

Design and Development of Weight Distribution of Trailer by using Hitch

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Abstract— In this project, the main objective is to let the student make their own project based on their own idea. We have to make a small model of weight distribution of trailer to study the various effects and loads acts on trailer. The main purpose is to reduce the swaying while applying load during running condition. This weight distribution system is used to decrease sag at the back of the vehicle when a trailer is attached and to transfer the tongue weight of the trailer to the vehicle and trailer axles, making the hitch able of higher trailer towing capacities. A weight distribution system should be used every time the trailer weight is greater than 50 percent of the tow vehicle weight. We have to show the weight distribution concept in small model. A vehicle which relies on gravity in several ways, weight distribution directly affects a variety of characteristics including handling, acceleration, grip, and parts life. For this reason, weight distribution varies with the vehicle's proposed usage. For example, drag cars capitalize on traction at the rear axle while countering the reactionary pitch-up torque. It generates this counter-torque by placing a small amount of counterweight at a great distance forward of the rear axle. Through project we have to show the concept of weight distribution for better and easy to understand, to know what the actual purpose is, the main advantage of this system is to reduced swaying.

Keywords: Weight Distribution, Tongue Weight, Acceleration, Grip, Pitch up Torque, Sway

I. INTRODUCTION

A. Problem Statement:

- 1) Sagging moment of trailer when gradual application of load.
- 2) Reduction in strength of trailer.
- 3) Stress concentration at single point will cause breakdown

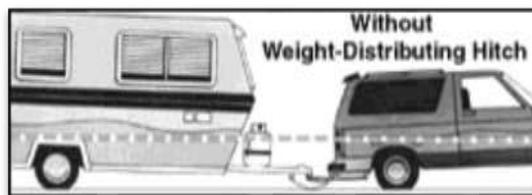


Fig 1.1 Weight distribution without hitch

B. Solution of the Problem

- 1) A weight distribution system is used to reduce sag at the back of the vehicle when a trailer is attached and to transfer the tongue weight of the trailer to the vehicle and trailer axles, making the hitch capable of higher trailer towing capacities.
- 2) A weight distribution system helps to make sure a smooth, level ride and allows you to tow to the highest capacity allowed by your hitch.

C. Weight Distribution



Fig. 1.2: Weight distribution with hitch

When you're towing a trailer with a standard rear-mounted hitch, your trailer's tongue weight is shift to the back axle of your tow vehicle. As a result, the back end of the vehicle may be compulsory lower and the front end raised. If this happens, your vehicle's back axle will stand the weight of not only the trailer, but much of your tow vehicle's weight as well. Less weight on the front axle of your vehicle can cause reduced performance in terms of steering, traction and stopping power. It can also enhance trailer sway. And your view of the road may be limited due to the uncomfortable angle [2]

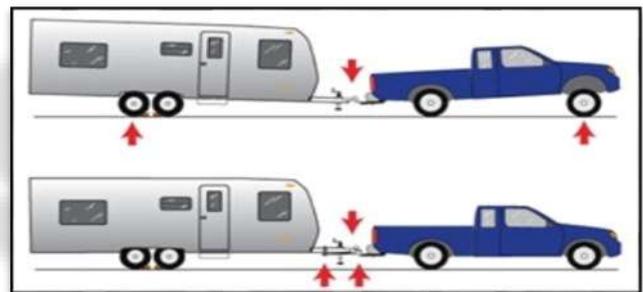


Fig. 1.3: Weight distribute

D. Need of Weight Distribution

- Your trailer weight (GTW) is more than 50 percent of your vehicle's weight (GVWR)
- The back of your tow vehicle sags when the trailer is hooked up
- You experience trailer sway
- Your tow vehicle's headlights point growing
- You find it difficult to steer or stop your rig
- You want to pull to the highest ability allowable by your vehicle's trailer hitch

E. Selection of Weight Distribution System

There are many dissimilar types of weight distribution systems on the market, each with different features. But before you can choose which of those features, you'd like to have, you must determine which size system will work best for your towing system as with any towing component, capacity is key [6].

- A weight distribution hitch will have two weight ratings –
- The gross trailer weight and
 - The tongue powers.

- 1) Gross Trailer Weight (GTW) refers to the weight of the fully loaded trailer in its actual towing condition GTW

is measured by placing the fully loaded trailer on a vehicle scale. Rating of weight distribution system must match or exceed your GTW.[5]

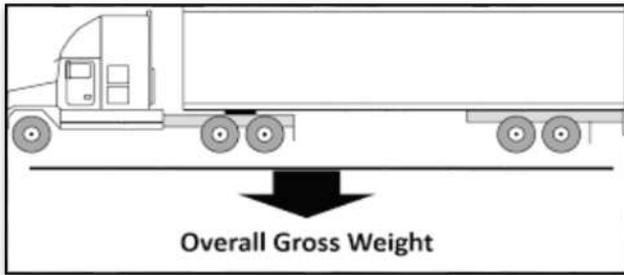


Fig. 1.4: Overall Gross Weight

- 2) Tongue Weight (TW) refers to the tongue weight of your trailer plus the weight of the cargo that sits behind the rear axle of your vehicle.
 - Trailer TW is measured using a Tongue weight scale. Typically, about 10 to 15 percent of GTW
 - Weight of cargo at the back the rear axle can be measured using a commercial scale
 - Weigh vehicle without cargo
 - Weigh vehicle with cargo loaded Subtract initial weight from weight of loaded vehicle [5]



Fig. 1.5: Tongue Weight

- Tongue Weight (for weight distribution) = trailer tongue weight + vehicle cargo load behind rear axle
- The TW rating is the most important factor in determining which size weight distribution system you should use.
- If the bars of the system you choose are speed too high for your setup, they will create a rigid ride, which can result in a bouncing trailer.
- If, on the other hand, the bars are not rated high enough, the system will be unable to properly distribute the weight, portrait it almost useless.



Fig. 1.5: Effects of Tongue Weight

F. Determination of Trailer Tongue Weight

In order to choose the accurate components to safely tow your trailer, you need to know its tongue weight. This is the weight that the fully loaded trailer exerts downward on the hitch ball of the tow vehicle. If you don't know the tongue

weight of your trailer, there are several dissimilar ways you can decide it [8].

- Weigh Safe ball mount
- Bathroom scale
- Commercial scale
- Tongue weight scale

G. Advantages

- Unparalleled Sway Control that self-adjusts according to load
- So quiet you won't even know it's there!
- Easy install — no spring bars needed!
- Doubles as standard a ball mount for towing without weight distribution
- The smoothest ride around — owners are saying they can't believe it!
- No problem backing up — unlike many other weight distribution hitches
- Weighs less than 60lbs!
- Lifetime Warranty (limited)[15]

II. METHODOLOGY

To understand the methodology of weight distribution of trailer first of all we have to know the parts and their selection used in this project.

A. Tongue Weight Scale:

We present a heavy-duty tongue weight scale that quickly, easily and precisely allows you to get the weight of the trailer tongue. This scale can weigh a trailer tongue with a weight of up to 2,000 lbs. Since tongue weight is typically 10% to 15% of the weight of the trailer, this scale can hold a gross trailer weight of up to 20,000 lbs. [8].



Fig. 2.1: Weight Scale

B. Weight Distributing Hitch:



Fig. 2.2: Hitch

The weight carrying hitch configuration transfers the entire tongue weight of the trailer to the tow vehicle. This increases the load to the back axle and reduces the load on the front axles. This is due in the direction of the additional vertical linear force from the trailer tongue weight. In addition, rotational forces centered at the back axle causes a portion of tow vehicle's weight to be transferred to the back axle. Typically, in this configuration the back-axle rating is the first rating to be exceeded. This is due to the additional trailer weight and vehicle weight transfer to the back axle.

If the trailer is too heavy it may cause vehicle handling problems. The vehicle may not be able to steer properly since there is not enough weight on the front tires. In addition, trailer sway issues may arise. In tremendous cases, the front tires are able to lift off the ground. If the tires pick up off the ground, the entire weight of the vehicle is supported by the rear axle. The weight has to support [1].

The weight distribution hitch configuration transfers the load from the vehicle's rear axle to the vehicle's front axle and the trailer's axle. This reduces to load on the rear axle allowing the tow vehicle to drag a superior trailer [1].

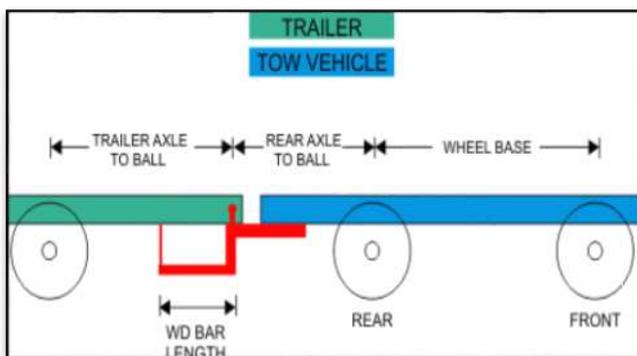


Fig. 2.3: Weight distribution hitches

C. Andersen Hitches:



Fig. 2.4: Andersen Hitch

This is a type of hitch we can use for weight distribution. When Andersen Hitches determined to create our own Weight Distribution Hitch, we required to obtain better on the models so as to we saw in the industry. That desire led us through two years of development and road testing, and resulted in a complete re design of weight distribution. And we left the competition in the dust! We were able to introduce the industry's first Anti-Sway, Anti-Bounce Weight Distribution Hitch. [15] The Andersen Weight Distribution Hitch (available with 4" or 8" drop/rise) doesn't just raise up the bar, it sets it at a completely new level — changing the industry forever! We combined current materials, technology and improvement to create the simplest, quietest, and most advanced weight distribution hitch on the road nowadays. Our weight distribution kits offer a first in the industry, giving trailer owners the most excellent anti-sway AND anti-bounce with the only true Motion-Dampening™ system around. In reality, we've found that people are shocked at how smooth and quiet the travel is compared to by means of anything thing else on the market today![15]

Weighing in under 60 lbs., this good-looking but tough work horse is rated up to 14,000 lbs. GTWR (1400 lbs. tongue). That means it can handle all of your heavy-duty trailer desires. This system also does double duty, because you can use it as a standard ball mount if you need to tow without weight distribution.[15]

D. Sway Control:

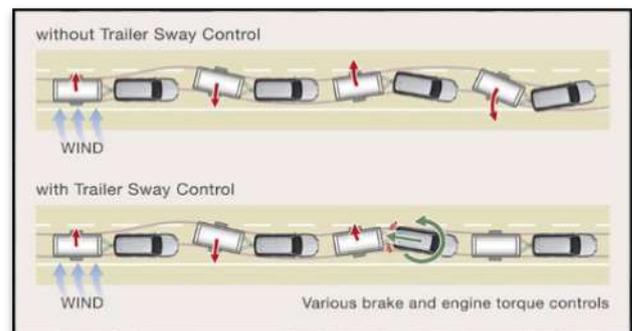


Fig. 2.5: Sway Control

Trailer sway, or fishtailing, is when a trailer begins to move from side-to-side on its own, finally resulting in flipping and (sometimes) turning the towing vehicle in excess of, excessively.[13] It's also important not to go beyond the maximum towing weight particular by the producer, and for people who have no experience towing to

keep away from towing a trailer that's heavier than the towing vehicle.[13]

Trailer Sway is the 1 cause of trailer accidents and the reason most campers provide up after only a few seasons and put their new trailer in the classified ads or Craigslist. That's unfortunate, because it can be avoided. But first, let's start with some basics: What is trailer sway?[13]

Trailer sway occurs when the side forces on the trailer cause the trailer to move side to side at the back the tow vehicle. We call it "fishtailing." Two factors are involved here: (1) the side forces on the travel trailer and (2) the location and type of pivot point that the trailer is connected to. Let's start with the thing we can't control: side forces on the trailer. [13]

Trailer sway can be caused by crosswinds, poor trailer loading (load being too far back), or insufficient spring bar tension in the weight distribution system. The use of a weight-distributing hitch by itself can help limit trailer sway by equally distributing the weight of the load, but it will do little to improve bend caused by crosswinds.[13] To help control sway, a sway-control device is suggested for most standard weight distribution systems. Because sway control is so essential, it is built into various systems. If you want to remain to add on a sway control device, you will likely be limited to a bar-style friction sway control. Trailer sway devices come in 2 basic types - those that reduce sway once it has begun and those that work to prevent sway altogether.[13]

1) Causes of Trailer Sway:

The primary reason of this out-of-control feeling is trailer sway. And, since trailer sway is the number one cause of trailer accidents, there is good reason to feel uncomfortable when towing. Trailer Sway, or fishtailing, is when the trailer begins to move side to side at the back the tow vehicle. consider of the tail wagging the dog similarity.[11]

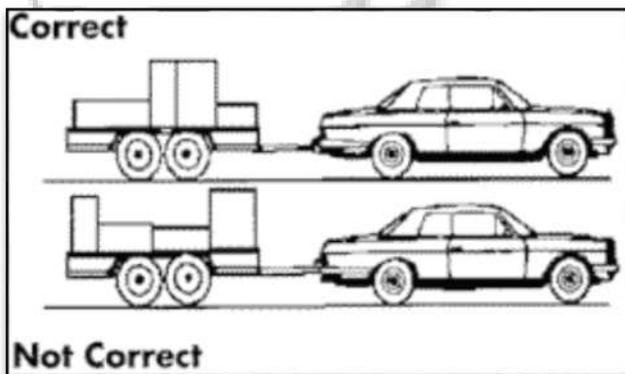


Fig. 2.6: Load applying conditions

The problem, of course, is that the tail in the case weighs somewhere from 3,000 to 12,000 pounds. If the tow automobile weighs less, and it usually does, an accident can result. Even when a heavy tow-vehicle is used, the trailer be able to still sway and break loose from the ball. Even a minor trailer accident results in thousands of dollars in compensation, a lost vacation, and more lost time receiving the trailer towed and repaired. [11]

2) Prevention Methods for Trailer Sway:

One of the bad things that can happen when you're trailering is the potential for your trailer to sway precariously back and forth, then eventually fall taking place one side,

bringing your vehicle down with it. Trailer sway is a serious and common issue for many trailer owners, and it can create driving and transporting your trailer a sticky, anxiety-inducing situation where you can potentially lose control of your vehicles. When you're on the road for long periods, especially, you should be able to drive with your trailer at virtual ease. Trailer sway can be reason by squall of wind, or the passing of big rigs, but can also be caused by a multitude of things that you can fix yourself [10].

- 1) Not Enough tongue weight: 10 to 12 percent of the trailers weight must be on the tongue (where it hitches to your vehicle). This is the most common cause for trailer sway. You can weigh your trailer by taking it to a commercial scale (at truck stops). For example, if the gross weight of your trailer is 2000 pounds, the tongue weight on the hitch should be about 200 pounds. Remove some items or redistribute the weight as necessary. Place heavier cargo at the front of the trailer, center the cargo left-to-right, and use reinforcements to tie down the cargo and prevent them from moving around. [10]
- 2) Tires: Make sure both your vehicle and your trailer have corrected air pressure. Also check to see that they are exactly the same size when inflated. [10]
- 3) Load capacity: do not overloads your trailer. Keep in mind that your load capacity includes the weight of the trailer, tongue, vehicle, and your passengers. [10]
- 4) Install a friction sway control device: They reduce the effects of sudden gusts of wind and sharp turning by applying resistance to the trailer and vehicle with respect to each other. When driving, stop and turn the adjustment handle a quarter of a turn in the clockwise direction, which adds more friction. Continue to do this until your trailer feels stable. They are available in three different styles, and should be used in trailers that have a low tongue weight percentage. For trailers that are over 5000 pounds, sway control devices should be attached to each side of the trailer hitch. [10]

III. PROPOSED WORK AND CALCULATION

This calculator will determine the weight and balance of a trailer or similar application. Units used are in, lbs. or mm and Newton's perspective. [10]

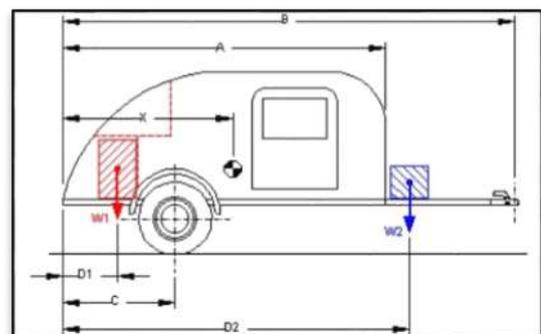


Fig. 3.1: Weight and balance equation diagram

Conversion.

1in =25.4 mm

1lbs = 4.4482 Newton's

1kg = 9.80665 Newton's

To determine the center of balance (CB) and weight locations following the following procedure.

Use the following to compute the CB location of vehicles. Multiply weight by distance of each axle from the reference line (in inches), and then divided the total results by the vehicle gross weight. The resulting fig is the number of inches to be measured aft from the reference line to the CB of the vehicle.

Center of balance formula.

W1 – Front axle weight

W2 - Rear axle weight

D1 – Distance from RDL to front axle or center of circulated tandem axle

D2 – Distance from RDL to rear axle or canter of articulated tandem axle.

The vehicle CB is computed to the nearest whole inch. Any answer with a friction of 0.5 or higher is increased to next higher number. If 4 or less, drop the number.

A. Calculations:

Step 1: weigh all axles individually.

Step 2: Mark weight above each individual axle.

Step3: Establish the RDL at the forward edge of the vehicle.

Step 4: measure all distances from RDL to center of each individual

Step 5: Distance multiplied by weight equals a moment.

Example of basic formula for determining the CB

$(D1 \times W1) + (D2 \times W2)$

Gross weight = CB from RDL [10]

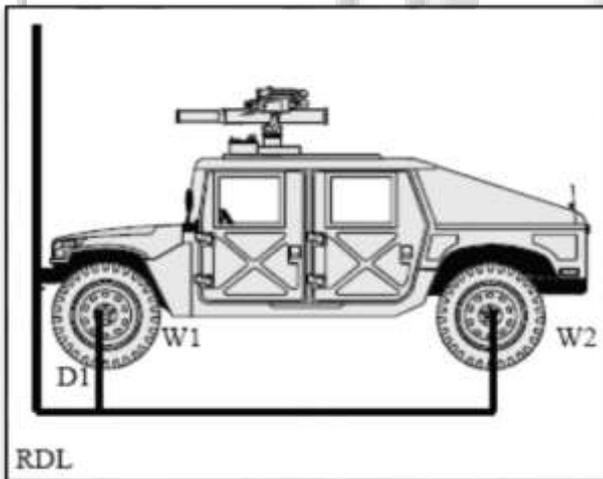


Fig. 3.2: Weight and balance equation diagram 2

D1 from RDL (from forward edge) to center of front axle = 20"

W1 front axle weight = 2,870 Ibs

D2 from RDL (from forward edge) to center of rear axle = 150"

W2 rear axle = 2,550 Ibs

20" x 2,870	=	57,400 moment
150" x 2,550	=	382,500 moment
		439,900 moment

W1 (2,870 Ibs) + W2 (2550 Ibs) = gross weight (5,420 Ibs)

Total moment (439,900) divided by gross weight = CB (81' from RDL)

$[(D1 (20") \times W1 (2,870 \text{ Ibs})) + [D2 (150" \times W2 (2,550 \text{ Ibs}))]$

Gross Weight (5,420 Ibs) = CB (81' from RDL) [10]

IV. CONCLUSION

To control the swaying effect of trailer by proper weight distribution and to avoid the various effect such as gross weight effect, tongue weight effect to make the trailer stable and to avoid accident causing from them. For reducing swaying, we applied the load at center which is less or sometime no swaying than applied load at the both ends of trailer. That's helps to smooth and safe driving to avoid misfortunes.

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