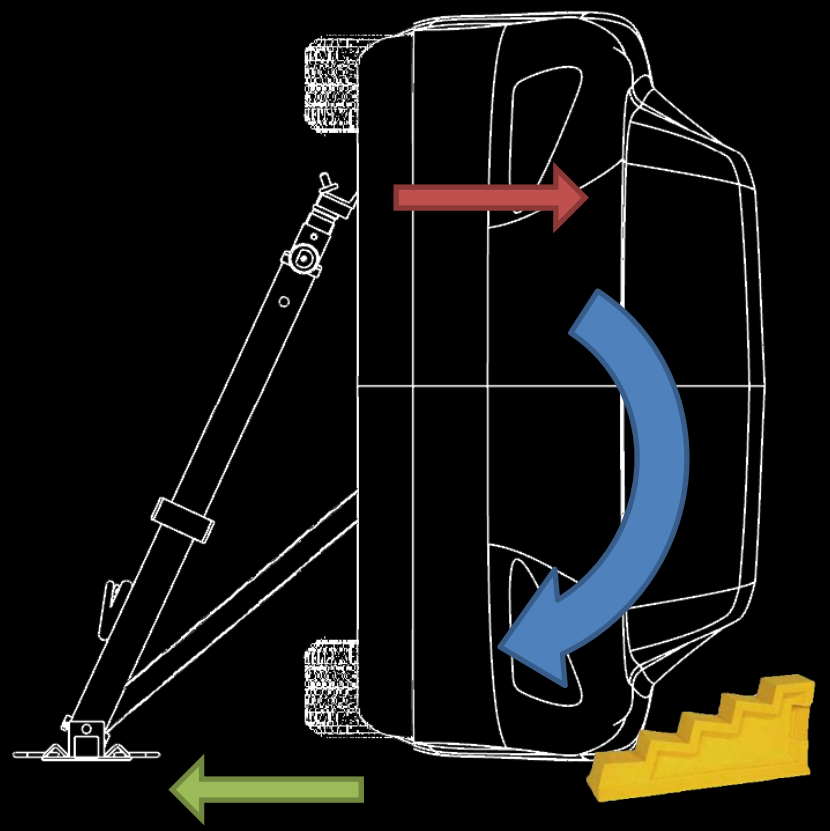




Unconventional Triangles 101

Use caution with single-sided setup

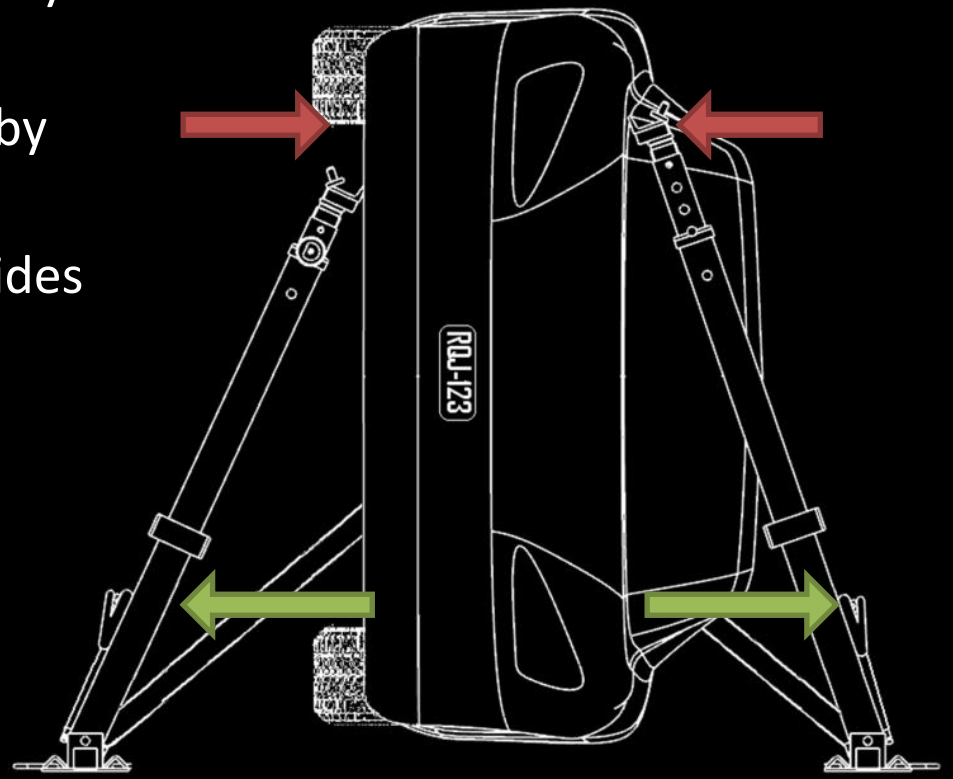
- A strut and strap placed on single side will create a twisting effect
- Cribbing at opposite side is often removed when cutting roof off
- Cribbing is necessary, but increases the footprint minimally
- Caution: Inadequate counteracting forces are present in this setup



Unconventional Triangles 101

Two struts are better than one!

- The push of one strut is countered by the push of the opposite strut
- The pull of one strap is countered by the pull of the opposite strap
- Struts should be aligned on both sides of vehicle

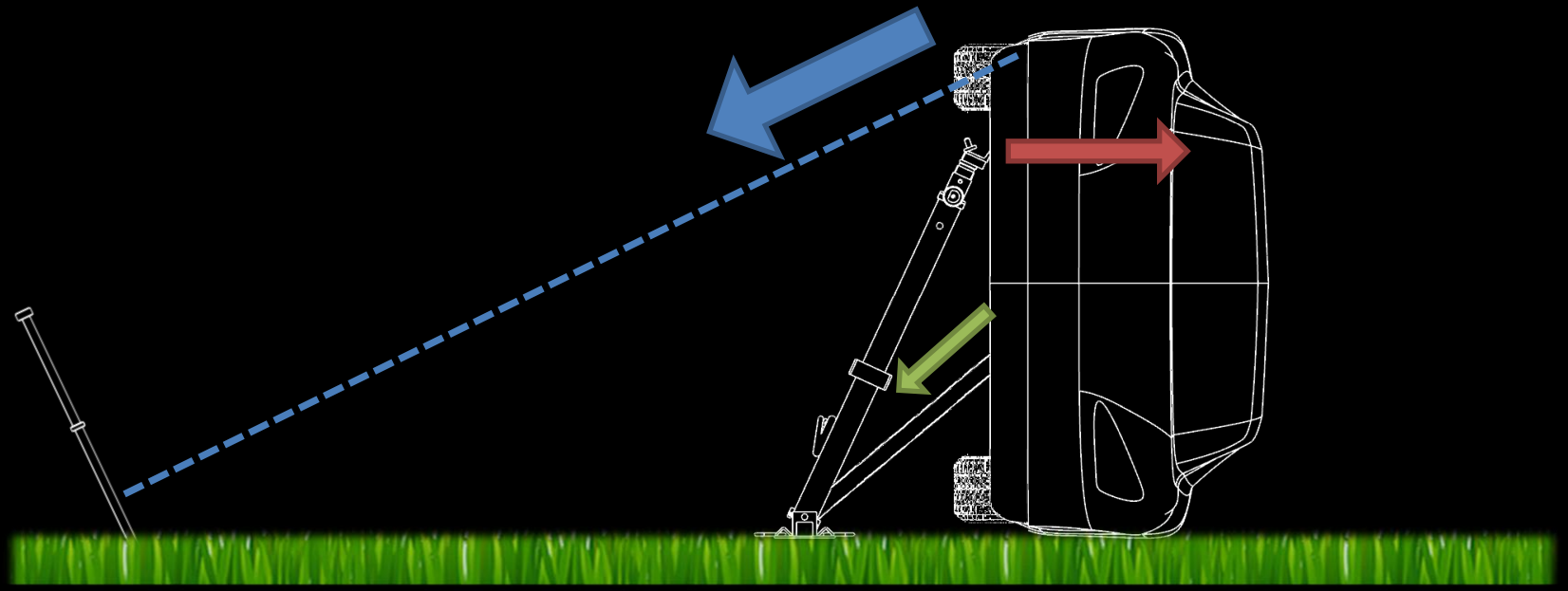


Counteracting forces are better

Alternatives to Opposing Struts

Tie-Lines, Stakes, Pickets, etc.

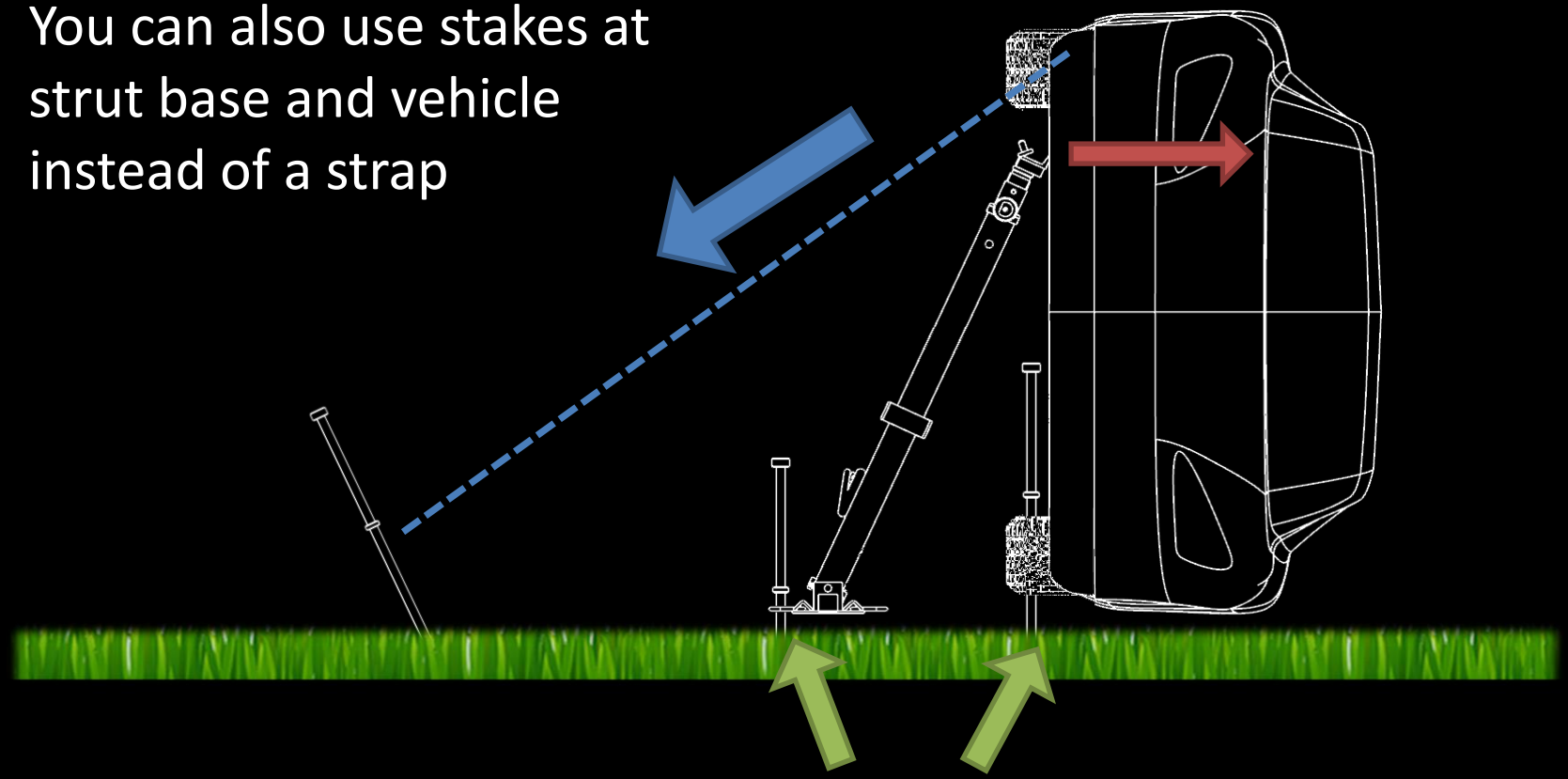
- If you're unable to set up struts on both sides of the vehicle, use a tie-line (blue line) to resist the strut from pushing and to keep the vehicle from rolling away
- The tie-line should be attached to the object **above** the strut head in this scenario to create counteracting forces.
- Note: If insufficient ground to vehicle contact, additional restraints may be required to prevent vehicle from sliding



Alternatives to Opposing Struts

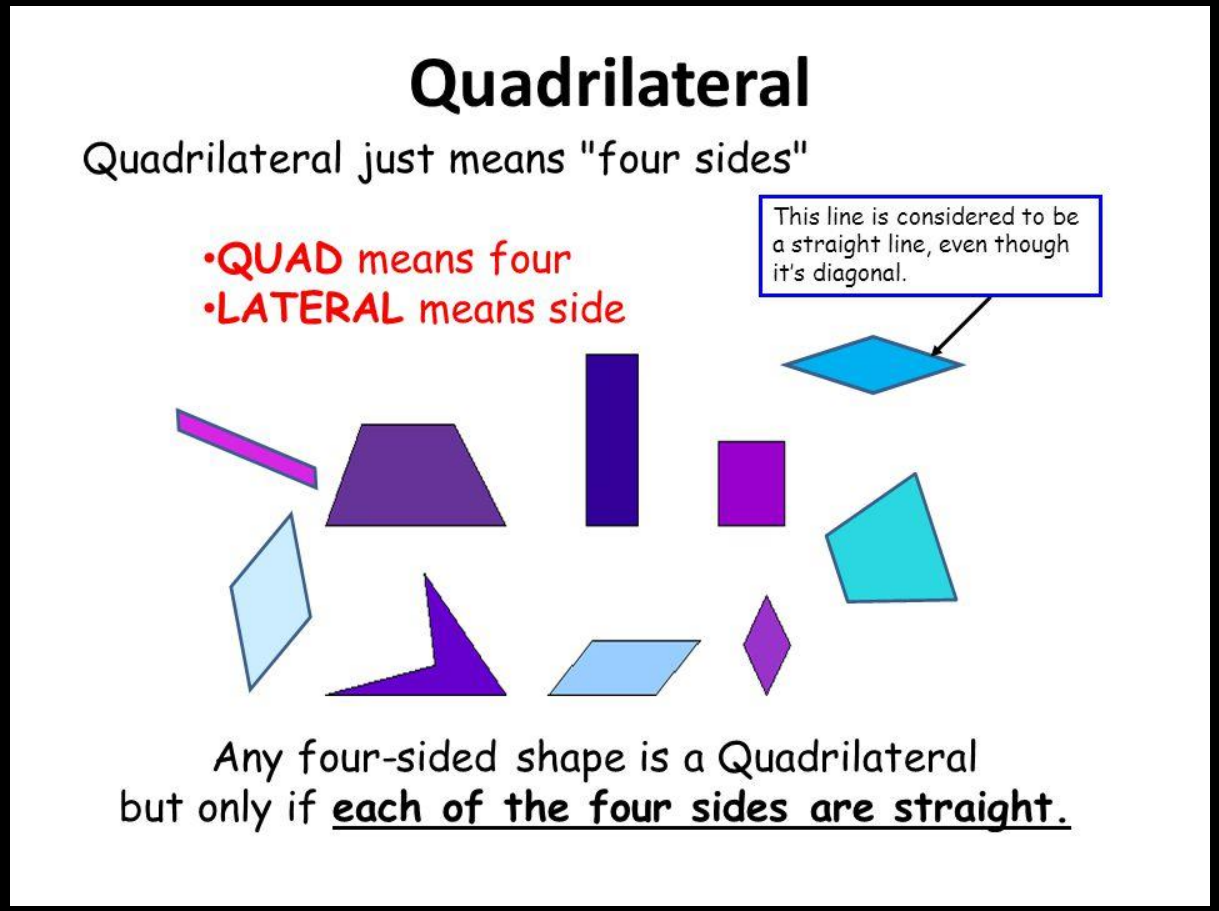
Tie-Lines, Stakes, Pickets, etc.

- You can also use stakes at strut base and vehicle instead of a strap



*If not using a strap, stake both the base AND the vehicle

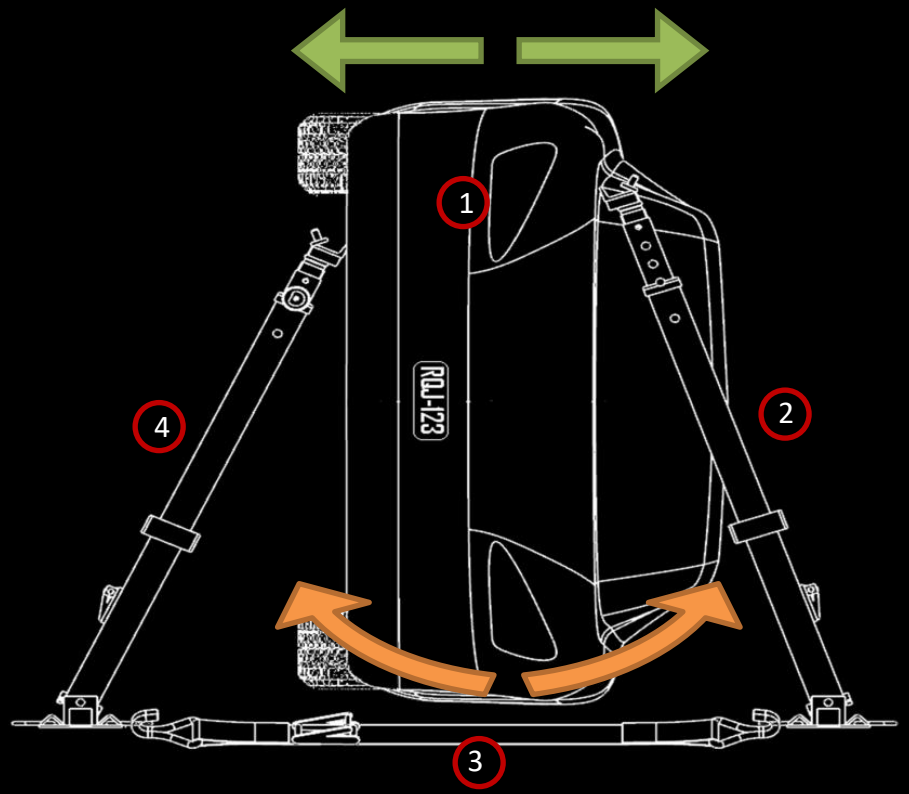
4-Sided Shapes 101



Reference: https://slideplayer.com/slide/2329469/

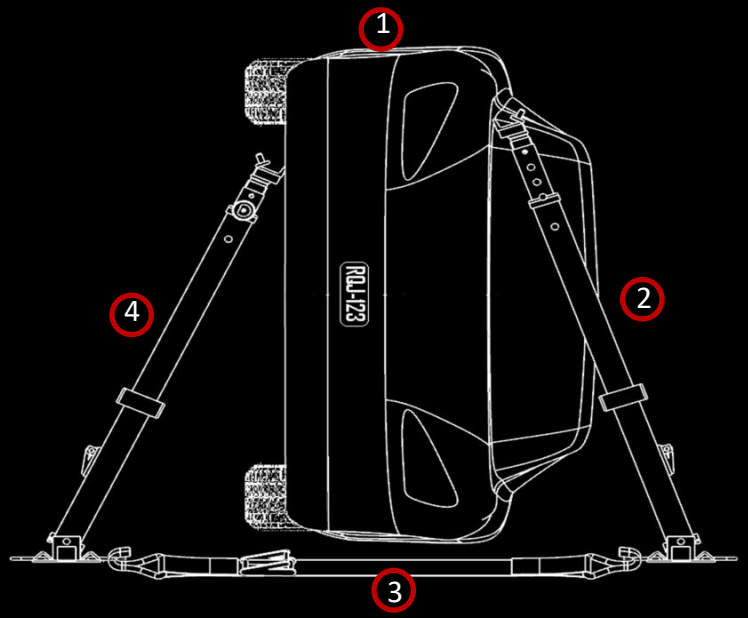
4-Sided Shapes 101

Use caution with 4-sided (or more) shapes!



- No forces restricting the bottom of the vehicle from moving (straps)
- Vehicle can potentially shift at the bottom
- The shape itself can shift since it’s not a triangle

Visualize the 4-Sided Shape



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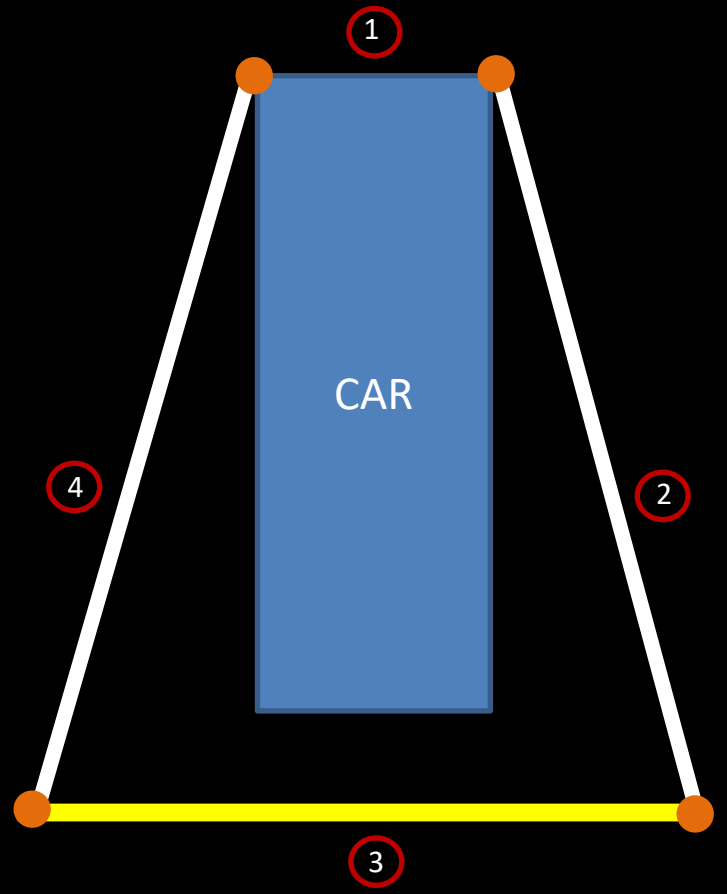
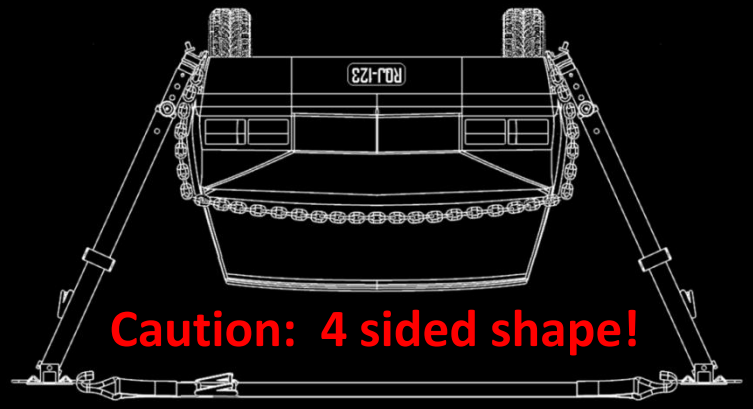
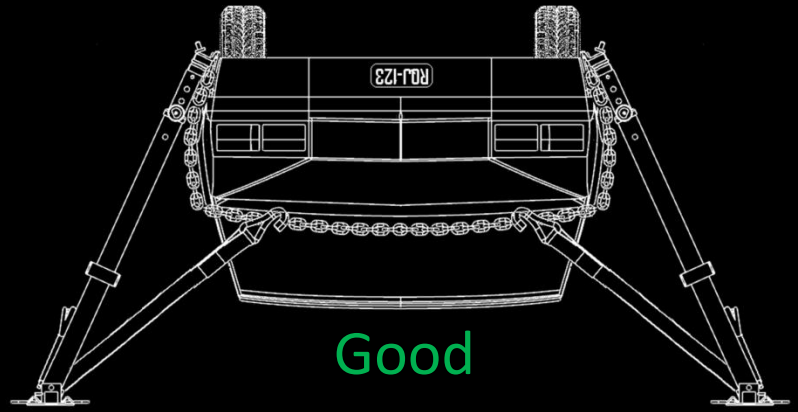


1 Vehicle 2 Strut 3 Strap 4 Strut

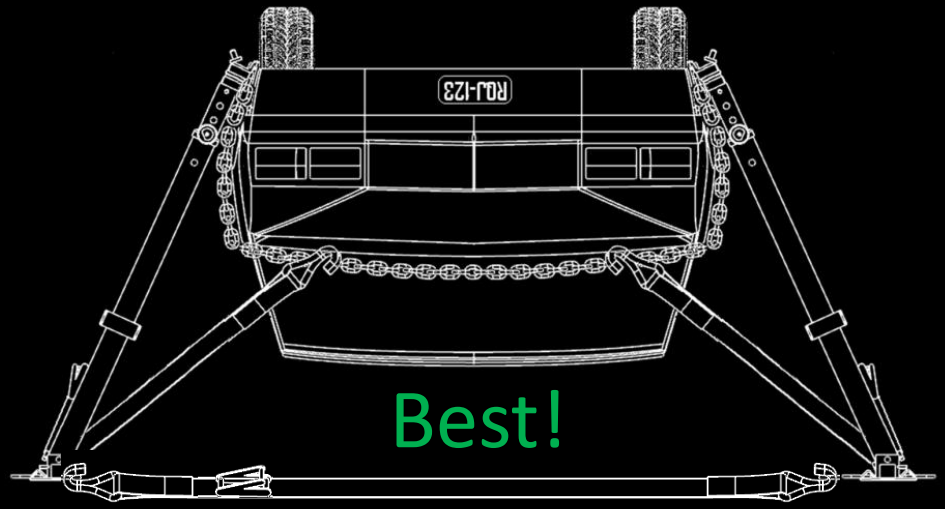
Know the Difference—It's Critical!



Caution: 4 sided shape!



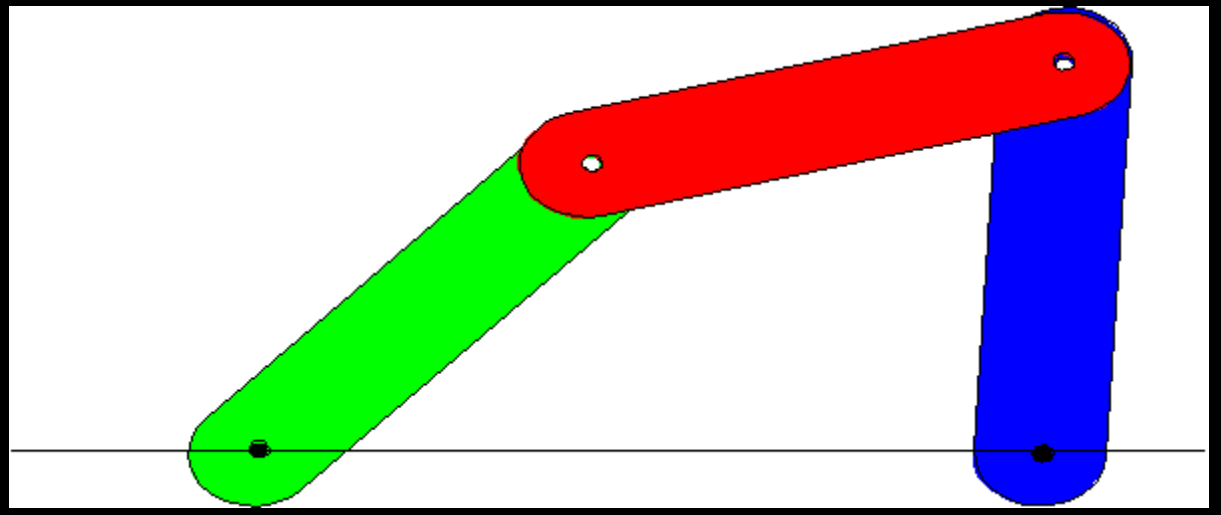
Good



Best!

Know the Difference—It's Critical!

These visuals represent an object with struts placed without triangles/sway straps being used



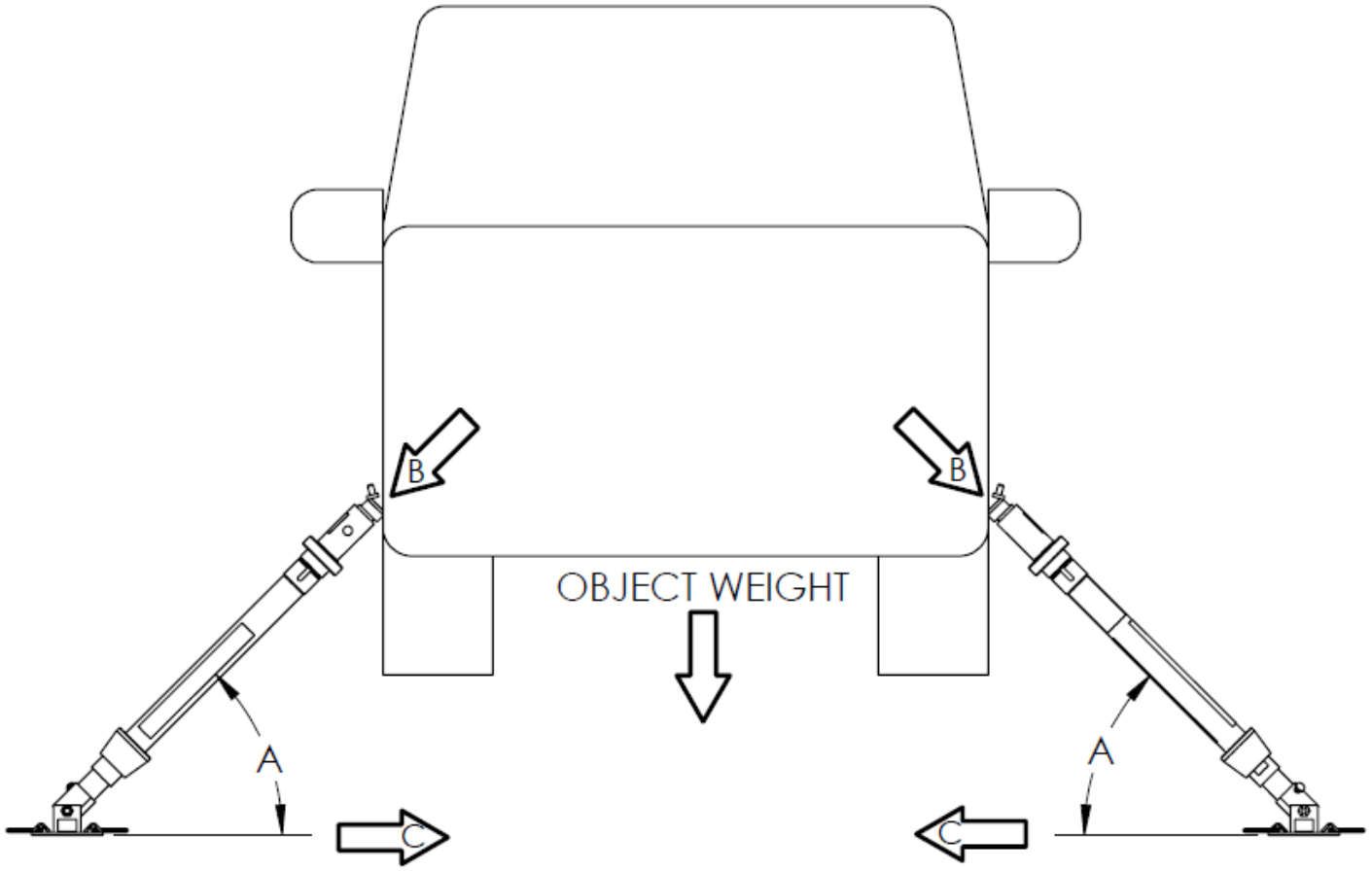
Strut Orientation

- Typically, we consider using a strut in a vertical position for collapse, in a horizontal position for trench rescue and at an angle with a strap attached for vehicle stabilization
- Let’s eliminate this “standard” we’ve generated
- Let’s also clear up the misconception that a strut has a different strength at different angles

Strut Loads VS. Angles

- A strut's strength is the same regardless of how it's oriented (gravity is negligible)
- What changes is the object load depending on the strut attack angle
- The load on a strut placed at a 45° angle is approximately 1.5 times the same load where the strut is at a 90° angle. See following figure and chart

Strut Loads VS. Angles



NOTES:
1. THE VALUES ABOVE WERE CALCULATED ASSUMING TERRAIN WAS FRICTIONLESS (HARD, ICY).
2. THE WLL ON ALL STANDARD BASE PLATE LINKS IS 6,000 LBS.

Strut Loads VS. Angles

TECHNICAL DATA SHEET

DATE UPDATED: 10/10/2018 | REV:

TITLE: WLL ON TWO STRUTS AT SAME ANGLE | PART NO.

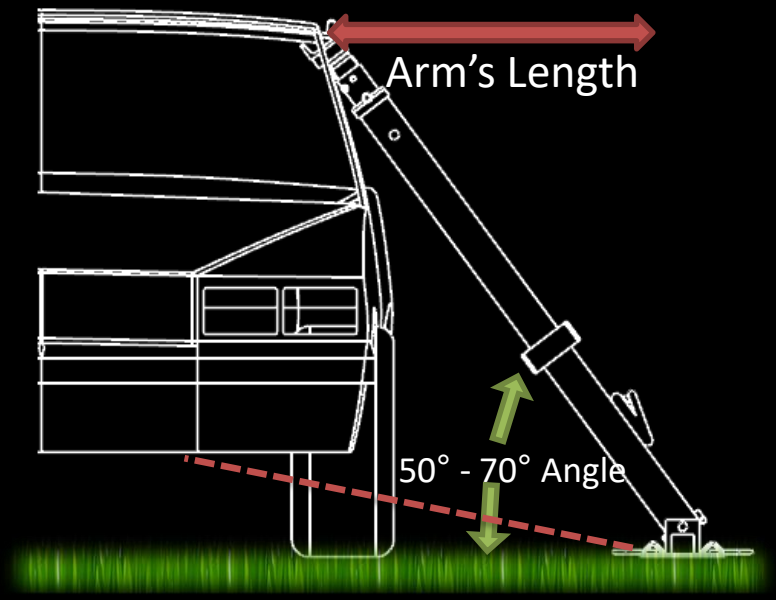
RES-Q-JACK® STABILIZATION ELEVATED

LOADING ON TWO STRUTS AT THE SAME ANGLE

OBJECT WEIGHT (lbs)	OBJECT WEIGHT (kgs)	A - ANGLE OF STRUTS (DEGREES)	B - COLUMN LOAD ON STRUTS (lbs)	B - COLUMN LOAD ON STRUTS (kgs)	C - HORIZONTAL FORCE ON LINKS (lbs)	C - HORIZONTAL FORCE ON LINKS(kgs)
1,000	453	45	707	320	500	226
1,000	453	67.5	541	245	207	93
1,000	453	90	500	226	0	0
2,000	907	45	1,414	641	1,000	453
2,000	907	67.5	1,082	490	414	187
2,000	907	90	1,000	453	0	0
3,000	1,360	45	2,121	962	1,500	680
3,000	1,360	67.5	1,623	736	621	281
3,000	1,360	90	1,500	680	0	0
4,000	1,814	45	2,828	1,282	2,000	907
4,000	1,814	67.5	2,164	981	828	375
4,000	1,814	90	2,000	907	0	0
5,000	2,267	45	3,535	1,603	2,500	1,133
5,000	2,267	67.5	2,705	1,226	1,035	469
5,000	2,267	90	2,500	1,133	0	0
6,000	2,721	45	4,242	1,924	3,000	1,360
6,000	2,721	67.5	3,247	1,472	1,242	563
6,000	2,721	90	3,000	1,360	0	0

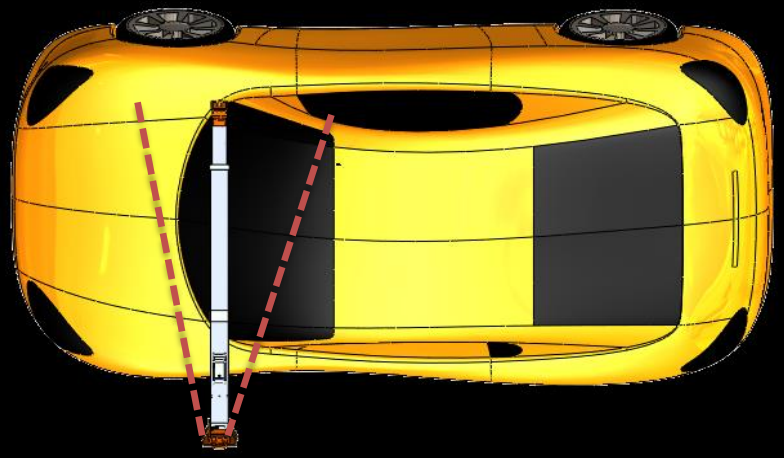
Strut Orientation: Angled Struts

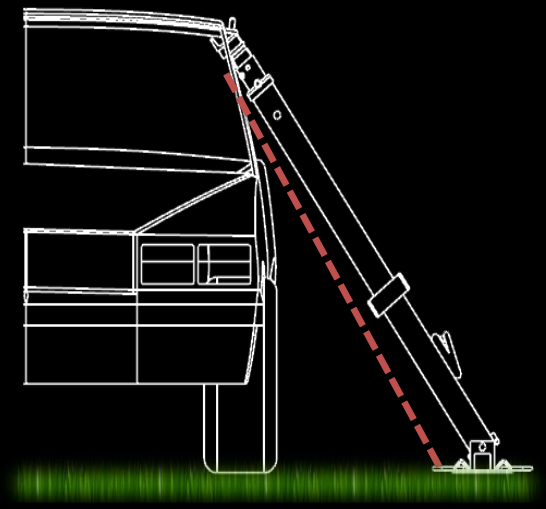
- Angled struts require a stake or a strap to prevent the base from sliding
- A strap attached to the object will also prevent the object from sliding away from the base and create our triangle desired for stabilization
- For basic angled strut setup on flat ground, place the strut base an arm's length away from the car at a 45-70° angle



Strut Orientation: Angled Struts

Do NOT hook straps too high. Straps must be hooked low to restrict movement and create the triangle we are looking for.

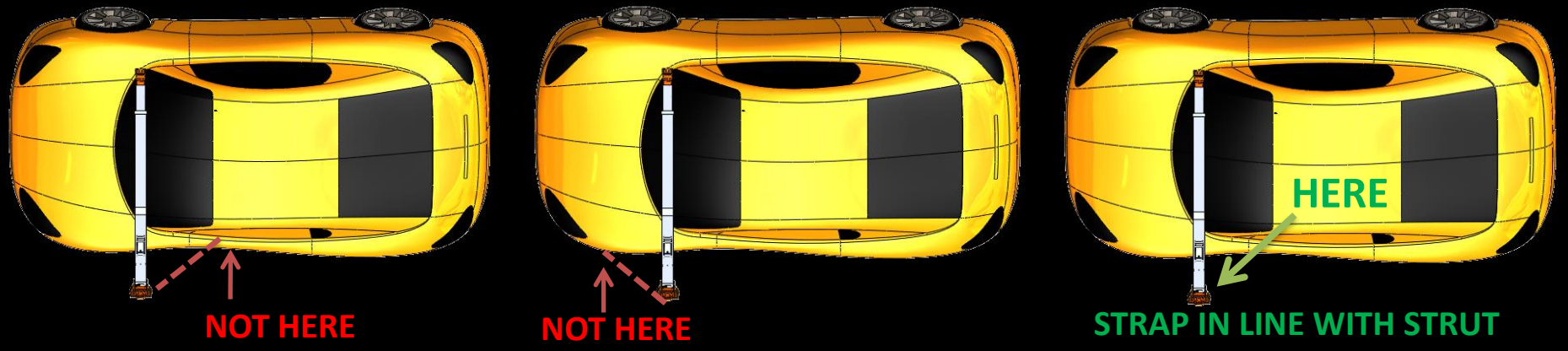




Notice in the right picture that there is no triangle. This is more like a door hinge that could allow strut base to swing or slide out.

Strut Orientation: Angled Struts

- With a **SINGLE** base restraint, position strap <u>in line with strut</u>

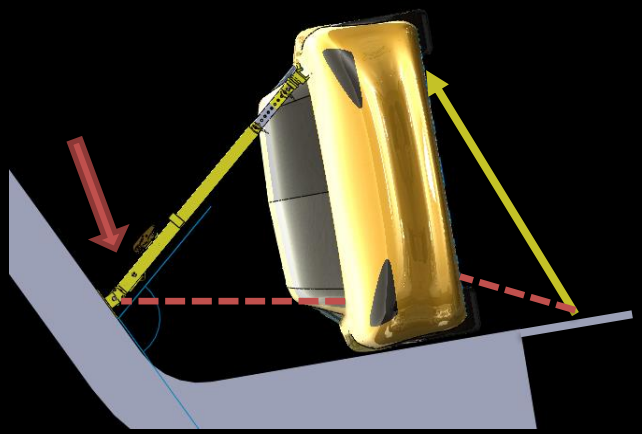


- If unable to use a single strap straight back to the object, use 2 straps to counter the pull on the side of strut or pull on the vehicle (one strap angled off each side of the strut as shown). Straps do not have to be angled exactly the same as long as you are creating counteracting forces.

Strut Orientation: Horizontal Struts

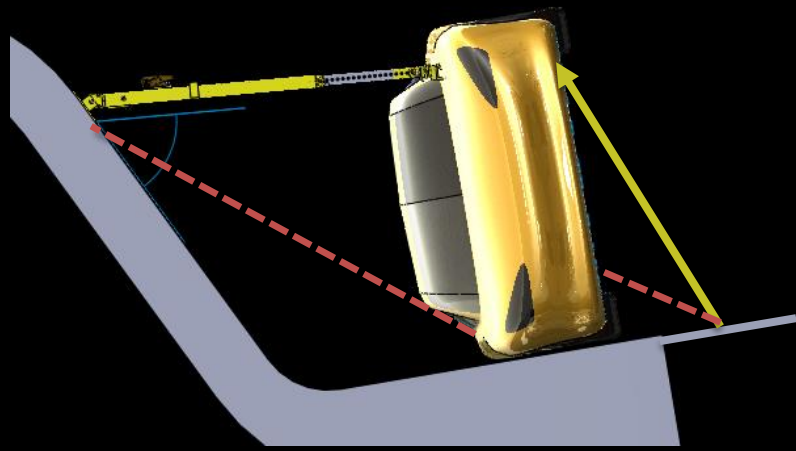
- Terrain and vehicle position may play a role in determining strut placement
- Pay attention to the ground/strut angle. The strut can move if placed at a bad angle.

Angle greater than 90º
BAD



Strut may swing out when strap is tightened

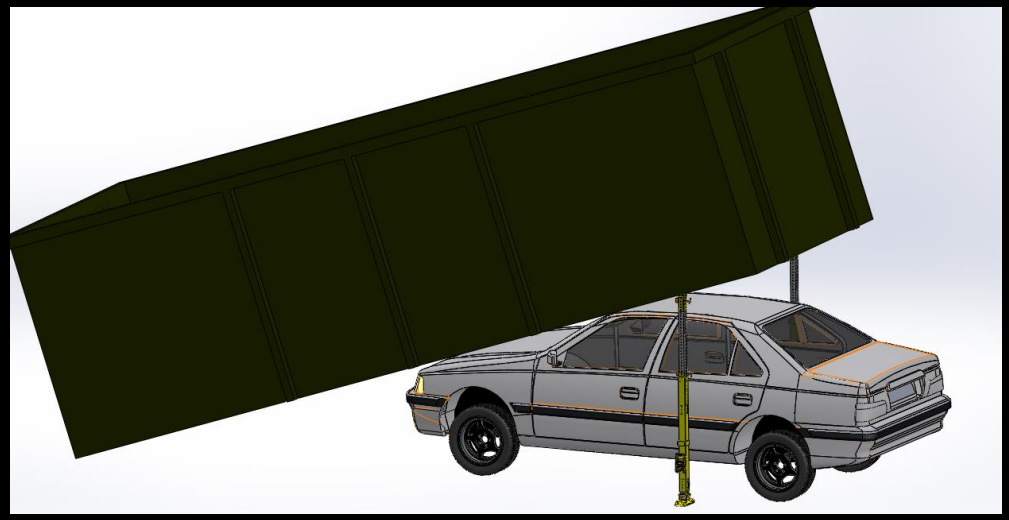
Angle less than 90º
GOOD



Strut should bear into ground when strap is tightened

Strut Orientation: Vertical Struts

- Less equipment
- Less time
- Minimizes load on strut
- On flat ground a vertical strut will most likely not need a base strap



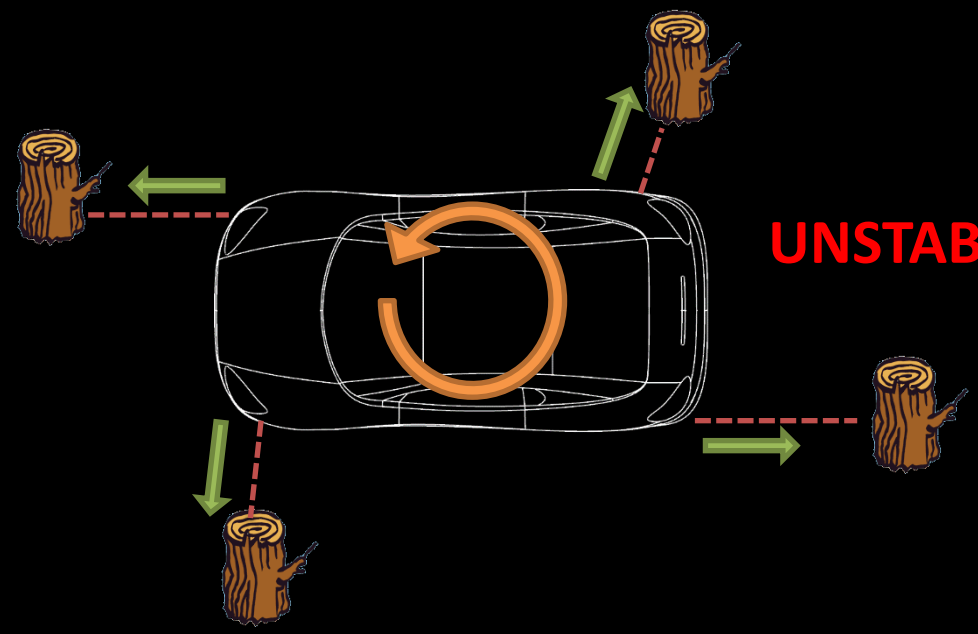
- The name of the game is COUNTERACTING FORCES. If you do attach any base restraints, they must be placed as a pair working in COUNTERACTING DIRECTIONS to prevent strut base movement
- Base stakes may not be necessary, but are a good idea to prevent base shifting
- Control shift or sway of object with stakes and/or tie-lines

Envision 3D Stabilization

- Look at the big picture— rotation, sliding, tipping, etc.
- For example, often times we'll focus on a side resting car tipping to the wheels or to the roof and not consider twist or slide
- View from all directions—where is the possible movement?
- Use stakes, pickets, tie lines, etc. to prevent movement

Tie-Lines

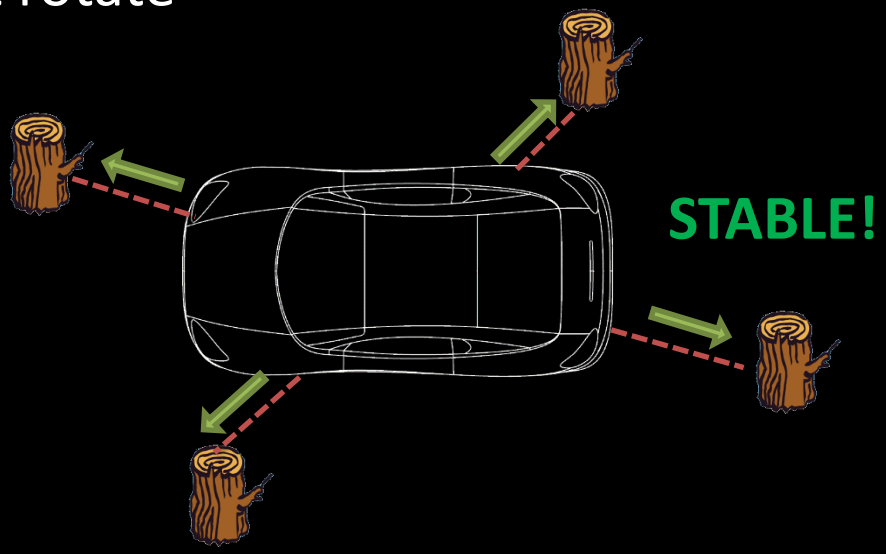
- Tie-lines should act in an “equal and opposite” way to avoid twisting or shifting of the vehicle



- In this figure all tie-lines are acting in a way that would cause counter-clockwise rotation
- Movement may not be realized while the object is on the ground, but may appear during a lift

Tie-Lines

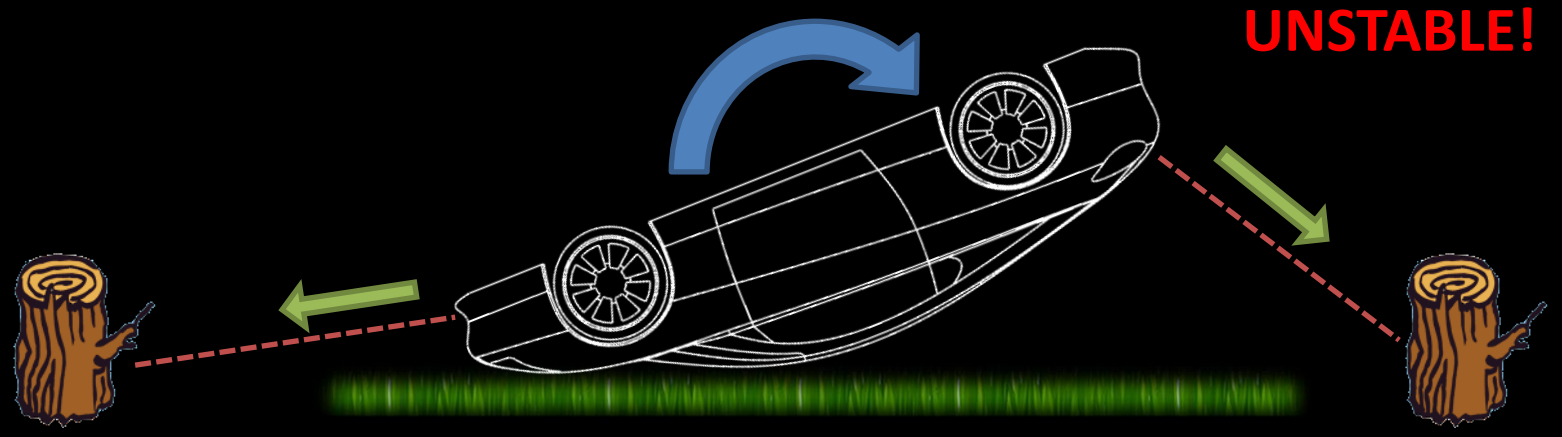
- Notice that the lines are now opposing. The vehicle is stable and will not rotate



- Everything looks great, right? Things may look fine from this angle, but could we be missing something?

Tie-Lines

- Envision all angles and possible movements



Vehicle now has the ability to pitch,
even though it may look stable

Multiple-Object Considerations

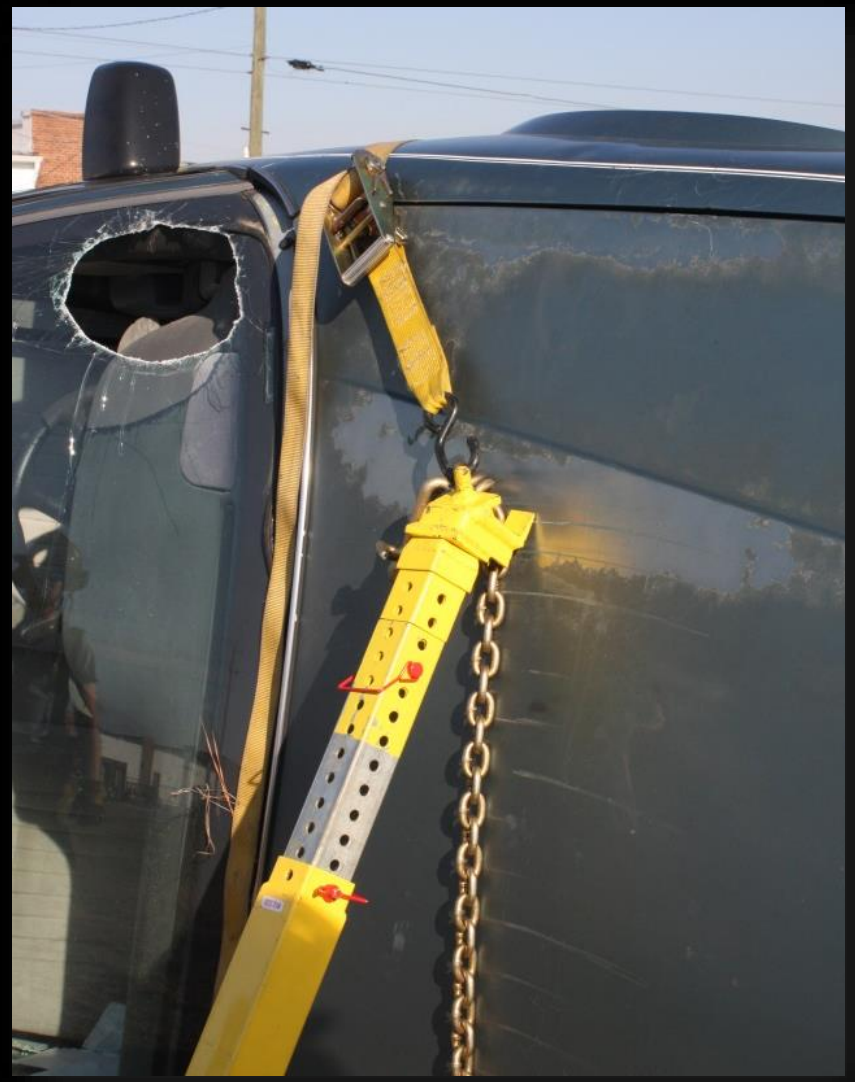
- Overrides
- Properly “Marry” Vehicles
- Caution making triangles
- Be aware of suspension components and treat appropriately

Purchase Points

- Purchase Points are the strut engagement locations on a vehicle or object.
- This is where the force of a strut would be applied to the object.
- You need to consider the load you will be placing on the object itself to determine the best spot for your purchase point so you don’t overload that area.
- Piercing sheet metal should be a last resort because of its weaker tendency and necessity for violent impact on an unstable object.

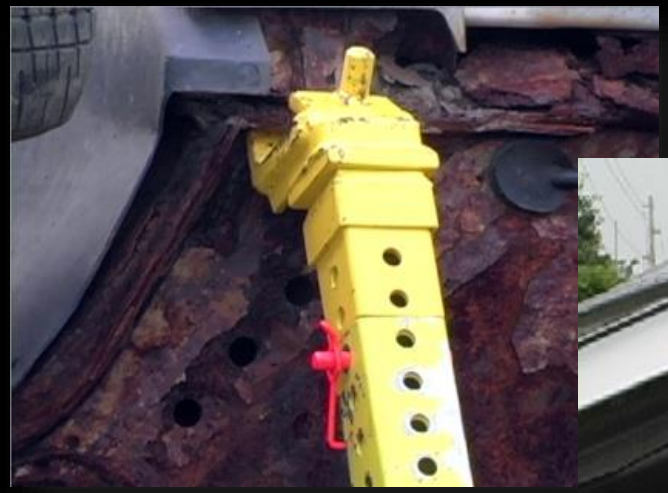
Purchase Points

Chain Wrap and Chain Grab



Purchase Points

“C End”

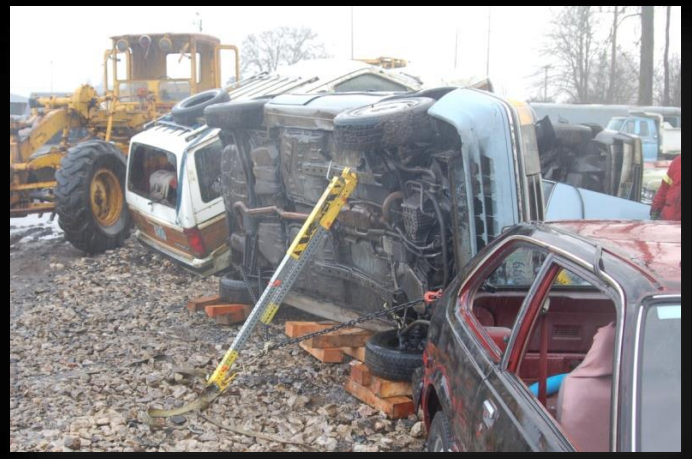


Purchase Points

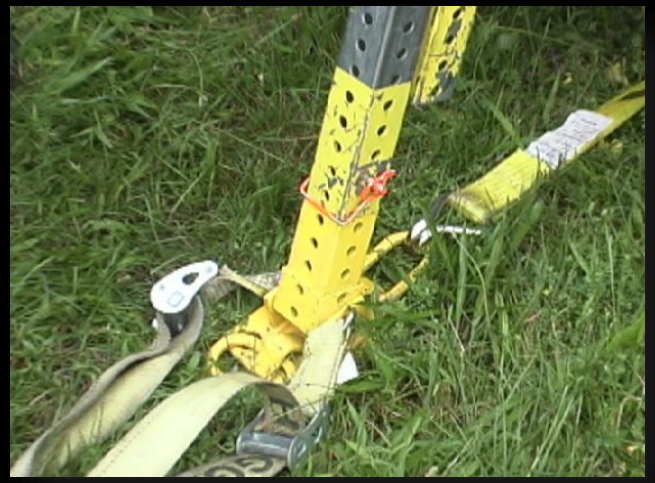
Round Point to factory holes in frame

Base Restraints

"D" Ring Cluster to Chain



Both ends of chain are secured to under carriage of car also using a cluster from the D Ring to the chain



Ratchet Strap to object or Base to Base or D Ring to D Ring

Stake Base

Part III:

Strut Lifting Concepts

Lifting Basics

- Why/When Should You Lift?
  - Partial ejection or entrapment
  - Relieve pressure on roof posts with an overturned vehicle
  - Create working space to access patients
  - Speed up operation to give the patient a better chance
  - Remove from overhead hazard with an override (ex. car on car)
- Why Lift With Struts?
  - Need to stabilize load during lift (even if using lift bags)
  - High engagement w/ struts with increased footprint
  - No need to “dig holes” under the load
  - Quick and easy
- We are complimenting cribbing, not replacing it. Remember to lift an inch, crib an inch.

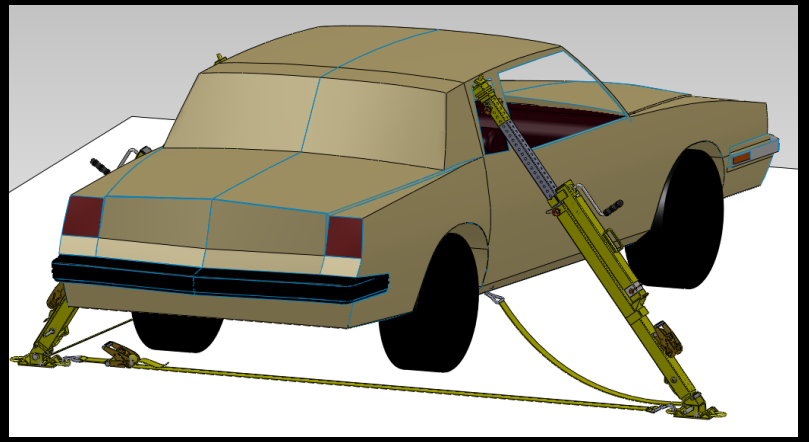
Lifting Basics

- Triangles are great for stabilization
- Triangles are not so great for lifting and must be incorporated properly
  - search YouTube “strut failure”
- Lifting against a tight triangle can result in dangerous tension buildup or strut failure
- Tension management is critical
  - Options: short lifts, crib and reset, dual straps or single “leash” straps with 4-sided shape combination, outrigging, etc.

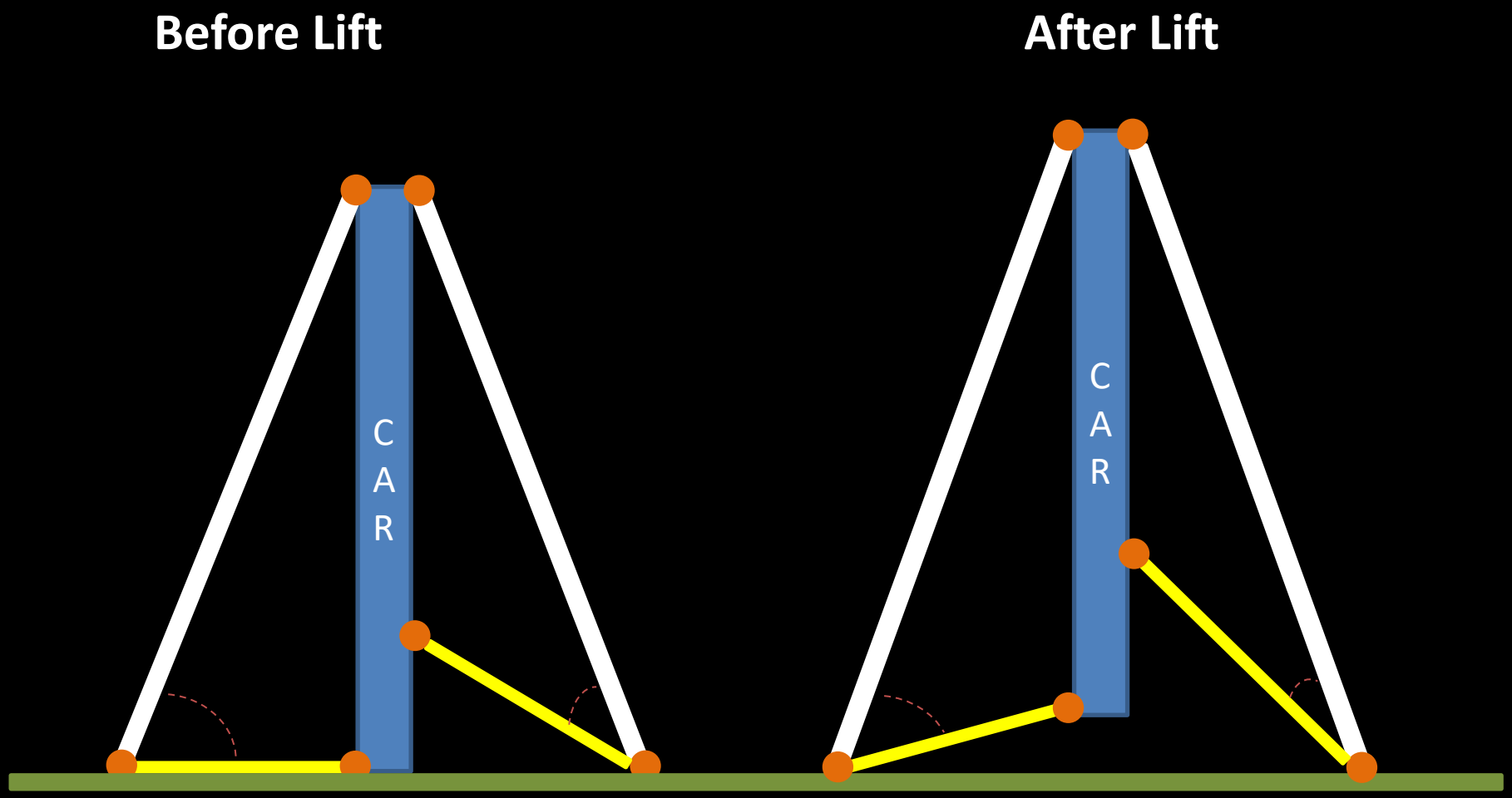
Lifting with Tension Management

“Leash, sway or triangle” Technique

- Leave slack in sway strap to allow for lift
- Make sure ratchet mechanism in LOCKED position with multiple wraps on the bale
- Tighten strap when lift is complete



Why do we keep triangle straps hooked low?

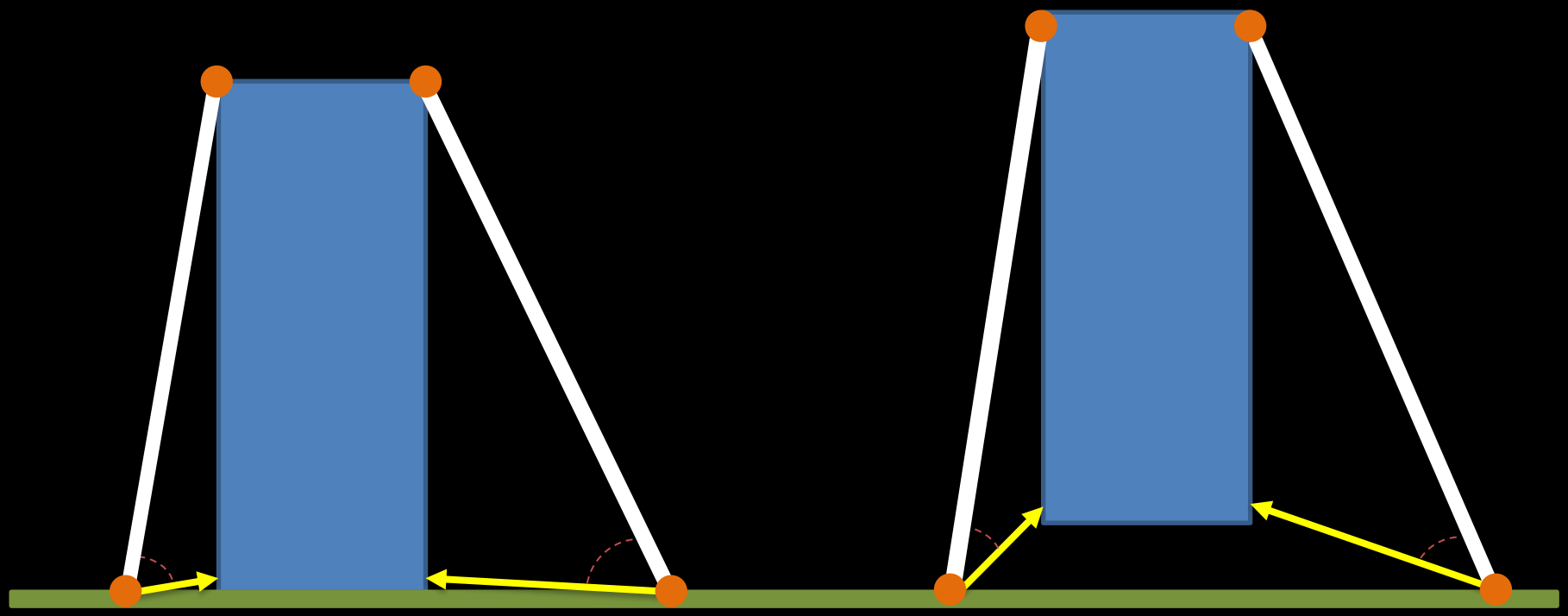


Why is length helpful to keep vertical force in straps down?

Short lengths build tension quicker than longer lengths

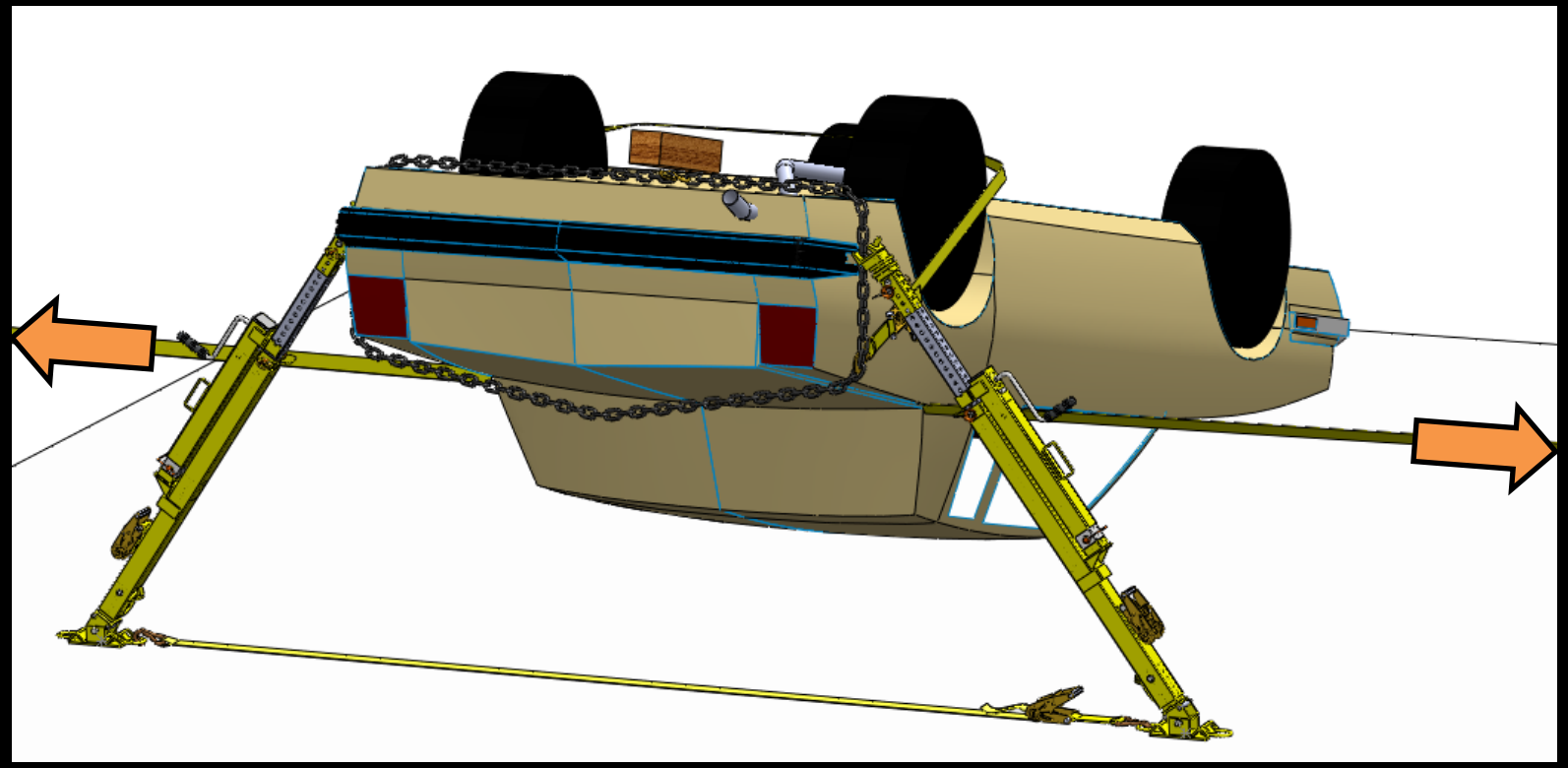
Before Lift

After Lift



Lifting with Tension Management

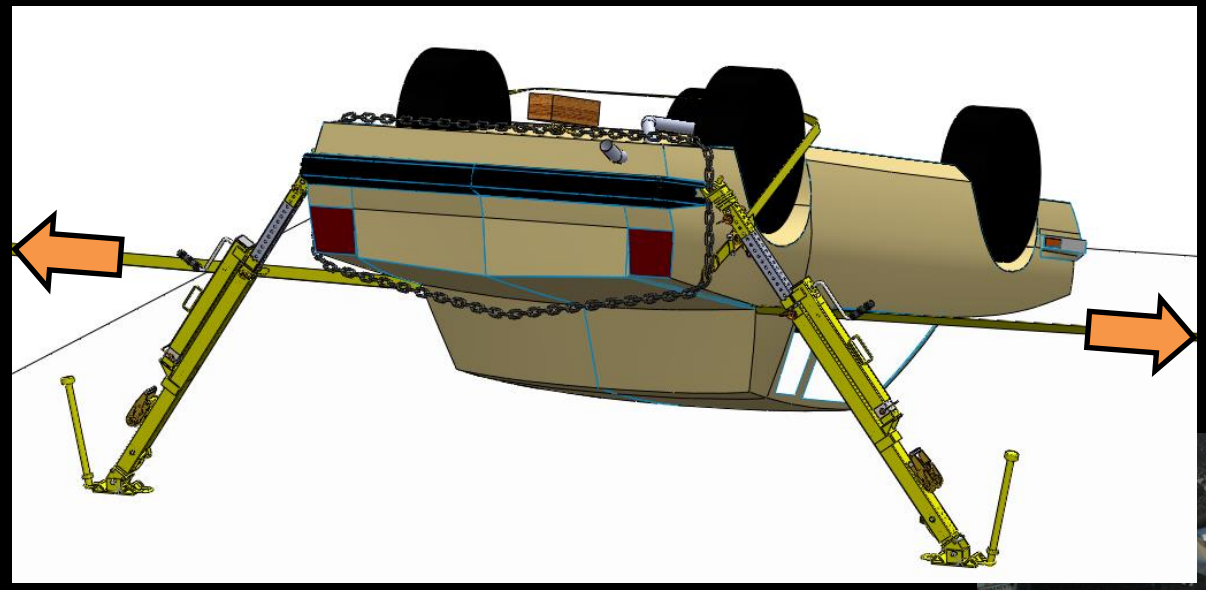
“Outrigger Alternative”



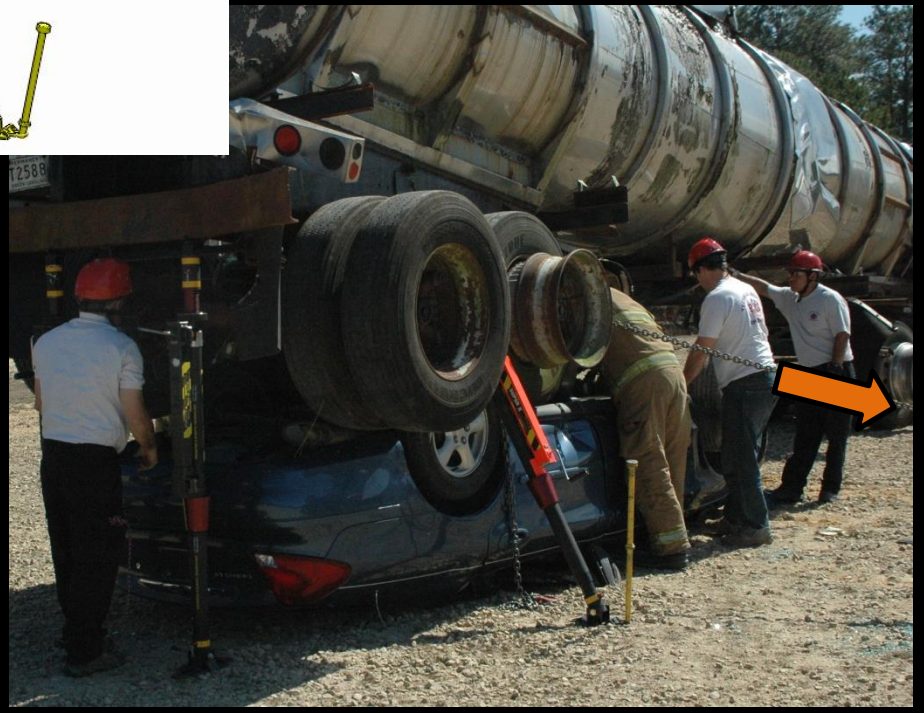
Using Base-to Base Strap

Lifting with Tension Management

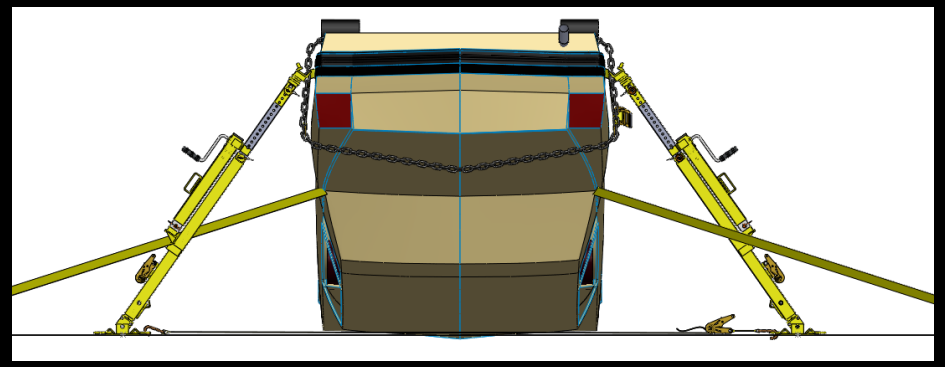
“Outrigger Alternative”



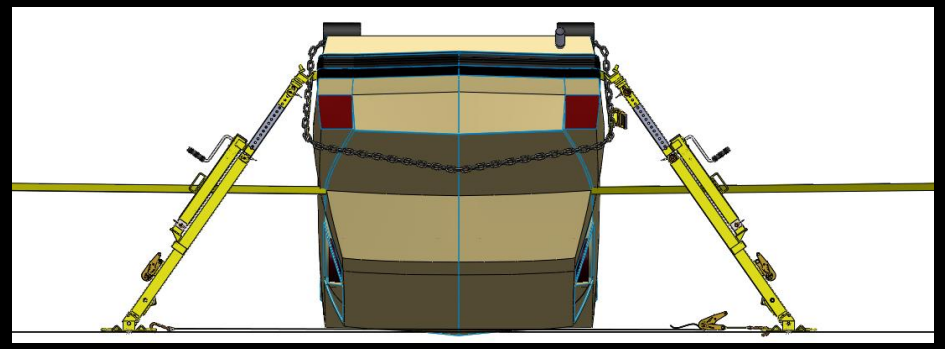
Using Staked Bases



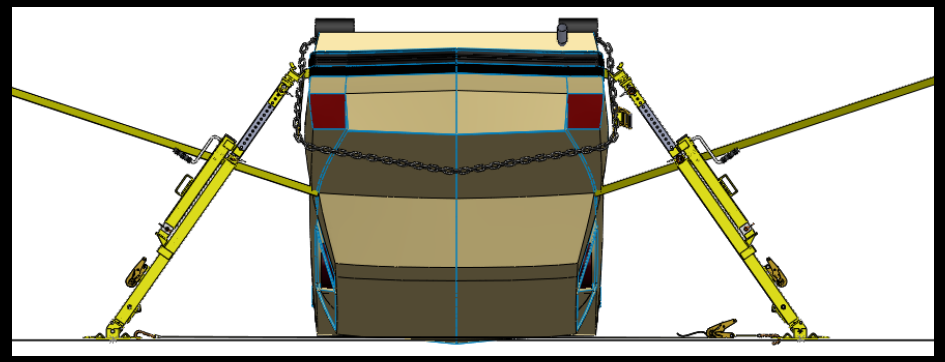
Understanding Outriggers



1. Tie line from a lower anchor point creates tension on straps while lifting



2. Flat strap with some length may not need adjustment



3. Tie line from a higher anchor point will create slack in straps and require tensioning as the lift progresses, which is easier compared to #1

Considering Strut Placement: Going Against Your Instinct

- The ideal location for lifting might be in a position that could later interfere with extrication or access to the patient.
- Lifting and stabilization can be broken down into 2 steps
  - 1st Step: Lift from ideal location for simple operation.
  - 2nd Step: Stabilize without interfering with extrication and remove interfering strut.
  - This may save time and produce a better, safer lift!

Critical Strut Feature

- The load may require use of heavy duty lift bags. In this case, LIFTING struts with ability to follow the load up and down are a necessity that make for the safest lift.
- In both cases, you want a strut that has infinitesimal length adjustment capability under the load without compromising user safety.
- Ever tried to crib a load on the way down?

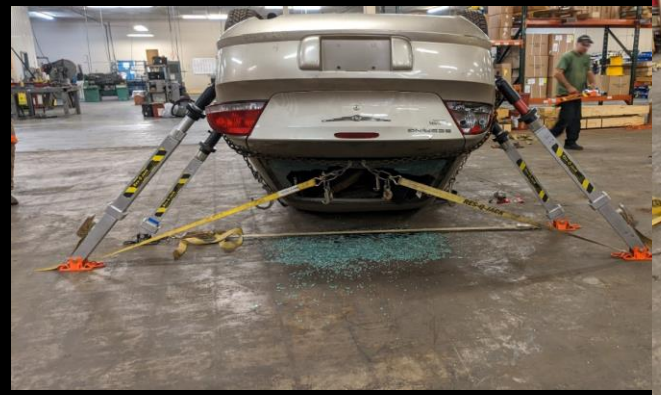
Overrides/Underrides

- Tie suspension down when needed on lower and/or upper vehicle **prior** to lifting if suspension is going to impact lift, otherwise, there may be a delay in object separation as suspension expands maintaining contact with bottom object
- Anchor upper and lower objects together in fashion that limits unwanted movement but allows desired movement/lift
  - In bottom left picture, notice left side of upper vehicle anchored to lower vehicles to create stable hinge point to allow safe lift of right side.
  - In bottom right picture, notice that the chain used for lifting also holds suspension from dropping which saves time and more equipment.

CONSTANT-STABILIZATION-LIFTING™ Technique by Res-Q-Jack, Inc.

- The purpose of the technique is to keep the car stabilized during the entire lift (hence the name, Constant Stabilization Lifting).

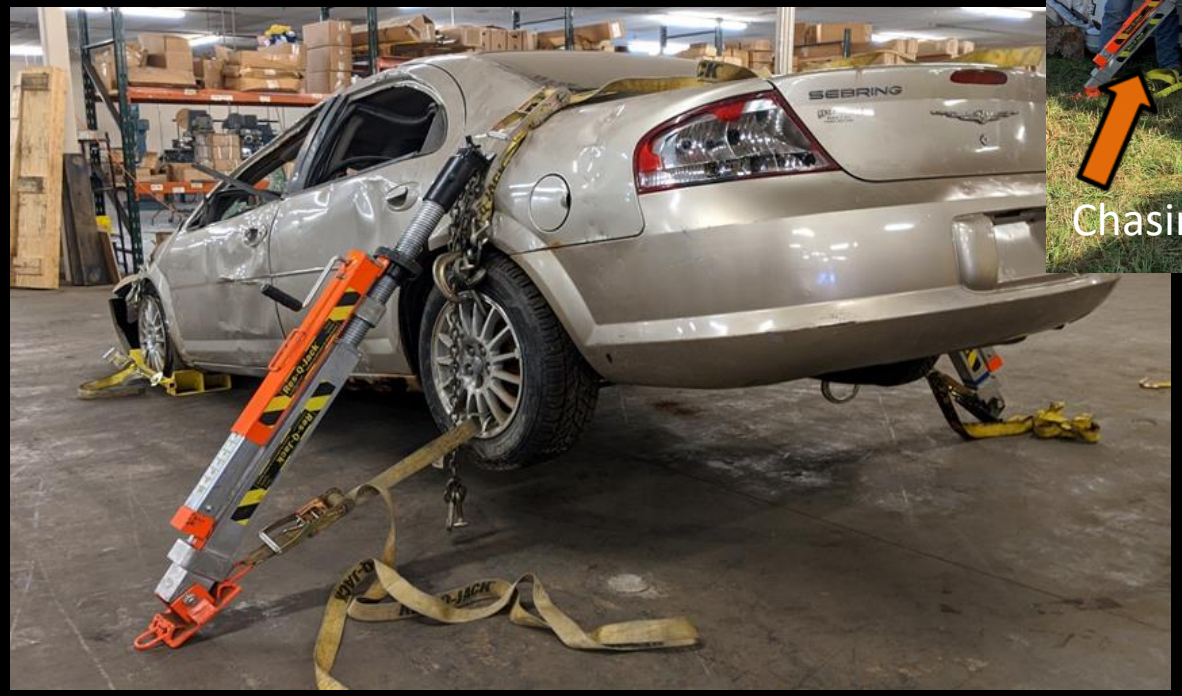
Insert written explanation by Cris as to what it and why we're using it. What are it's pros and cons?



Wheel Resting CSL™ Lift

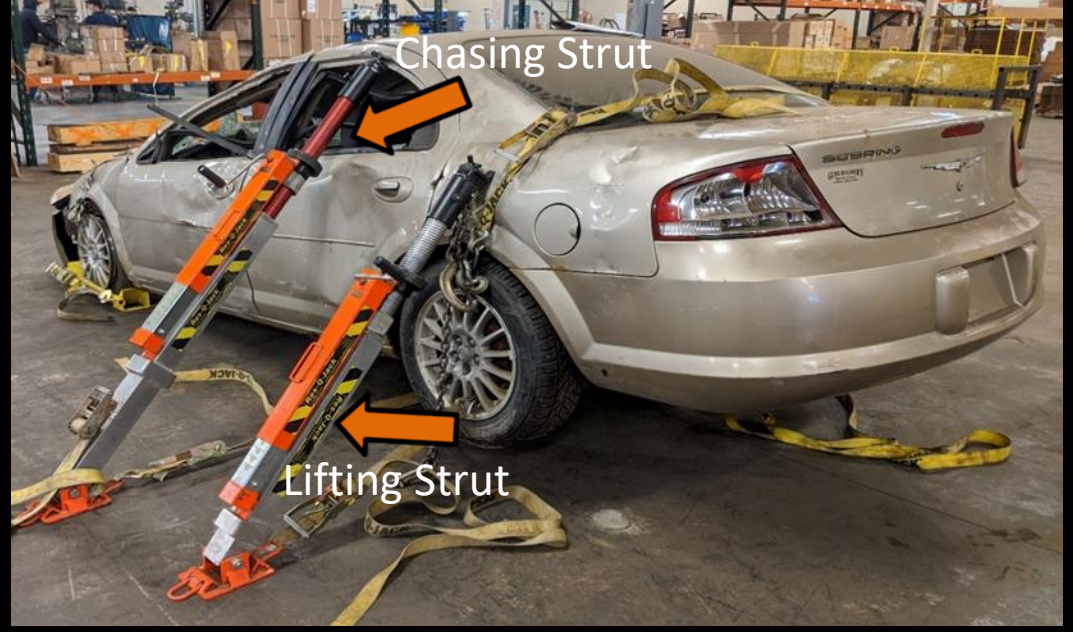
Follow instructions in Lift B from our Quick Reference Guide with the following changes:

- Do not use the sway or triangle straps on this initial set of struts.



- These initial struts will become the lifting struts that will follow the lifting struts.

● Add a 2nd set of struts parallel to this initial set behind this pair of struts.
● Attach triangle or sway control straps between the bases of these struts and the vehicle along with an optional base to base strap if possible.
● This 2nd set of struts will be the stabilization or “chase” struts.
Start the lift with the initial set of lifting struts.



● While lifting, the stabilization struts will begin to loosen. To maintain a stable lift, chase the lift with these struts. Do not lift or get ahead with the stabilization struts making sure that only the designated lifting struts are being used to lift.

- Note: base to base straps on our chase struts (if incorporated) will likely loosen. This can be tightened now or later in the lift.

● If the lift gets to a point where the struts begin to lean towards the front of the vehicle, you will need to attach a strap to the stabilization and possibly the lifting struts to the front of the vehicle.
● If space is needed and all straps are tight on the stabilization struts you can now remove the lifting struts and their components.

- Note: the bases of the stabilization struts may tilt up in the front as shown. Although not an issue, the tilt could be remedied with a base to base strap or you could utilize struts with on-board back-mounted straps that do not connect to base link.

Side Resting CSL™ Lift

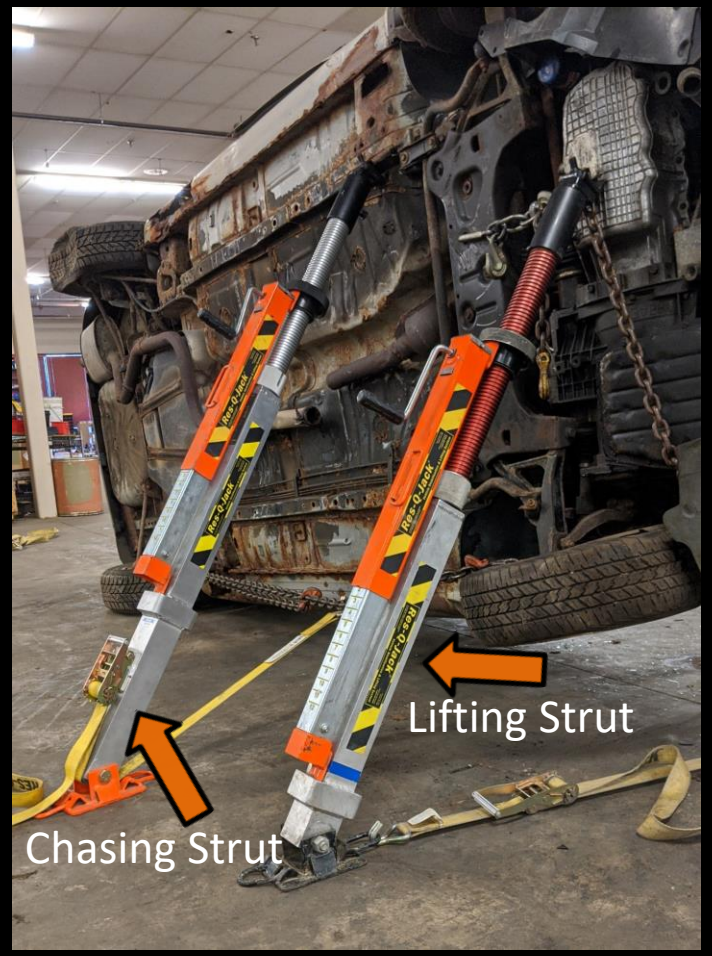
Follow instructions in Lift C (side-resting front lift) from our Quick Reference Guide with the following changes:

● Once you have clearance underneath the front of the vehicle, set up a second set of struts including a base to base strap which will now become the lifting struts.

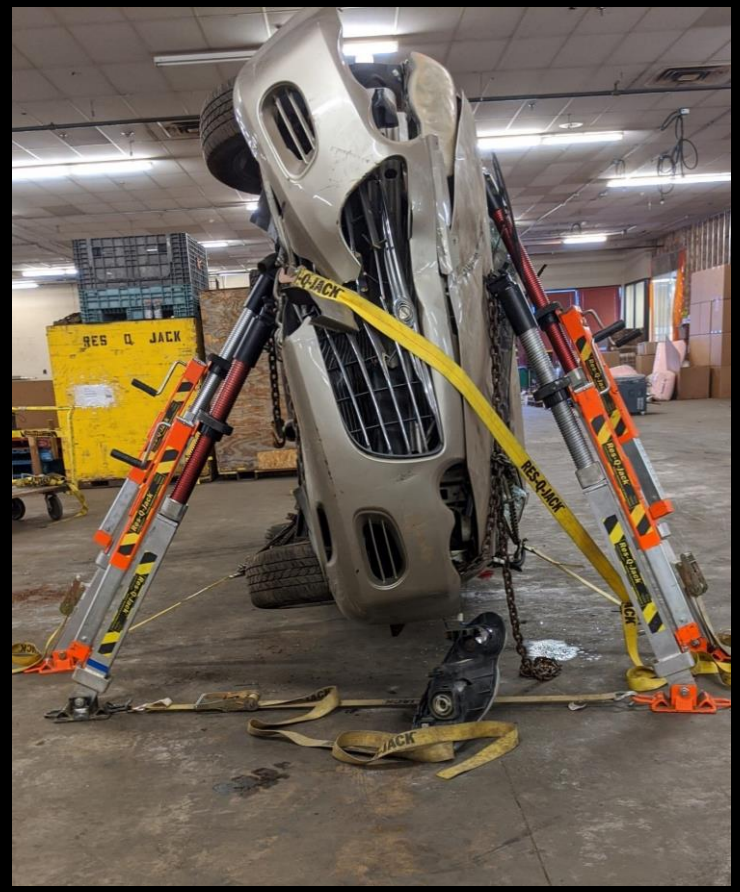
● The initial struts now become the stabilization or “chase” struts. Resume lifting with the front set of lifting struts while chasing the lift with our initial set of struts.

● While lifting, the stabilization struts will begin to loosen. To maintain a stable lift, chase the lift with these struts. Do not lift or get ahead with the stabilization struts making sure that only the designated lifting struts are being used to lift from this point on.

- Note: base to base straps on our chase struts (if be tightened now or later in the lift.



● If the lift gets to a point where the struts begin to lean towards the rear of the vehicle you will need to attach a strap to the stabilization struts and possibly the lifting struts to the rear of the vehicle.



● If needed, 1 set of struts may be removed if remaining set of struts have direct tieback from strut bases to vehicle forming triangles with tension. A base to base strap on this set of struts may not be necessary but is highly recommended.

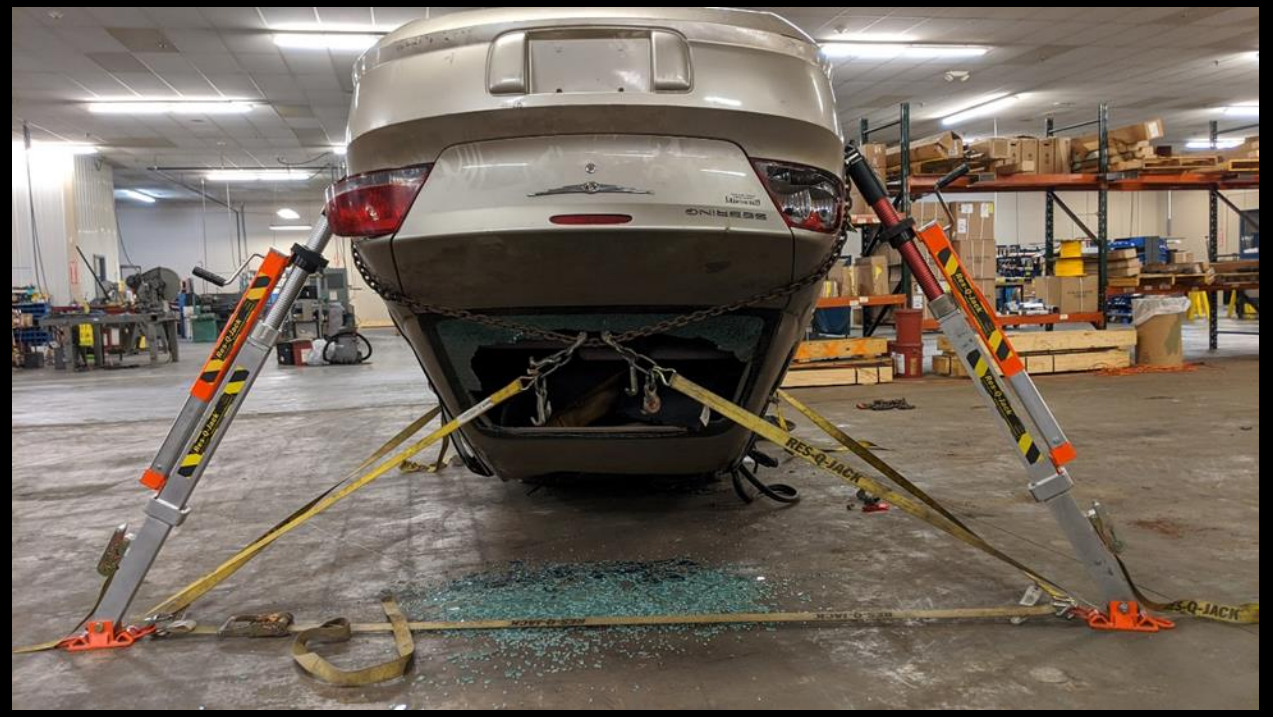
Roof Resting CSL™ Rear Lift

● Follow instructions in Lift D (roof-resting rear lift) from our Quick Reference Guide with the following changes:

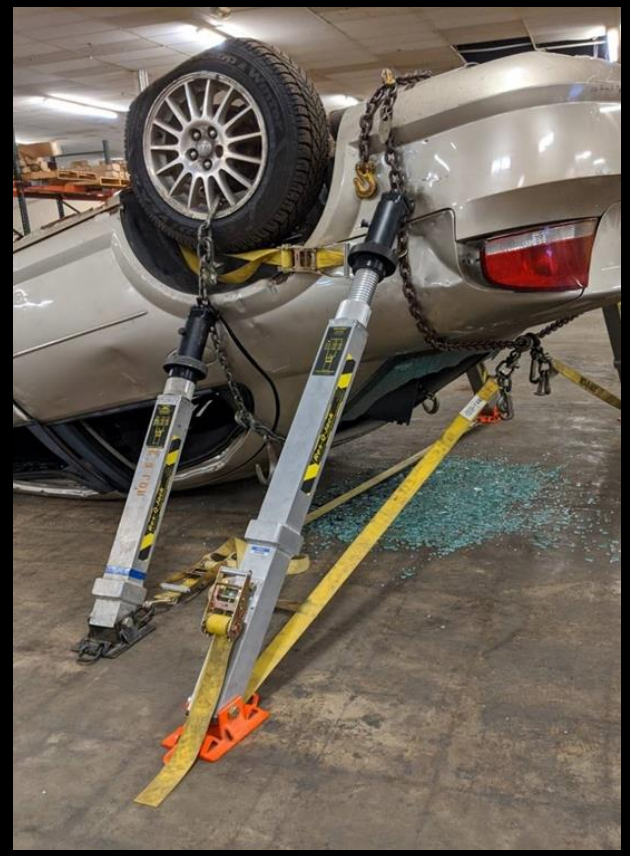
● Tighten sway straps without lifting.

-Note: base to base strap on these initial struts is optional but recommended.

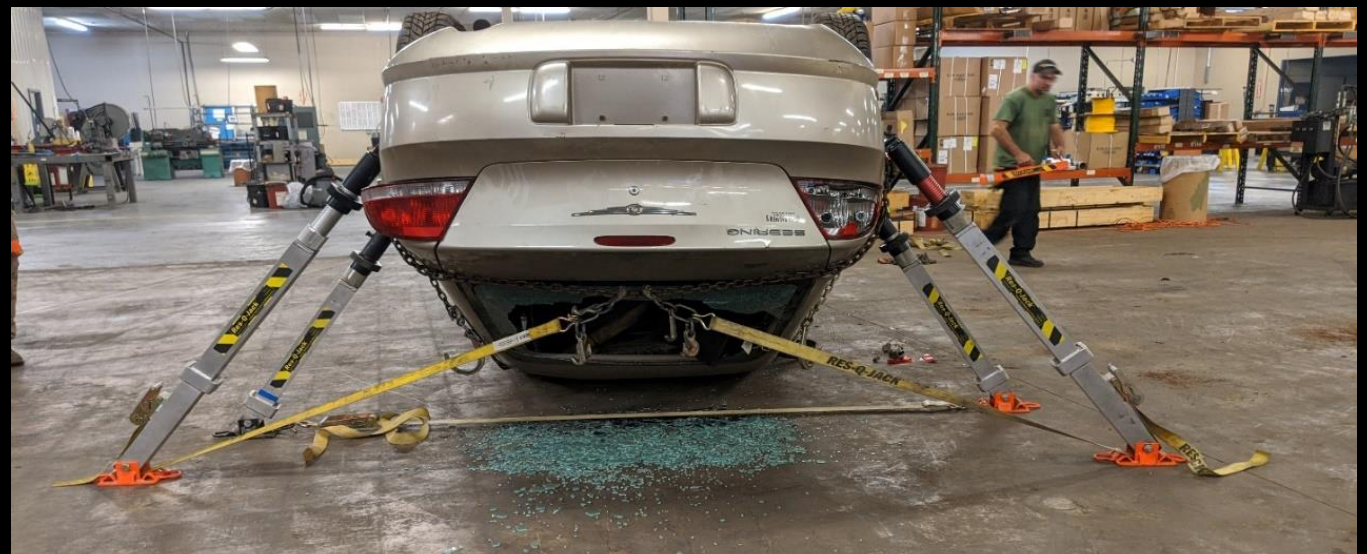
● These initial struts will become the stabilizing or “chase” struts that will follow the lifting struts.



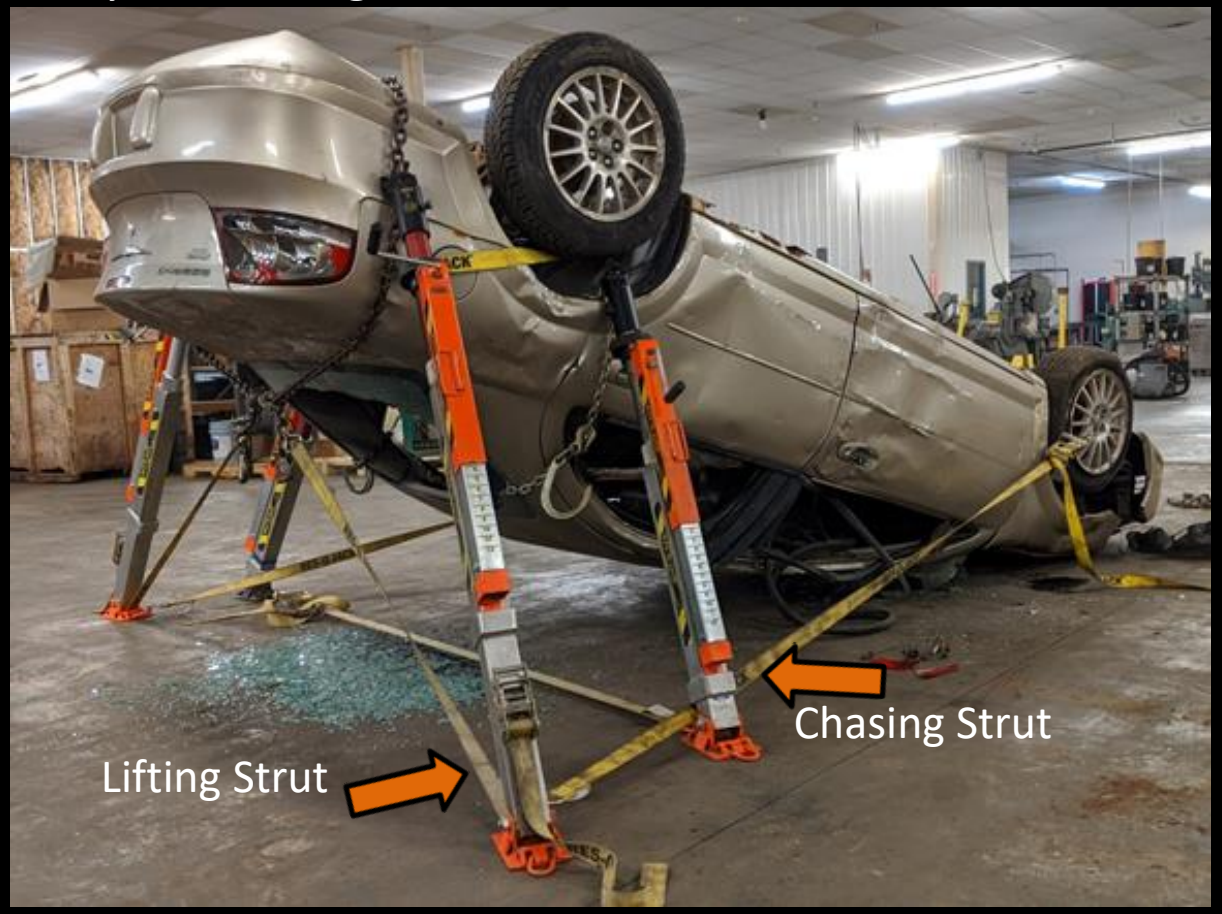
- Add a 2nd set of struts parallel to this initial set in front of this pair of struts.
- Attach a base to base strap only (no triangle or sway straps) of sufficient WLL.
- This 2nd set of struts will be the lifting struts. Perform the lift using these struts.
- While lifting, the initial stabilization struts will begin to loosen. To maintain a stable lift, chase the lift with these struts. Do not lift or get ahead with the stabilization struts making sure that only the designated lifting struts are being used to lift.



- Note: Base to base straps on the chase struts (if incorporated) will likely loosen. This can be tightened now or later in the lift.



● If the lift gets to a point where the struts begin to lean towards the front of the vehicle, you will need to attach a strap to the stabilization struts and possibly the lifting struts to the front of the vehicle.



● If space is needed and all straps are tight on the stabilization struts, you can now remove the lifting struts and their components to create more room for extrication.

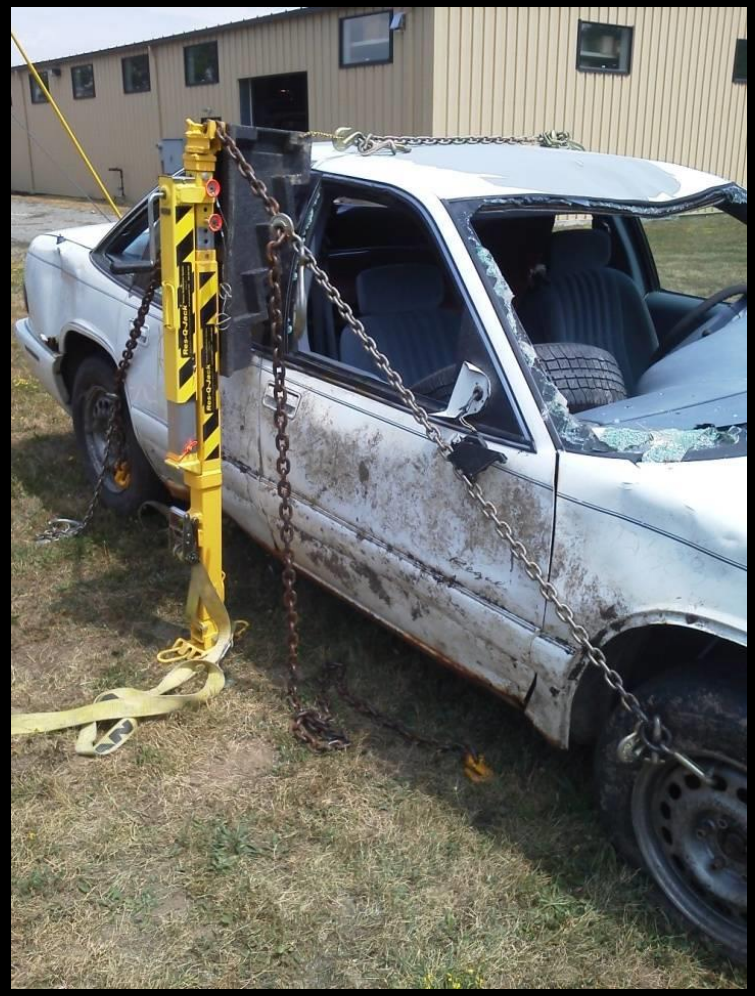
Part IV:

Strut Lifting Scenarios

Wheel Resting Side Lift

- Crib under both sides of vehicle.
- Tie down suspension.
- Check both front and rear wheels.
- Place strut between A and B posts at 40-70° angle leaving 4” minimum between strut and door skin. Engage head with roof rail.
- Hook large J-Hook to the roof rail near head of strut. Run chain across roof to the opposite side of the car. Hook ratchet strap to the end of this chain and pass the strap under the car to opposite side where the strut is placed.
- Hook the strap to the base of the strut. Tighten until secure.
- To lift, operate the jack. Lift an inch, crib an inch.
- **Note: Avoid side loading the strut!**

Alternative Wheel Resting Side Lift



Alternate Setups:

1. Vertical strut w/ step chock.
   - Pictured to the left
2. Chain to Near Side
   - Run a chain from the undercarriage of the car and attach to the strut head using chain grab
3. No Roof Rail (Convertible)
   - Use the “Chain to Near Side” Technique
   - Use the Darlington Lift Technique

Wheel-Resting Rear Lift

- Crib under both sides of vehicle.
- Tie down suspension.
- Check both front and rear wheels.
- Place two struts on opposite sides close to the rear roof posts at 40-70° angle.
- Connect the bases of the two struts with a ratchet strap and tighten.
- Loosely attach sway straps from the strut bases to the undercarriage of the vehicle forming triangles. Ensure there are multiple wraps on the bale and the ratchet is in the locked position.
- To lift, operate both jacks at the same time. Lift an inch, crib an inch. Tighten straps when lift is complete.

If patient interferes with a base-to-base strap, stake base of each strut

Alternative Wheel-Resting Rear Lift

Alternate Setups:

1. Substitute Stakes for Base-To-Base Strap
   - This replaces the base-to-base strap by connecting the struts through the ground
2. No Roof Rail (Convertible)
   - Use the “Chain to Near Side” technique.
   - Use the Darlington Lift technique.

Side-Resting Front Lift

- Crib under both sides of vehicle. Use at least 4 wedges (2 on front, 2 on back)
- Place strut at A post in the corner of windshield.
- Connect J-Hook to the lower A post to create a base restraint.
- Place second strut at the underside of the vehicle, opposite the first strut.
- Engage the strut head with the frame or structurally sound area
- Pull the chain to rear wheel assembly, remove slack and reconnect the chain using cluster
- To lift, operate jacks at the same time. Lift an inch, crib an inch.

Caution: In this scenario, we are lifting using triangles. Keep straps at ground level and only use for short lift. If higher lift is desired, transition to alternate setup after clearance is created beneath vehicle.

Alternative Side-Resting Lifts

1. Rear-Lift
   - Back of the vehicle is lighter. Disadvantage is the weakness of the C Post.

2. Chain Wrap Around Hood or Rear
   - Wrap chain around hood or rear. Lift from chain at side of vehicle. Use opposing struts, one on each side.

Roof-Resting Rear Lift

- Crib both sides of vehicle. Use tie lines as necessary to control all possible movement. Use a picket at each front corner to secure the vehicle if needed.
- Wrap the chain around the vehicle near the rear of the trunk, removing slack and hooking the chain to itself at the high side of the vehicle.
- To remove additional slack, slide the chain forward so the final position of the chain is tightly secure, centered between the wheel well and the rear of the trunk.
- Place a strut on each side of the vehicle at the rear fender. Engage the end fittings with the chain wrap near the middle of the rear fender, as shown.
- Connect the bases of the struts to each other with a ratchet strap; tighten to remove slack in chain.
- Secure the chain from sliding off the vehicle by connecting a snap hook from a ratchet strap into a link of chain, below the strut engagement. Run the strap around the rear wheel. Use cribbing to protect the strap from sharp objects or hot exhaust. Connect the strap to the chain around the opposite wheel.
- To lift, operate jacks at the same time. To control sway, tighten the secondary straps as needed. Lift an inch, crib an inch.

Alternative Roof-Resting Rear Lift

Alternative Setup:

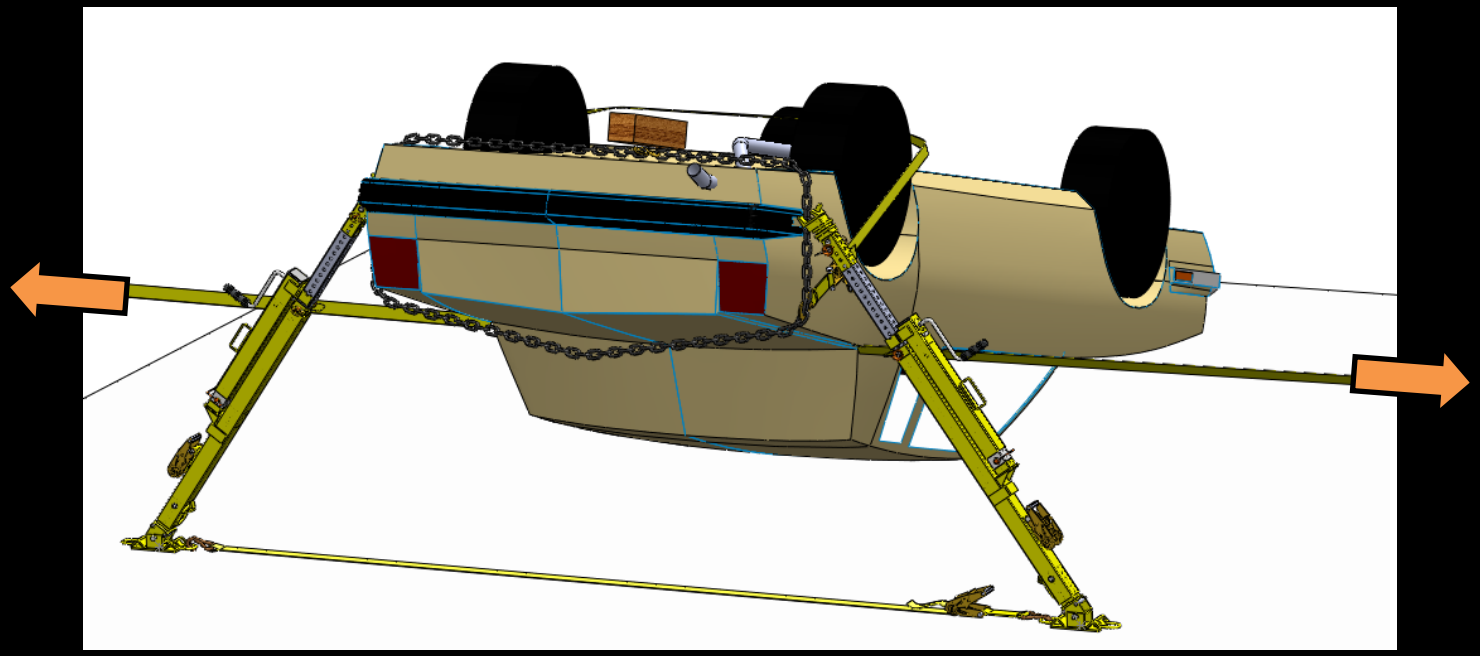
- 3-Point Rear Lift
  - Use a 3rd strut at the rear of the vehicle. Attach 2 straps from the base of the 3rd strut to the bases of the first 2. One strap from each base of the original 2 to a forward point of the vehicle.

- Improved 2-Point Rear Lift
  - With struts leaning slightly toward the front of the car, attach their bases to forward points of the vehicle and lift.

Alternative Roof-Resting Rear Lift

Outrigger Sway Control

- Replace the sway straps with straps attached to remote picket.
- Easier lift, better access to rear windshield.



Barrier Rear Lift

- Option 1: Use Roof-Resting Rear Lift procedure
- Option 2: Place 1 strut in back center of trunk, use tie-backs to control motion of vehicle

Barrier Controlled Roll

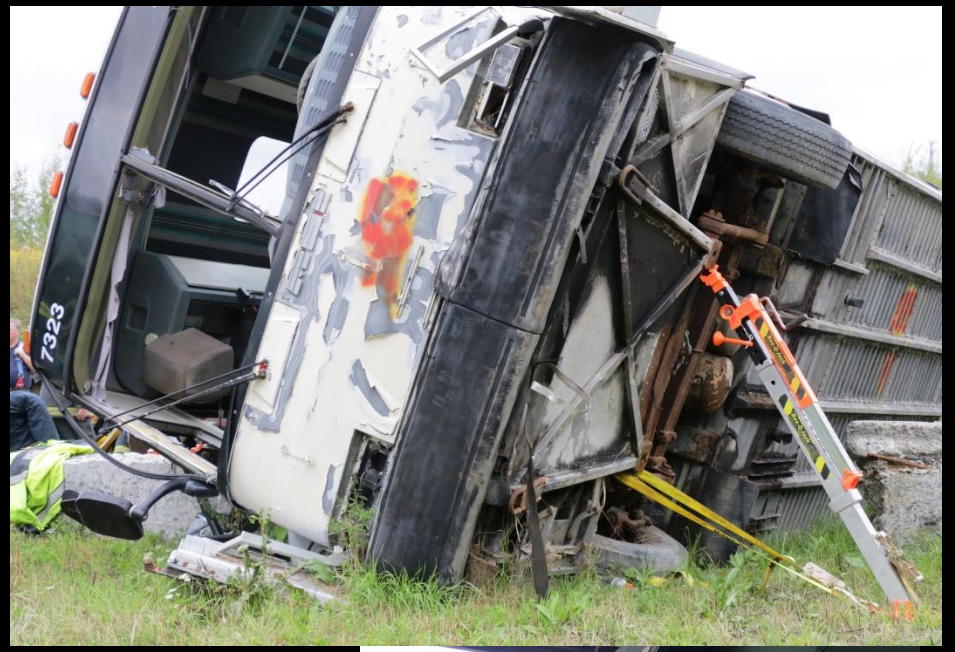
- Use concepts in Wheel-Resting Side Lift
- Strut options:
  - One Strut
    - -If you can get the strut near the center of the weight of the car (near the A-Post)
  - Two Struts

Dumpster Override

- Goal: Lift top object and crib with enough room for roof removal
- Use tie-lines, stakes
- Strut Setup: Similar to Roof-Resting Rear Lift, with or without chain wrap. Struts opposite each other with base-to-base strap, adding triangles with ratchet straps
- Alternate Setup: Use vertical struts under the dumpster by creating a purchase point with chain

Bus Overrides

- Use vertical struts under the bus or leaning toward the bus (with base restraints)
- Preventing Movement:
  - Stake bases and restrain bus by tie-lines
  - Ratchet straps from bases to underside of bus



Parallel Override

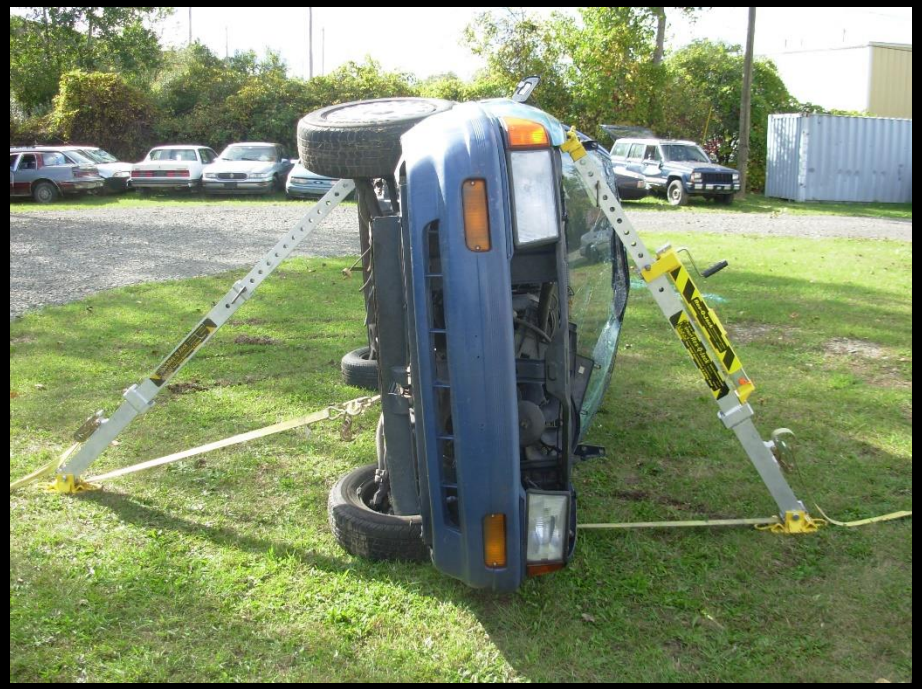
- Options:
  - Front Lift on Upper Car
  - Rear Lift on Upper Car
  - Control Roll Upper Car

T-Bone Override

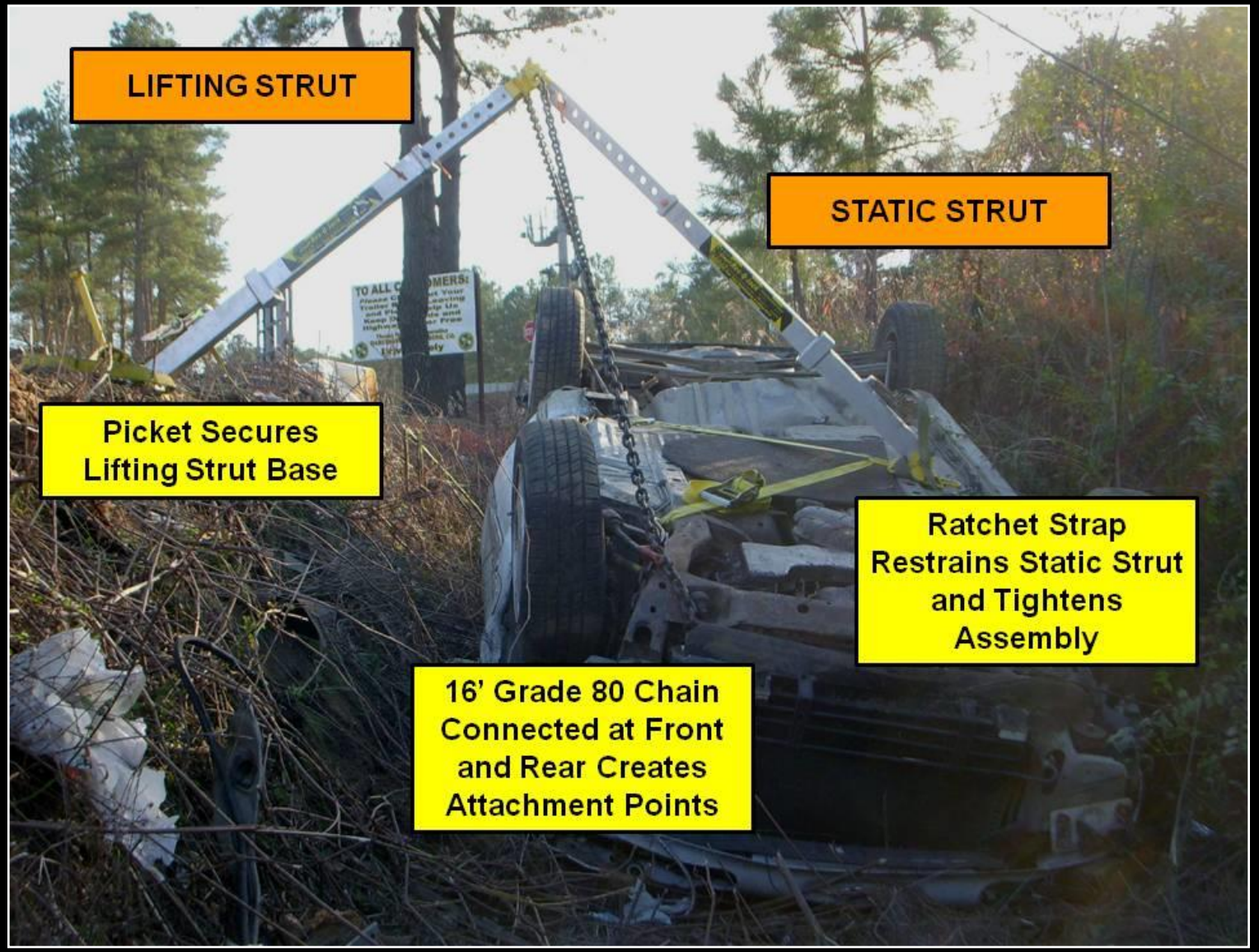
- Use concepts from Wheel-Resting Side Lift and Parallel Override
- Hinge Point: Side of car near cab of truck
- Set up struts using chains to create purchase points
- Restrain base plates or create triangles

Controlled Roll

- In early 2000's, we pioneered the controlled roll to speed up rescue operations
- Controlled Roll is a lift force applied against a 2nd opposing lifting force which acts as a brake to control or limit the amount of movement allowed



Darlington Lift/Roll



Darlington Lift/Roll

Roof-Resting Car

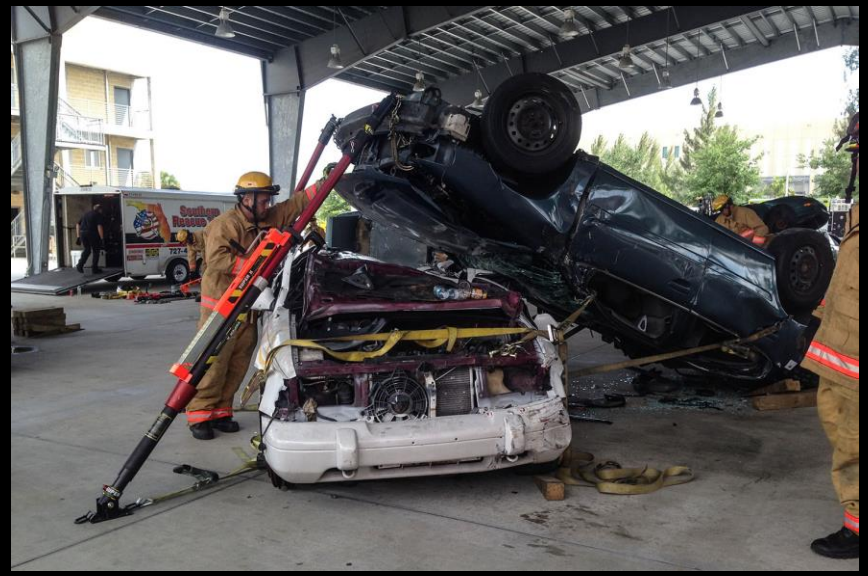
Wheel-Resting Car

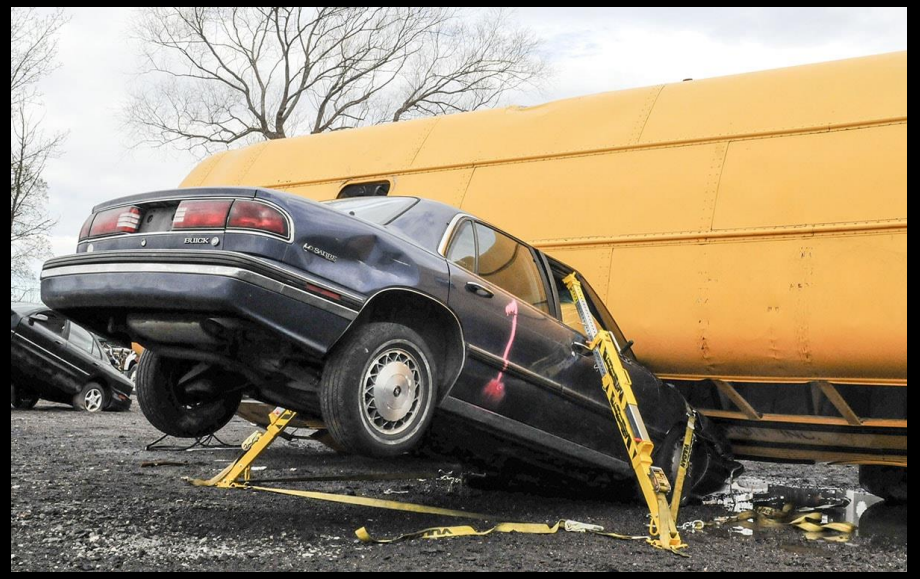
Concrete Slab

Tripod Setup

Other Scenarios

Other Scenarios





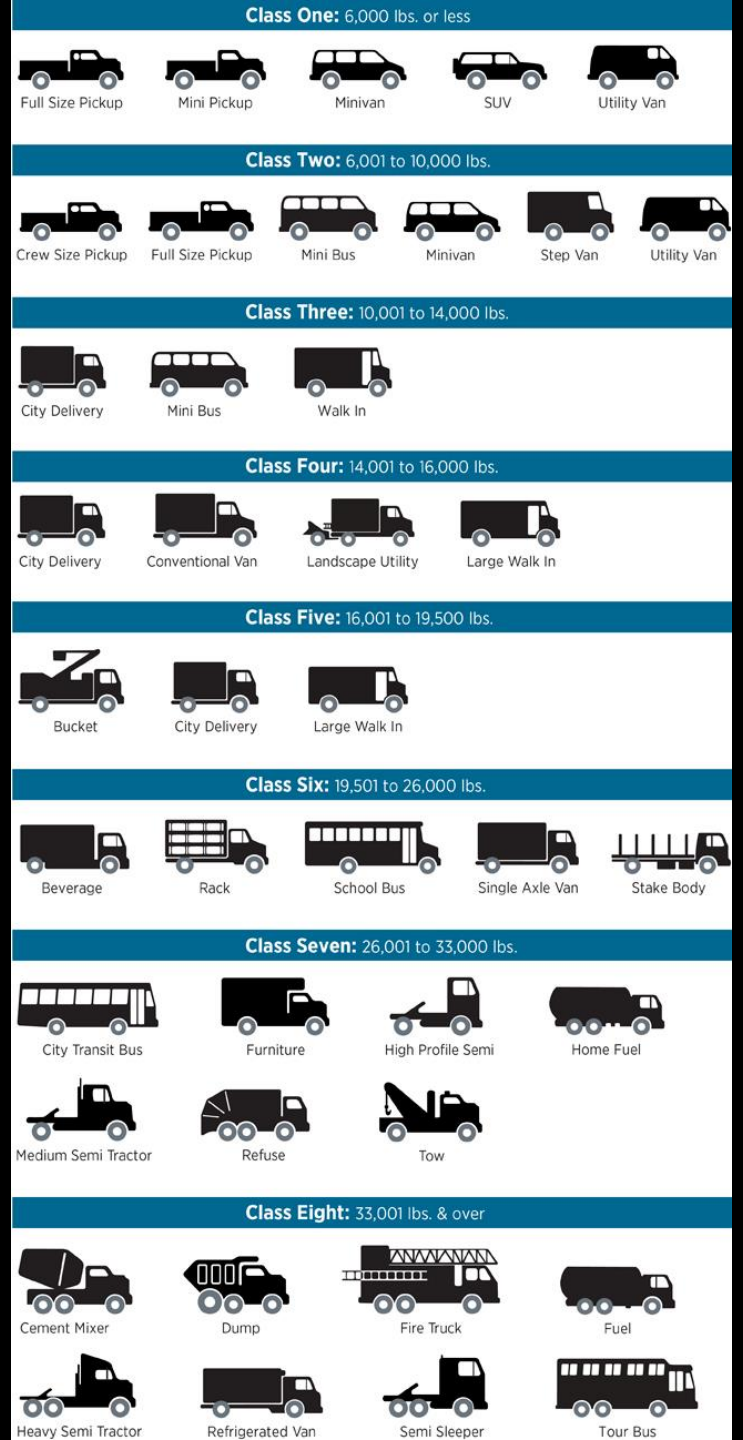
Part V:

Calculating Loads

Calculating Loads

What's it weigh?

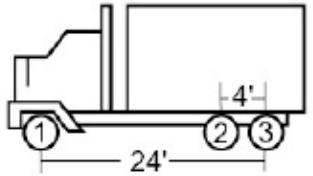
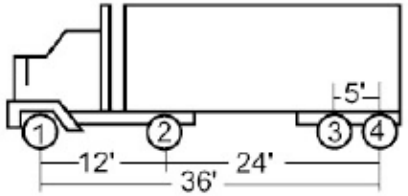
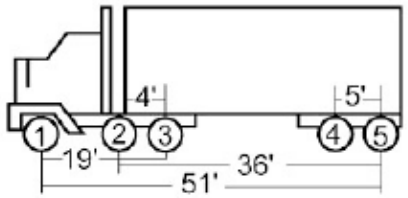
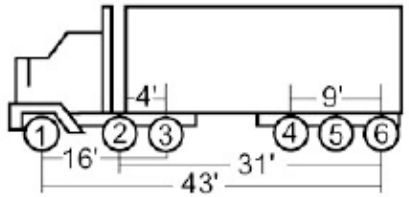
Vehicle Type	Approx. Weight (lbs.)
Passenger Car – Compact	2500
Passenger Car – Mid-Size	3300
Passenger Car – Large	3800
Mini Van	3900
SUV – Standard Size	4000
SUV – Large Size	5600
Pickup – Small	4000
Pickup – Standard	4500
Pickup – Large	6000
Steel	489 per ft^3
Concrete	150 per ft^3



RES-Q-JACK®

Calculating Loads

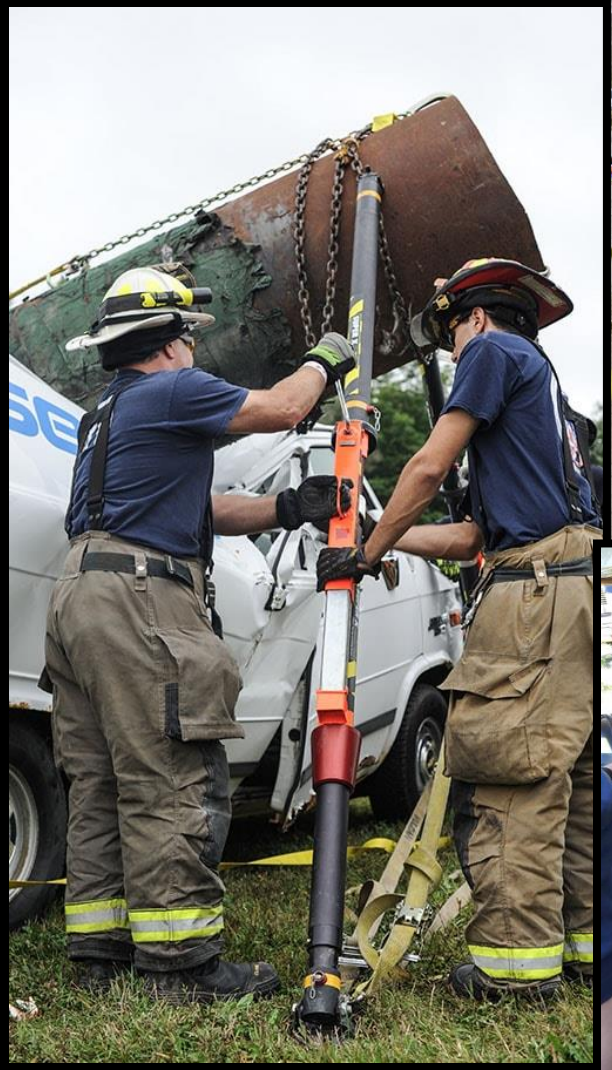
What's it weigh?

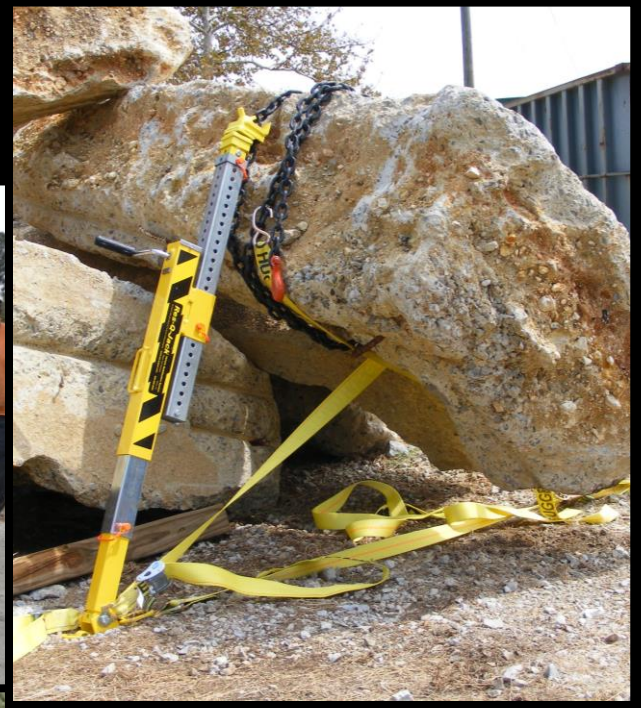
Vehicle or Combinations	Maximum Weight, Pounds	
	Axle **1**	20,000
	Axles 2,3	34,000
	Axles 1,2,3	54,000
	Axle **1**	20,000
	Axle 2	20,000
	Axles 3,4	34,000
	Axles 1,2	40,000
	Axles 2,3,4	54,000
	Axles 1,2,3,4	66,000
	Axle **1**	20,000
	Axles 2,3	34,000
	Axles 4,5	34,000
	Axles 1,2,3	50,000
	Axles 2,3,4,5	68,000
	Axles 1,2,3,4,5	80,000
	Axle **1**	20,000
	Axles 2,3	34,000
	Axles 4,5,6	42,500
	Axles 1,2,3	48,000
	Axles 2,3,4,5,6	67,500
	Axles 1,2,3,4,5,6	80,000

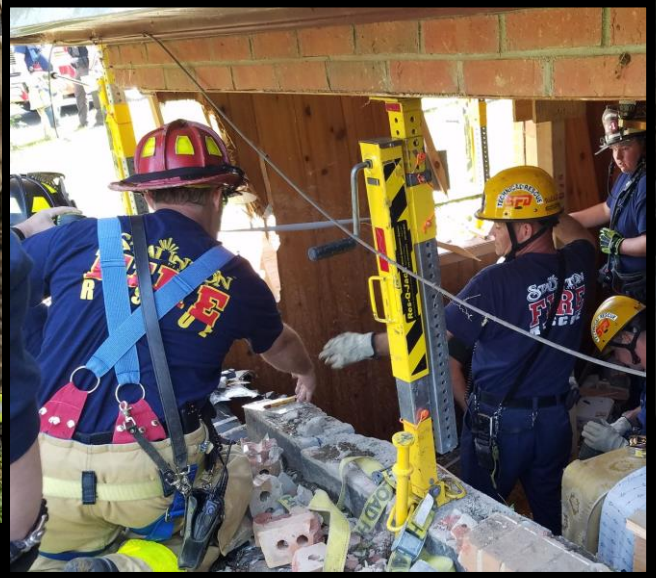
Reference: http://thetruckersplace.com/BridgeFormula.aspx

Calculating Loads

What's it weigh?







Calculating Loads

What's it weigh?

How do we estimate weights of objects?

density X volume = weight

$(lb./ft^3)$ X (ft^3) = (lb.)

Calculating Loads

What's it weigh?

- Residential wood frame construction

Floor System Dead Load

Floor Dead Load Calculation		
Carpet & Pad		3.00 psf
Conc o/ stl deck		35.00 psf
Joists		
wt/ft	16.00 plf	
spacing	5.83 ft	
Jst Wt		2.74 psf
Ceiling		1.80 psf
Misc		1.46 psf
Total Unit Weight		44 psf

Interior Wall Dead Load

Interior Wall Dead Load Calculation	
1/2" GWB	2.20 psf
Stl Studs	1.31 psf
1/2" GWB	2.20 psf
Misc	1.29 psf
Total Unit Weight	7 psf

Roof System Dead Load

Roof Dead Load Calculation	Slope/12	Flat	Slope fact	Adjusted	
Asphalt Shingles	8	2.5	1.20	3.00	psf
Reroofing				3.00	psf
1/2" Plywd Sheathing	8	1.5	1.20	1.80	psf
Trusses @ 24" O.C.					
2x6 Top Chord	8	1.1	1.20	1.32	psf
2x4 Web	8	0.7	1.20	0.84	psf
2x6 Btm Chord	0	1.1	1.00	1.10	psf
Insulation	0	3.6	1.00	3.60	psf
5/8" GWB	0	2.8	1.00	2.80	psf
Misc				1.52	psf
		Total Unit Weight		19.00	psf

Reference: https://www.bgstructuralengineering.com/BGASCE7/BGASCE7003/BGASCE700302.htm

Calculating Loads

What's it weigh?

Table 1. Typical Design Dead Loads

(a) Material Weights

Substance	Weight, lb/ft³ (kN/m³)
Steel	490 (77.0)
Aluminum	165 (25.9)
Reinforced concrete:	
Normal weight	150 (23.6)
Light weight	90–120 (14.1–18.9)
Brick	120 (18.9)
Wood	
Southern pine	37 (5.8)
Douglas fir	34 (5.3)

Table 1. Typical Design Dead Loads

(b) Building Component Weights

Component	Weight, lb/ft² (kN/m²)
Ceilings	
Gypsum plaster on suspended metal lath	10 (0.48)
Acoustical fiber tile on rock lath and channel ceiling	5 (0.24)
Floors	
Reinforced concrete slab per inch of thickness	
Normal weight	12½ (0.60)
Lightweight	6–10 (0.29–0.48)
Roofs	
Three-ply felt tar and gravel	5½ (0.26)
2-in insulation	3 (0.14)
Walls and partitions	
Gypsum board (1-in thick)	4 (0.19)
Brick (per inch of thickness)	10 (0.48)
Hollow concrete block (12 in thick)	
Heavy aggregate	80 (3.83)
Light aggregate	55 (2.63)
Clay tile (6-in thick)	30 (1.44)
2 × 4 studs 16 in on center, ½-in gypsum wall on both sides	8 (0.38)

Reference: http://web.engr.uky.edu/~gebland/CE%20382/CE%20382%20Four%20Slides%20per%20Page/L2%20-%20%20Loads.pdf

Calculating Loads

What's it weigh?

Table 2. Typical Design Live Loads

Occupancy Use	Live Load, lb/ft^2 (kN/m^2)
Assembly areas and theaters	
Fixed seats (fastened to floor)	60 (2.87)
Lobbies	100 (4.79)
Stage floors	150 (7.18)
Libraries	
Reading rooms	60 (2.87)
Stack rooms	150 (7.18)
Office buildings	
Lobbies	100 (4.79)
Offices	50 (2.40)
Residential	
Habitable attics and sleeping areas	30 (l.44)
Uninhabitable attics with storage	20 (0.96)
All other areas	40 (l.92)
Schools	
Classrooms	40 (l.92)
Corridors above the first floor	80 (3.83)

Reference: http://web.engr.uky.edu/~gebland/CE%20382/CE%20382%20Four%20Slides%20per%20Page/L2%20-%20%20Loads.pdf

Calculating Loads

What's it weigh?

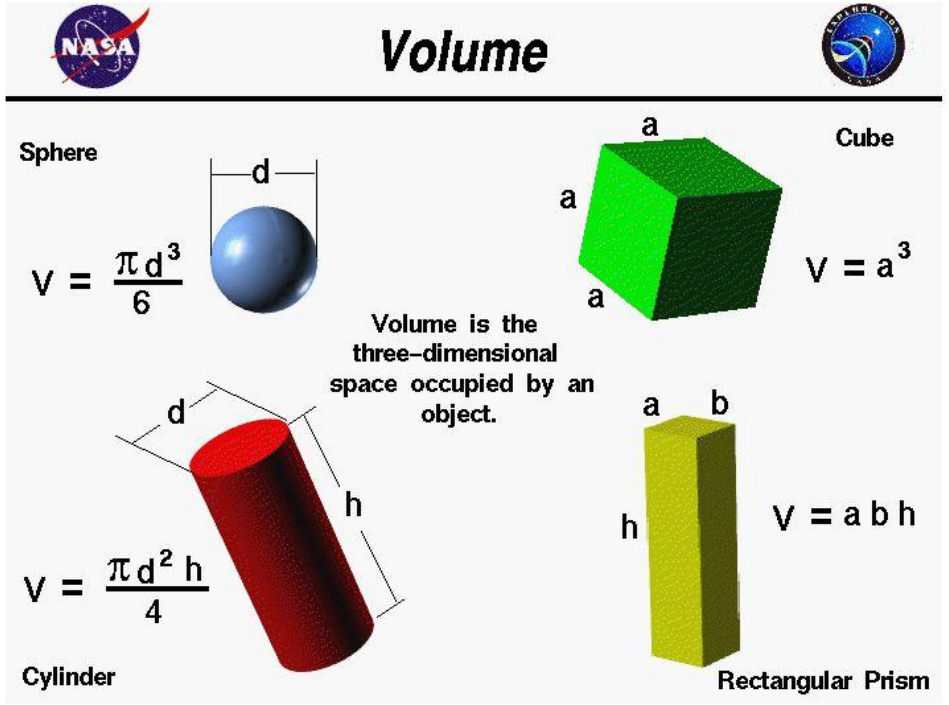
Wood	Density (lb/ft^3)
Alder (Hardwood)	26-42
Aspen (Hardwood)	26
Balsa (Hardwood)	7-9
Beech (Hardwood)	32-56
Cedar (Softwood)	23
Douglas Fir (Softwood)	33
Hickory (Hardwood)	37-58
Juniper (Softwood)	35
Magnolia (Hardwood)	35
Mahogany (Hardwood)	31-53
Maple (Hardwood)	39-47
Oak (Hardwood)	37-56
Pine (Softwood)	22-35
Poplar (Hardwood)	22-31
Redwood (Softwood)	28-55
Spruce (Softwood)	25-44
Teak (Hardwood)	41-61
Walnut (Hardwood)	40-43
Yew (Softwood)	42

Reference: http://www.charltonandjenrick.co.uk/news/2017/02/softwood-vs-hardwood/

Calculating Loads

What's it weigh?

Volume of regular objects can be calculated from a few measurements



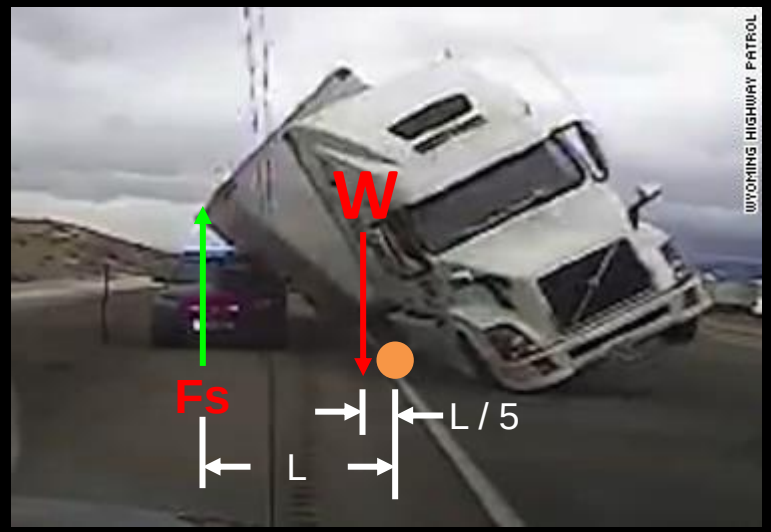
Reference: https://cellcode.us/quotes/a-volume-of-cone-calculator.html

Calculating Loads

What's it weigh?

- Many factors dictate the load a strut will experience
  - Ground contact, angle of load, weight of vehicle, weight of contents, number of struts, object center of weight…
- In the left picture, more load is placed on the bottom vehicle vs. the right picture.

$\Sigma M_{\bullet} = 0$
$Fs \times L = W \times L / 2$
$Fs = W / 2$



$\Sigma M_{\bullet} = 0$
$Fs \times L = W \times L / 5$
$Fs = W / 5$

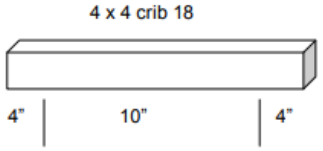
Part VII:

Wood Cribbing and Accessory Information

Wood Cribbing

FEMA Crib Stack Limitations

The cribbing stack height is limited 3 times the length of the base. Remember that there needs to be a 4 inch overlap on each end. Example, an 18 inch piece of cribbing needs 8 inches of overlap leaving a usable base length of 10 inches. Therefore in the example below the max height of the crib stack can only be 30 inches or 2 ½ feet.



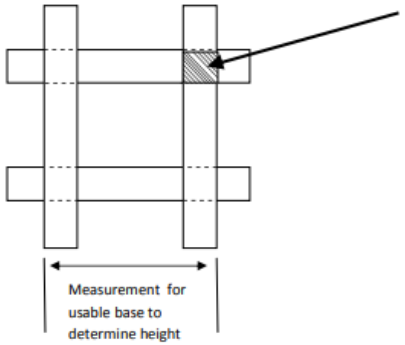
New guidelines from FEMA now limit the crib stack heights to 4 feet for 4x4 lumber and 6 feet for 6x6 lumber. The table below shows the allowable height of a crib stack based on the overall length of the cribbing block.

4 x 4 x 24"	Ok to 4 feet
6 x 6 x 24"	Ok to 4 feet
6 x 6 x 30"	Ok to 5 ½ feet
6 x 6 x 36"	Ok to 6 feet

A rule of thumb for contact area strength is 500 psi.

3.5 x 3.5 x 500 = 6,000 lbs

5.5 x 5.5 x 500 = 15,000 lbs



4 x 4: Each contact point can support 6,000 pounds. A 2 tier crib stack can support 24,000 pounds. A 3 tier stack can support 54,000 pounds.

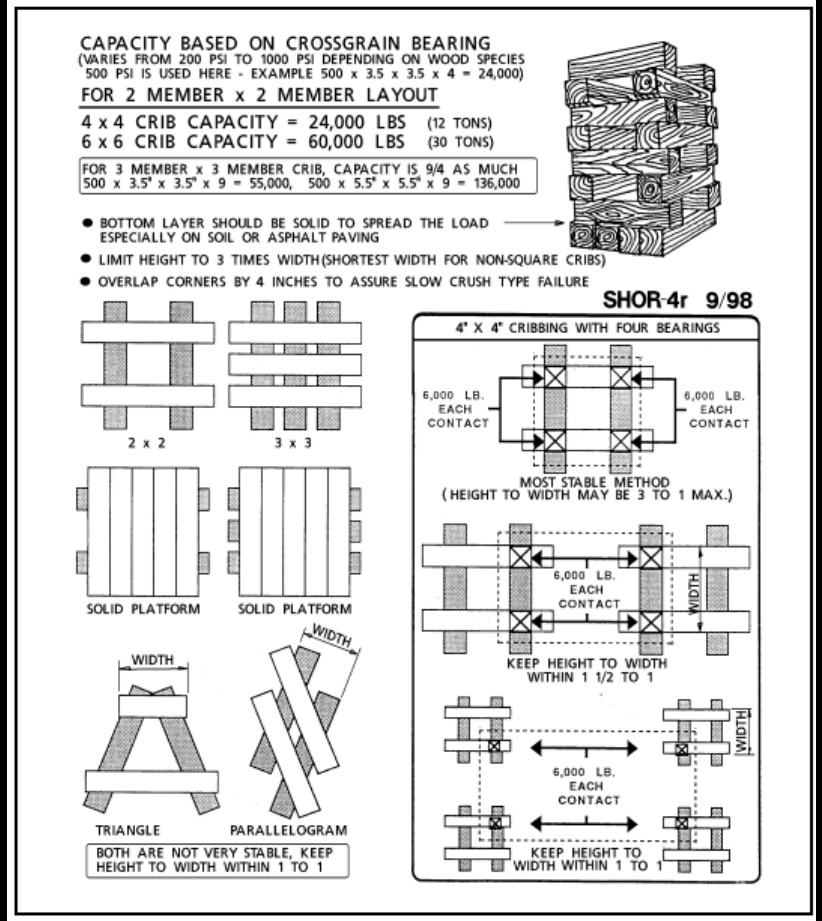
6 x 6: Each contact point can support 15,000 pounds. A 2 tier crib stack can support 60,000 pounds. A 3 tier stack can support 135,000 pounds.

FEMA NATIONAL US&R RESPONSE SYSTEM
STRUCTURAL COLLAPSE TECHNICIAN 01-00

MODULE 2a SHORING BASICS

VERTICAL SHORING SYSTEMS (continued)

CRIBBING – CAPACITY AND LAYOUT



SM 2A 12

Reference: (1) https://tr2fd.com/download/40/technical-rescue/2214/fema-crib-stack-limitations.pdf
(2) https://www.fema.gov/pdf/emergency/usr/module2a.pdf

Ratchet Straps, Chains, Etc.

- Cam Strap: 700 lb. WLL

- Snap Strap: 2000 lb. WLL

- Double Wire Hook Strap: 3300 lb. WLL

- Chain Strap: 3300 lb. WLL

Ratchet Straps, Chains, Etc.

Reference: https://baprod.com/_pdf/WLL-Label.pdf

Part VII:

RQJ Product/Equipment Overview

Super X-Strut®

Item # SPX-EX56 (Long Strut)

- Column WLL: 19,300 LBS.
- Lifting WLL: 6,000 LBS
- Extended Height: 100"
- Collapsed Height: 67.5"
- Weight: 46 LBS

Item # SPX-EX41 (Short Strut)

- Column WLL: 19,300 LBS.
- Lifting WLL: 6,000 LBS
- Extended Height: 68.5"
- Collapsed Height: 51.5"
- Weight: 36 LBS

*Able to add 36” of extension, limited to two extensions.

Super X-Strut®

SWIVEL CRG END FITTING

The Super X-Strut® Comes standard with our Swivel C.R.G. head fitting which gives you a variety of purchase point options and rotates 360° to easily find any purchase point.

QUICK-RELEASE END FITTINGS

Change end fittings in an instant with the pull of a single retaining pin. Because Super X-Strut® is compatible with other manufactures end fittings, you can swap out with neighboring departments during mutual aid response.

PIN-FREE OPERATION

The Super X-Strut® threaded tube design eliminates the need for pins, making set-up faster than ever. The threaded tube allows for infinitesimal height adjustment when stabilizing or lifting and lowering loads.

ALUMINUM CONSTRUCTION

The Super X-Strut® is milled from solid 6061-T6 aluminum for superior strength when shoring, stabilizing and lifting, without adding weight.

Apex X-Strut®

Item # APX-STRT-L (Long Strut)

- Column WLL: 7,750 LBS.
- Lifting WLL: 6,000 LBS
- Extended Height: 91.5"
- Collapsed Height: 58.75"
- Weight: 41 LBS

Item # APX-STRT-S (Short Strut)

- Column WLL: 12,500 LBS.
- Lifting WLL: 6,000 LBS
- Extended Height: 62.75"
- Collapsed Height: 45.125"
- Weight: 33 LBS

*Able to add 36” of extension, limited to two extensions.

Apex X-Strut®

SWIVEL CRG END FITTING

The Apex X-Strut® Comes standard with our Swivel C.R.G. head fitting which gives you a variety of purchase point options and rotates 360° to easily find any purchase point.

QUICK-RELEASE END FITTINGS

Change end fittings in an instant with the pull of a single retaining pin. Because Apex X-Strut® head fittings are compatible with other manufactures end fittings, you can swap out with neighboring departments during mutual aid response.

ALUMINUM CONSTRUCTION

The Apex X-Strut® features the combination of a milled aluminum inner tube with a welded aluminum chassis for superior strength when shoring, stabilizing and lifting, without adding weight.

PIN-FREE /TWIST-FREE OPERATION

Threaded inner tubing allows for fast and smooth adjustments without pins. The unique design allows for a positive stop, keeping the inner tube from rotating under lighter loads, and eliminating the risk of overextension.

Auto X-Strut®

Item # ATX-STRT-L (Long Strut)

- Column WLL: 3,250 LBS.
- Lifting WLL: 2,500 LBS
- Extended Height: 88.25"
- Collapsed Height: 54.5"
- Weight: 33 LBS

Item # ATX-STRT-S (Short Strut)

- Column WLL: 3,250 LBS.
- Lifting WLL: 2,500 LBS
- Extended Height: 67"
- Collapsed Height: 44"
- Weight: 30 LBS

*Able to add 36” of extension, limited to two extensions.

Auto X-Strut®

QUICK-RELEASE HEAD FITTINGS

Change head fittings in an instant with the pull of a single retaining pin. Auto X-Strut® is compatible with our Super X-Strut® end fittings and other manufactures end fittings, so you can swap out with neighboring departments during mutual aid response.

ALUMINUM CONSTRUCTION

The Auto X-Strut® features a unique combination of a welded square chassis with a machined round inner tube, both made from 6061-T6 aluminum for lightweight performance.

PIN-FREE OPERATION

The Auto X-Strut® triple-lead threading allows for fast and smooth adjustment without pins, making setup and chasing a breeze. The threaded tube allows for infinitesimal height adjustment when stabilizing or lifting and lowering loads.

TWIST-FREE INNER TUBING

The Auto X-Strut® features a positive stop for the inner tubing, keeping the tube from rotating under lighter loads, and eliminating the risk of over-extension.

Aluminum X-Strut®

X-STRUT® LIFTING POWER

The Aluminum X-Strut® transforms from a shoring strut to a lifting strut in seconds with our removable mechanical Add-On Jack, giving you 6,000 Lbs. of lifting capacity with 12 inches of travel.

Need to lift more than a foot? Just remove the pin-free Add-On Jack and reset for 12 more inches of lift.

BASE-MOUNTED D-RINGS

Pivoting rings built into the baseplate allow for fast attachment of straps, hooks and chains, or double as a picket receiver when anchoring is needed.

3 SIZES AVAILABLE

Available in long strut (pictured), short strut, or the mid-sized Phoenix strut for increased storage options and lower lift engagements.

Item # ALX-STRT (Long Strut)

- Column WLL: 9,700 LBS.
- Lifting WLL: 6,000 LBS
- Extended Height: 98"
- Collapsed Height: 56"
- Weight: 42 LBS

Item # SAX-STRT (Short Strut)

- Column WLL: 9,700 LBS.
- Lifting WLL: 6,000 LBS
- Extended Height: 66"
- Collapsed Height: 40"
- Weight: 30 LBS

Item # ALX-STRT-PH (Phoenix)

- Column WLL: 9,700 LBS.
- Lifting WLL: 6,000 LBS
- Extended Height: 86.25"
- Collapsed Height: 50"
- Weight: 37 LBS

Aluminum X-Strut®

SWIVEL CRG HEAD FITTING

The Aluminum X-Strut® includes our Swivel C.R.G. head fitting which rotates 360° to easily find any purchase point.

OVERSIZED CONE PINS

The Aluminum X-Strut® operates with our custom-manufactured oversize cone pins. The special flared-design automatically aligns with the jack for faster setup. The unique shape also makes these pins easier to grip and harder to lose.

ON-BOARD RATCHET STRAP

The Aluminum X-Strut® and Phoenix Aluminum X-Strut® each include a ratchet strap with wire hooks mounted on the side of the strut chassis, keeping your strap right where you want it for faster response.

ALUMINUM CONSTRUCTION

The Aluminum X-Strut® is built from 6061-T6 aluminum for extra strength without adding significant weight.

Steel X-Strut®

Item # STX-STRT (Long Strut)

- Column WLL: 4,000 LBS.
- Lifting WLL: 4,000 LBS
- Extended Height: 81.5"
- Collapsed Height: 53.5"
- Weight: 38 LBS

Item # SSX-STRT (Short Strut)

- Column WLL: 4,000 LBS.
- Lifting WLL: 4,000 LBS
- Extended Height: 59"
- Collapsed Height: 40"
- Weight: 27 LBS

Steel X-Strut®

SWIVEL CRG END FITTING

The Steel X-Strut® Comes standard with our Swivel C.R.G. head fitting which gives you a variety of purchase point options and rotates 360° to easily find any purchase point.

ERGONOMIC CONE PINS

Our exclusive cone pin design features a flared end, making these pins easy to grip and hard to lose on scene. The flared end also helps automatically line up the available Add-On Jack for fast and easy attachment.

BUILT-IN RATCHET STRAP

The Steel X-Strut® includes a ratchet strap with wire hooks mounted on the side of the strut chassis, keeping your strap right where you want it for faster response.

RUGGED STEEL CONSTRUCTION

The Steel X-Strut® is built from durable steel for 4,000 lbs. of strength, then powder coated for years of durability.

RJ3 Jackstand

FEATURES

- **2:1 Safety Factor** on strut, jack and accessories.
- **Integrated Jack** provides 4,000 lbs. of built-in lifting power (2:1)
- **Modular Design** allows for multiple configurations to suit your needs.
- **Rugged Steel Construction** provides durability.
- **Pinned End Fittings** allow you to easily swap out heads for your application.
- **Swivel CRG Head Fitting** comes standard, allowing for a wide range of purchase points.
- **Base-Mounted D-Rings** allow you to attach different straps or secure with stakes or pickets.
- **CAM Buckle Straps** come pre-attached to the strut base for quick deployment.
- **18" Extension Tubing** included with strut for alternate configurations.
- **RAM Configuration** turns the strut into a short ram (with additional end fitting-see catalog).

- **Column WLL:** 4,000 LBS.
- **Lifting WLL:** 4,000 LBS
- **Extended Height:** 106"
- **Collapsed Height:** 52.5”
- **Weight:** 53 LBS

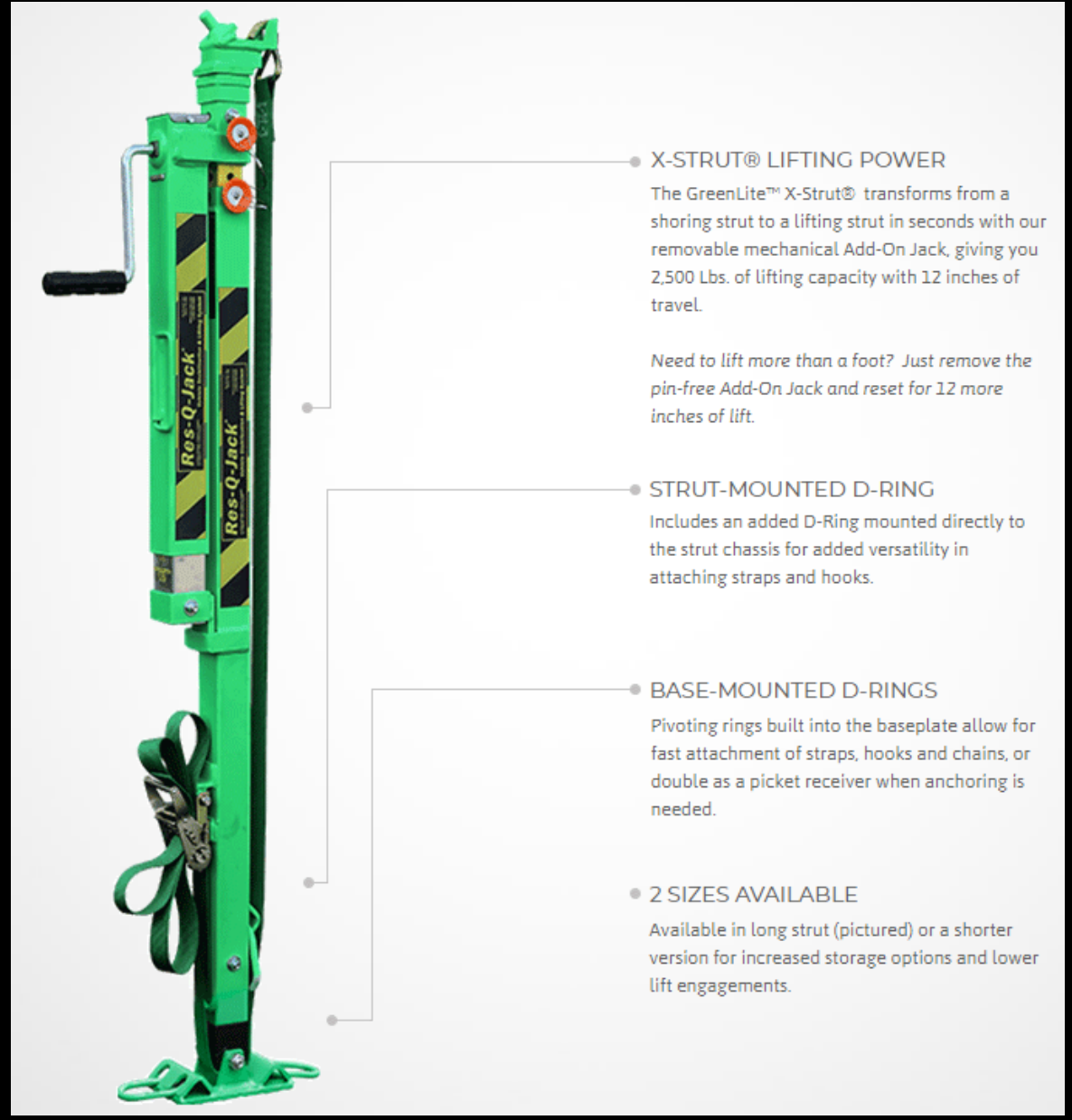
SpaceSaver Jackstand

FEATURES

- **2:1 Safety Factor** on strut, jack and accessories.
- **Integrated Jack** provides 4,000 lbs. of built-in lifting power (2:1)
- **Modular Design** allows for multiple configurations to suit your needs.
- **Rugged Steel Construction** provides durability.
- **Pinned End Fittings** allow you to easily swap out heads for your application.
- **Swivel CRG Head Fitting** comes standard, allowing for a wide range of purchase points.
- **Base-Mounted D-Rings** allow you to attach different straps or secure with stakes or pickets.
- **CAM Buckle Straps** come pre-attached to the strut base for quick deployment.

- **Column WLL:** 4,000 LBS.
- **Lifting WLL:** 4,000 LBS
- **Extended Height:** 103.5"
- **Collapsed Height:** 36.5”
- **Weight:** 54 LBS

GreenLite X-Strut®



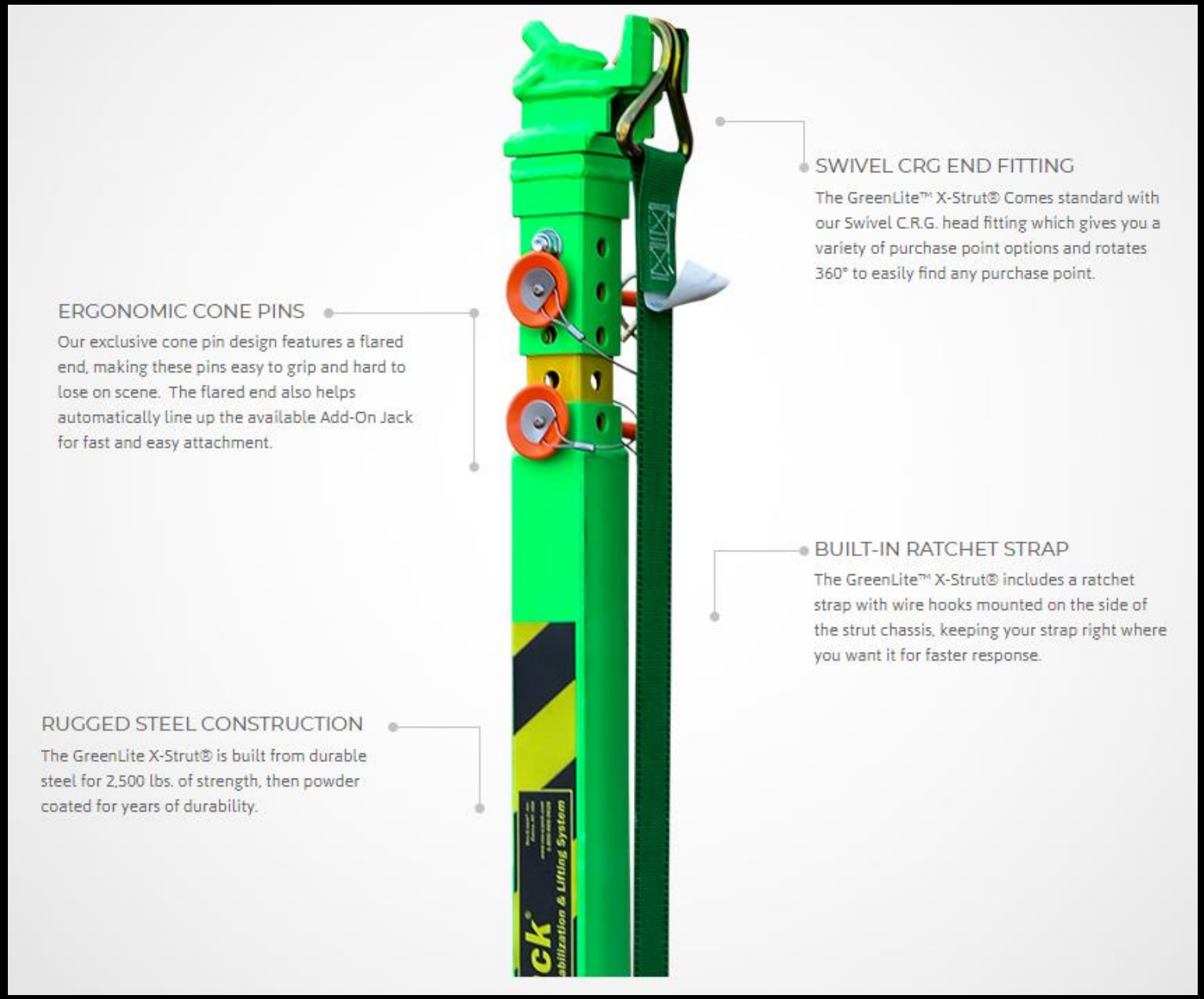
Item # GLX-STRT (Long Strut)

- Column WLL: 2,500 LBS.
- Lifting WLL: 2,500 LBS
- Extended Height: 85.5"
- Collapsed Height: 54.25"
- Weight: 29 LBS*

Item # SGL-STRT (Short Strut)

- Column WLL: 2,500 LBS.
- Lifting WLL: 2,500 LBS
- Extended Height: 62"
- Collapsed Height: 42"
- Weight: 22 LBS*

GreenLite X-Strut®



ERGONOMIC CONE PINS

Our exclusive cone pin design features a flared end, making these pins easy to grip and hard to lose on scene. The flared end also helps automatically line up the available Add-On Jack for fast and easy attachment.

RUGGED STEEL CONSTRUCTION

The GreenLite X-Strut® is built from durable steel for 2,500 lbs. of strength, then powder coated for years of durability.

SWIVEL CRG END FITTING

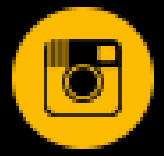
The GreenLite™ X-Strut® Comes standard with our Swivel C.R.G. head fitting which gives you a variety of purchase point options and rotates 360° to easily find any purchase point.

BUILT-IN RATCHET STRAP

The GreenLite™ X-Strut® includes a ratchet strap with wire hooks mounted on the side of the strut chassis, keeping your strap right where you want it for faster response.

Get involved—
Follow and tag us on social media!

Facebook.com/resqjack



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