

SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with ‘A+’ Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai



DEPARTMENT OF AGRICULTURE ENGINEERING

19AGT202 – MACHINE DESIGN

II YEAR IV SEM

Case Study: Trailer design for a Tractor



Introduction



- A trailer is generally an unpowered vehicle towed by a powered vehicle (tractor). It is commonly used for the transport of goods and materials.
- Sometimes recreational vehicles, travel trailers, or mobile homes with limited living facilities, where people can camp or stay have been referred to as trailers.



Types of Trailer



AUTO HAULER



BOTTOM OR
SIDE DUMP TRAILER



BULK COMMODITY
TRAILER



CONCESSION TRAILER



DRY FREIGHT TRAILER



DUMP BODY TRAILER
OR TRANSFER BOX



FLATBED TRAILER



GOOSENECK TRAILER



HORSE TRAILER



LIVESTOCK TRAILER



LOGGING TRAILER



LOW-BOY TRAILER



POLE TRAILER



REFRIGERATED DRY
FREIGHT TRAILER



TANK TRAILER



TILT TRAILER



TRAVEL TRAILER



UTILITY TRAILER



Flat Bed Trailers



- Flatbeds are extremely popular and are widely used because they exude a great sense of versatility.
- Generally, a flatbed is used to load freights on its tip, sides, and rear.
- With these capabilities, flatbeds have truly become the primary and leading assets of the trucking farm.





Dry Van Trailers



- Dry Van trailers are generally enclosed and are commonly used to carry and protect the freights from the harmful elements of the weather or the roads.
- Freights can be loaded on the rear and are commonly loaded using a loading dock.
- It is similar to a curtain van and it can be loaded from its side too.





Refrigerated Trailers



- Refrigerated trailer is a temperature-controlled type of trailer.
- It is generally used for transporting chilled or frozen products.
- The temperature inside this trailer can be controlled whatever the outside weather .





Lowboy Trailer



- A Lowboy Trailer is an unpowered trailer which is commonly used to haul freight.
- These kinds of trailers are generally designed to carry and transport taller goods and items
- Basically, a lowboy that has two axles can haul around 20,000kg.





Basic Trailer Layout

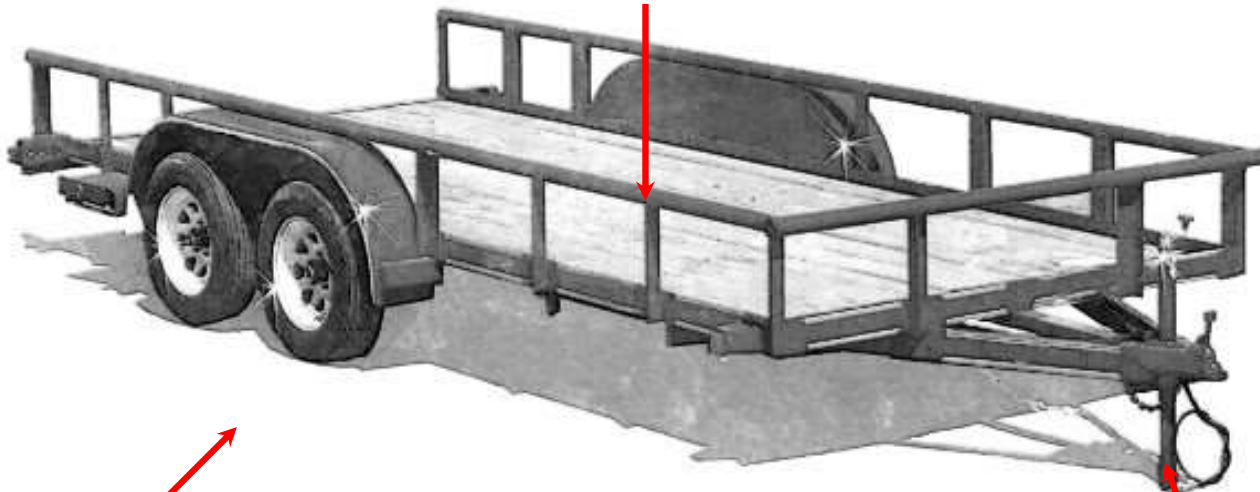
1. The tongue
2. Axle location
3. Chassis



Trailer Layout



Rear member/
Trailer Chassis



Wheel & axle

Tongu
e



The Tongue

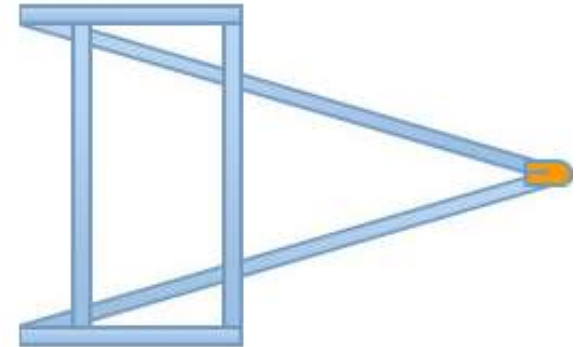
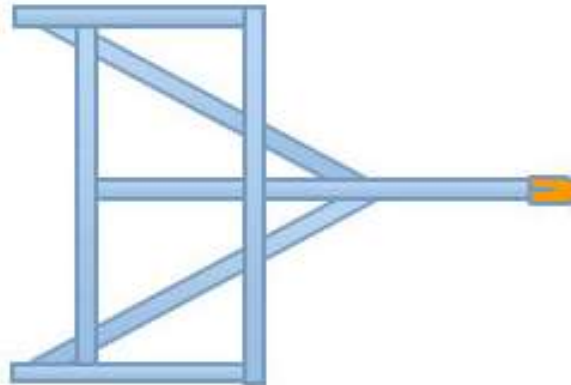
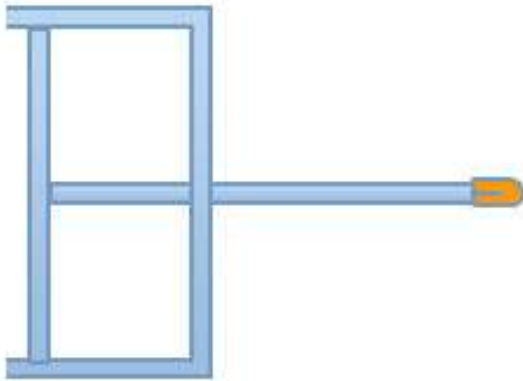


- The tongue does a couple of important jobs apart from being the part that keeps trailer attached and at a distance from tow vehicle.
- The tongue keeps trailer in balance when towing and assists in keep weight on the tow hitch which is required for controlled towing.
- The tongue should be long enough to allow a reasonable turning radius and clearance to the vehicle when backing.
- If the tongue is short, it may be an indication of weakness or shortcuts in the design. Short tongues affect both driveability and stability -- basically back up, turning radius and jack-knife susceptibility.





- There are 3 main styles of tongue :-
 1. The straight tongue
 2. The Compound tongue

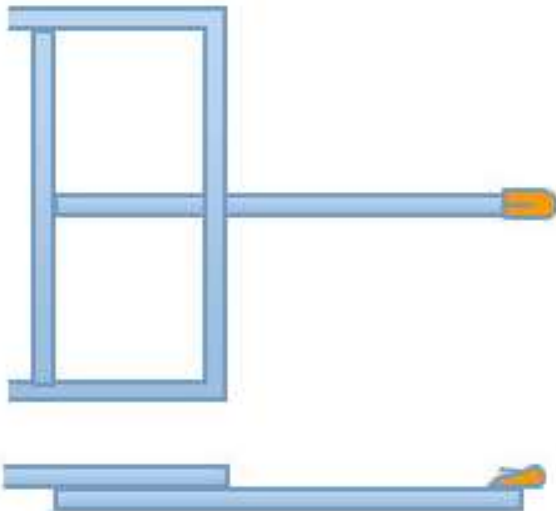




The straight tongue



- This design harks back to the old horse and cart.
- It is a bit old fashioned but still has its uses particularly on dinghy and agricultural trailers.
- Whilst this design has less chance of getting jack-knifed when reversing, if the tongue does get damaged it creates a highly stressed section which can rapidly cause internal cracking or failure.

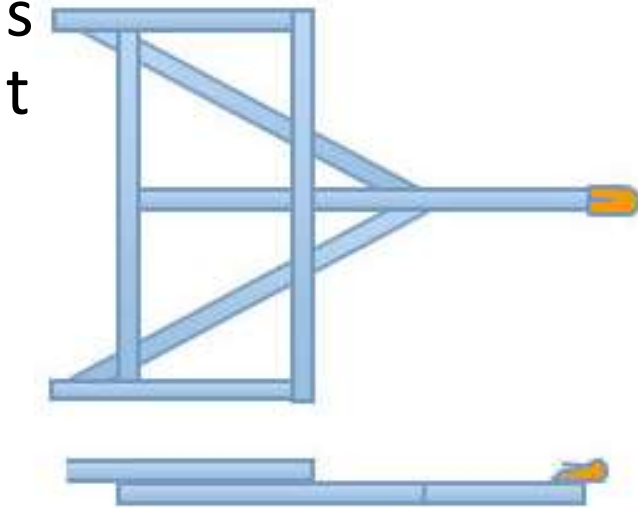




The Compound Tongue



- The composite tongue is a variation of the single tongue design with lateral supports to both strengthen the tongue and provide support to the chassis
- Composite tongues give the benefits of good clearance to the tow vehicle when reversing around
s re support to the sides of the

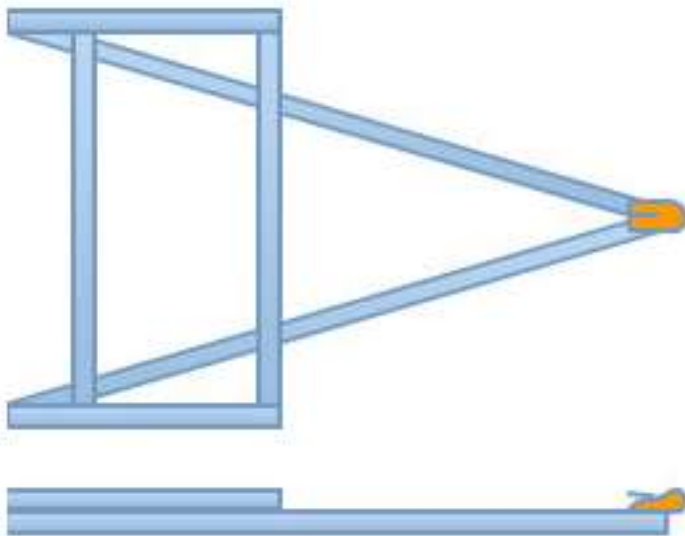




The “A” frame Tongue



- This style tongue is one of the most common due to the strength the full angle frame gives to the trailer.
- The longer a tongue can be (to a point where the tongue weight becomes excessive) the more smoothly and stable the trailer will travel. It will also be more responsive and forgiving when reversing.
- A disadvantage is the greater chance of the tongue being damaged when jack-knifed while reversing.





Axle location

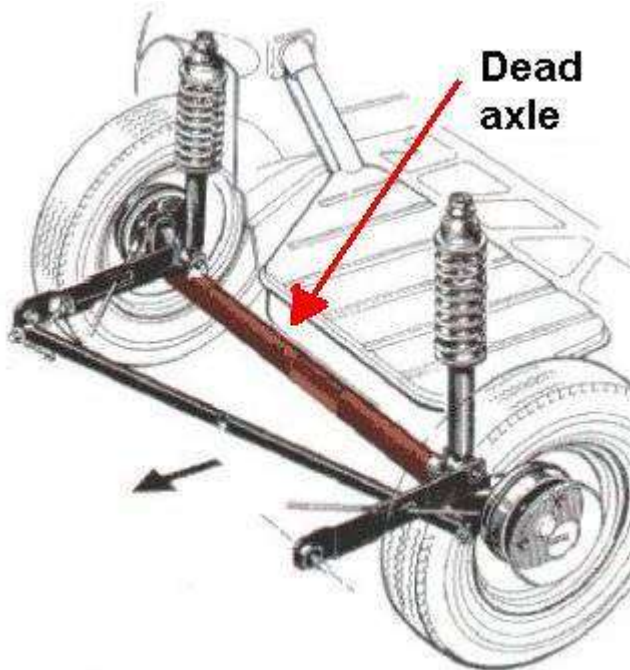


- An **axle** is a central shaft for a rotating wheel or gear.
- The axle should be behind the load center for stability.
- Often trailers have the axle at or just barely behind the center of the bed.
- This is short sighted with respect to versatility, but it is also an indication of weakness.
- For most applications, the axle should be noticeably behind the center of the bed, and for maximum versatility, allow the axle position to be adjusted





- There are 2 main styles of axle :-
 1. Dead axle (lazy axle)
 2. Lift axle

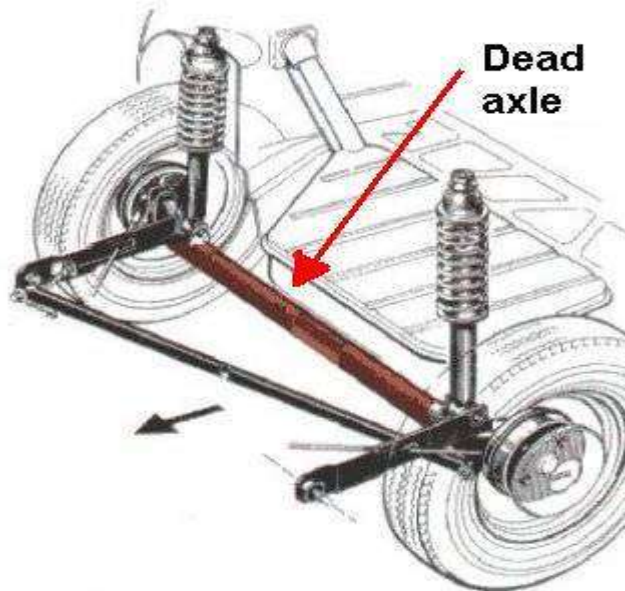




Dead Axle



- A **dead axle**, also called **lazy axle**, is not part of the drivetrain but is instead free-rotating.
- The rear axle of a front-wheel drive car is usually a dead axle.
- any trucks and trailers use dead axles for strictly load-bearing purposes.
- Dead axles are also found on semi trailers, farm equipment, and certain heavy construction machinery serving the same function.





Lift Axle



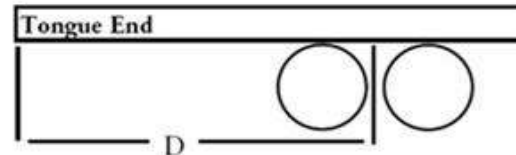
- Some dump trucks and trailers may be configured with a **lift axle** (also known as **airlift axle** or **drop axle**), which may be mechanically raised or lowered.
- The axle is lowered to increase the weight capacity, or to distribute the weight of the cargo over more wheels, for example to cross a weight restricted bridge. When not needed, the axle is lifted off the ground to save wear on the tires and axle, and to increase traction in the remaining wheels.
- Lifting an axle also alleviates lateral scrubbing of the additional axle in very tight turns, allowing the vehicle to turn more readily.
- In some situations removal of pressure from the additional axle is necessary for the vehicle to complete a turn at all.





How to Determine Correct Axle Position

1. Weigh the trailer (under wheels) "Wheel Weight".
2. Obtain "Tongue Weight" (actual).
3. Measure distance from tongue to axle, or to center between Dual Axle Set (D).
4. Determine Total Weight:
Total Weight = Tongue Weight + Wheel Weight.



IF TONGUE WEIGHT IS GREATER THAN 10% OF TOTAL WEIGHT

If tongue weight is greater than 10% of Total Weight, decrease distance "D" by "X" where

$$X = \frac{(\text{Tongue Weight} - 10\% \text{ Total})}{\text{Total Weight}} \text{ Times } D$$

Example #1 - Tongue greater than 10% of Total Weight

Tongue Weight = 1025#
 Wheel Weight = 7200#
 D = 264"
 Total Weight = 8225#
 % Tongue Weight = $\frac{1025}{8225} = 0.1246$ or 12 1/2%
 "X" = $\frac{1025 - 822.5}{8225} \text{ Times } 264 = 6.499"$

Move the Axle(s) toward the Tongue of the trailer approximately 6 1/2"

$$\text{New } D = D - 6 \frac{1}{2} = 264 - 6 \frac{1}{2} = 257.5"$$

IF TONGUE WEIGHT IS LESS THAN 10% OF TOTAL WEIGHT

If tongue weight is less than 10% of Total Weight, increase distance "D" by "X" where

$$X = \frac{(10\% \text{ Total} - \text{Tongue Weight})}{\text{Total Weight}} \text{ Times } D$$

Example #2 - Tongue less than 10% of Total Weight

Tongue Weight = 300#
 Wheel Weight = 8200#
 D = 264"
 Total Weight = 8500#
 % Tongue Weight = $\frac{300}{8500} = 0.035$ or 3 1/2%
 "X" = $\frac{850 - 300}{8500} \text{ Times } 264 = 17"$

Move the Axle(s) toward the Rear of the trailer approximately 17"

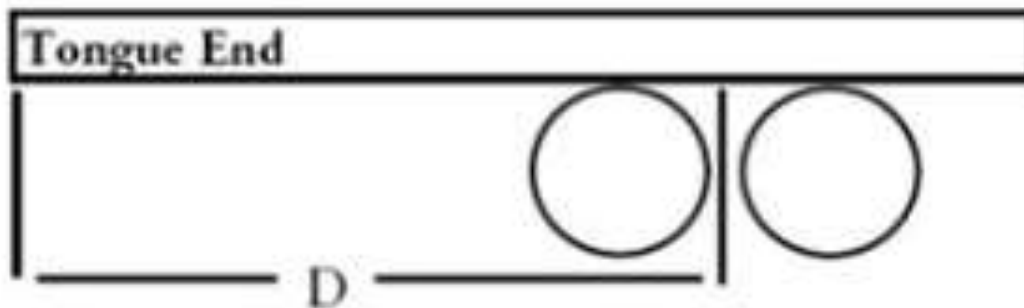
$$\text{New } D = D + 17 = 264 + 17 = 281"$$



Example



A trailer was design as shown in figure below. Tongue weight of the trailer is 1025kg and wheel weight is 7200kg. Distance D (tongue end to axle) is 2.64m. **Verify** whether the axle position for the trailer is correct or wrong. Prove your verification by using calculation.





Trailer Chassis



- Trailer chassis is a frame upon which the main parts of a trailer are built.
- The design of a trailer chassis will be different than one for pleasure vehicles because of the heavier loads and constant work use.
- Usually the loading and unloading occurs over this member, so it should be disproportionately larger (stronger) than the other cross members.





Trailer Stability



- **Load distribution**
- **Trailer length**
- **Dynamic loads**
- **Centre of gravity**



Load distribution



- The trailer load should always be reasonably distributed from *side to side*.
- Load the trailer *front to back* with at least 10% of the trailer weight on the hitch.
- With typical trailers, more weight on the hitch is better for stability.
- 15% is usually a good number.
- To illustrate, 5th wheel trailers have much more weight on the hitch, and they tend to be pretty stable. The extreme example is over-the-road trucks. They carry up to 50% of the load at the front.



An extreme example of poor load distribution



Trailer length



- Longer trailers typically tow better or more accurately, a greater separation between the rear most wheels of the tow vehicle and the fore most wheels of the trailer.
- A long tongue can facilitate such separation.
- Evaluate trailer length in the context of width.
- Look at the width of the trailer with respect to the tow vehicle *and* with respect to length .



Dynamic loads



- Dynamic loads exert varying amounts of force upon the structure that is upholding them.
- For instance, heavy pipe isn't tied down, it'll roll from side to side or front to back. This constantly changing load makes the trailer move.



Center of gravity



- A point from which the weight of a body or system may be considered to act. In uniform gravity it is the same as the center of mass.
- In general, a lower center of gravity helps improve stability of the trailer.



Trailer Strength



- **Load Capacity**
- **Construction**
- **Materials**
- **Components**



Load Capacity



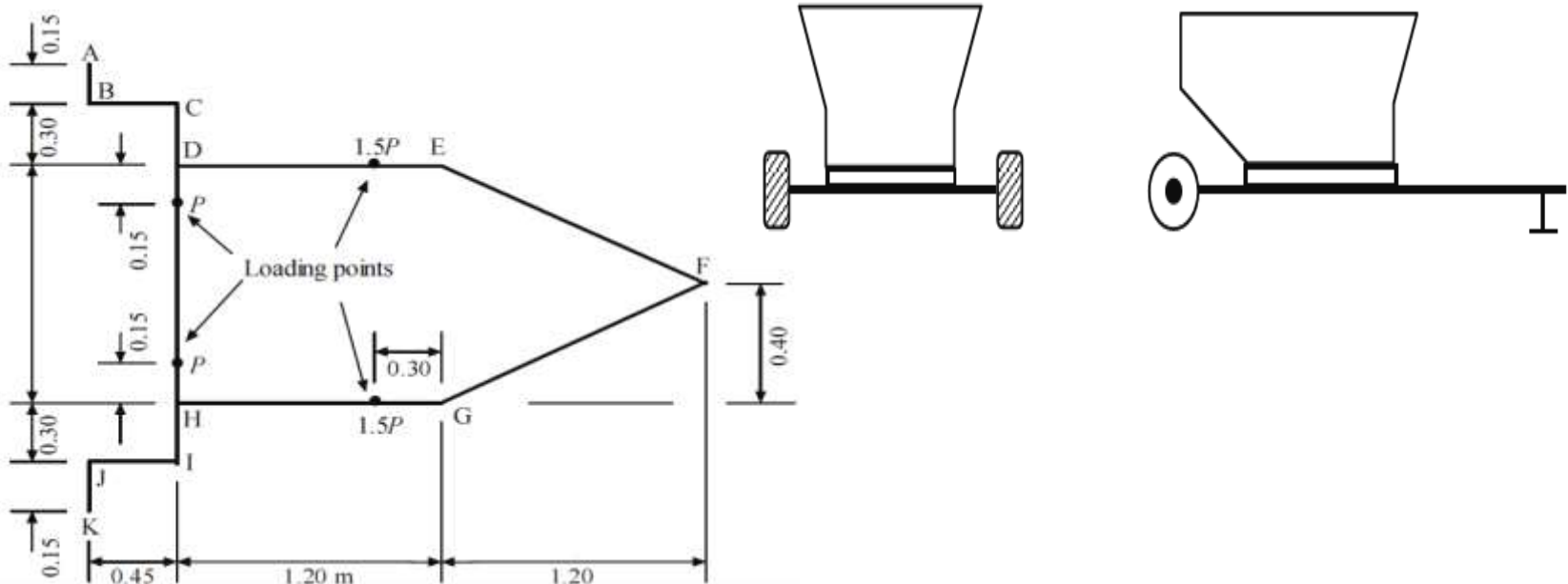
- The maximum load for which the trailer is designed to carry will determine much about the strength of the trailer.
- It will also determine how strong the trailer should be.
- Judge trailer strength with respect to its intended capacity.



Calculation of load capacity



A company makes a portable bulk bin as shown in the figure below. The grid consists of nine members, AB, BC, JK, IJ, CDHI, DE, GH, EF, and FG. The members that attach the wheels to the framework, ABC and IJK, lie in the same horizontal plane as the rest of the grid. Design loads, P for the plane grid is 2kN. All the labels in the figure in unit meter (m) The company was decided to construct the portable bulk bin with rectangular solid mild steel 1090 (30mm x 40mm). **1) Calculate** the reaction force for point I and C . **2) Calculate** the maximum design load, P for portable bulk bin. Given ultimate tensile strength for mild steel 1090 is 841MPa.





Assignment



Discuss how the three factors (construction, materials & components) contribute to trailer strength. Provide relevant evidence for your discussion.