Control of Side-Loads and Errors When Weighing On Jacks

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Resolved: Jacking the aircraft when weighing with load cells can cause side-loading of the load cell.

What is Side Loading?

- A load cell is a spring and has a designed axis of loading.
- Force generated against the load cell outside of this axis can result in errors to the reading.

- Side loads are not part of the actual weight applied – they are an unwanted force that will improperly add or subtract weight from the desired reading.

Other key relational words

- Off-center loading
- Non-axial loading
- Horizontal loads

When weighing on jacks, we want the load to be applied in the most vertical manner possible in order to achieve optimal results.

SIGNS OF SIDE LOAD ERROR

- Large zero-return values – not just a few, but many graduations.

  Example: 50,000 lb. Capacity load cell
  35,000 lb. Actual applied load
  20 lb. Reading after weight removed from cell

- Failure of load cells – no sensible output (value) or visible physical damage

  Example: 50,000 lb. Capacity load cell
  35,000 lb. Actual applied load
  20,000 lb. Reading

  Example: Dents, broken sealant or potting compound, exposed gauges, and/or deformed structure.

- Failure of jacks to fully retract – jacks not returning to a full down position.

  Example: Mechanic using crow bar to pry down the jack ram

Example: After weighing, person standing on jack ram so it fully retracts prior to stowing in container.

- Aircraft falling from jacks – jack adapter rotates out of load cell socket/cup.

  Example: Jack pushed through wing or fuselage

  Example: Aircraft jack point-contacting surface of load cell

CAUSES OF SIDE LOAD ERROR

1. Attitude Change –

As the aircraft is brought to level attitude, the distance between the jacking points geometrically changes thereby causing bending of the jack ram and thus generating a side load (see attachment 2).

2. Cocked Jacks (tri-pod type) –

Spring loaded wheels support the jack during positioning and initial applied load. The base of the jack makes solid contact with the floor as a greater load is applied, yet the aircraft has already begun to rotate into level position thereby applying a side load (see attachment 3).

SIDE LOAD ERRORS

All load cells are prone to side loading errors.

- Typical errors range anywhere from 0.1% to 30% of imposed force.

Example:

Actual applied weight	50,000 lb.
0.1% of side load error	50 lb.
0.1% of scale error	50 lb.

= 100 lb. of potential total error or +/-0.2% accuracy

- Internal structural damage - most load cell specifications allow for only 25-50% of off center loading before structural damage may occur. Structural damage may occur and gradually affect the accuracy. This may not be noticed until the load cells have been returned to the calibration lab and found to be out of tolerance.

SOLUTIONS TO MINIMIZE SIDE LOAD ERRORS

- Level the aircraft prior to jacking – service the struts or control tire pressure as done when weighing on platforms; and then jack evenly.

- Limit the aircraft pitch while jacking – individually control each jack to raise the aircraft evenly; and then level the aircraft. This will not eliminate, but will minimize the bending of the jack ram.

- Center tri-pod jacks before engagement to aircraft – this will eliminate cocking once full load is applied

- Rotate load cells – turn each cell by 45 ◦ after each weighing to test for repeatability.

- Mathematically correct aircraft CG from a measured angle – vertical c.g. must be known and airframe manufacturer should provide correction formula or table.

- Use platform scales – eliminates side load errors induced by jacks.

CONCLUSION & DISCUSSION

Is further discussion and consideration warranted for possible SAWE Recommended Practice?

We must accept aircraft will continued to be weighed on load cells

- Because they are more inexpensive as opposed to platforms
- Because they allow other on-going maintenance to be performed and take up less room than platforms.
- Because they are more portable than platforms
- Because some aircraft cannot be leveled simply by servicing the struts

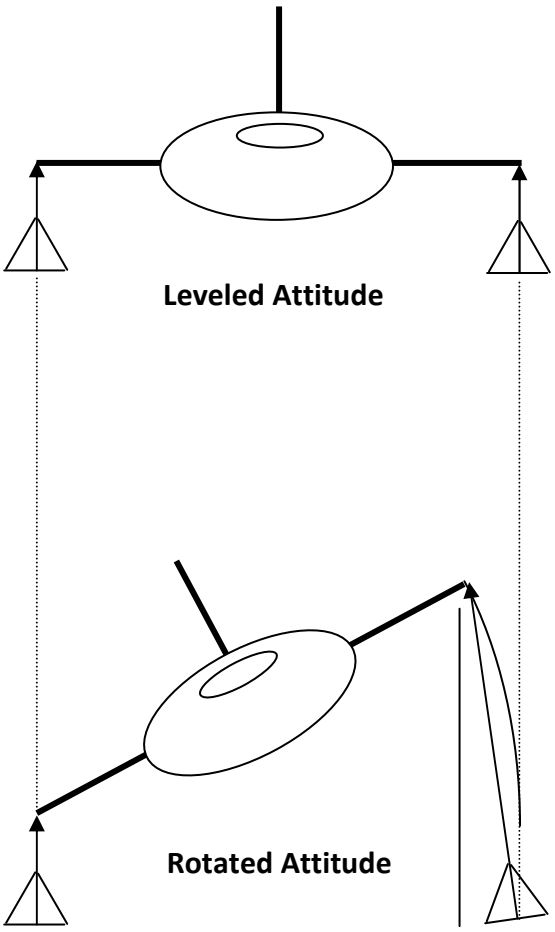
Weighing with under-axle jacks reduces potential for side loads

- Eliminates cocking of jacks as with spring loaded tri-pod jacks
- Less ram extension equals less potential bending that generates side force
- Less ram extension makes jacking safer

Weighing with tri-pod jacks is still prevalent

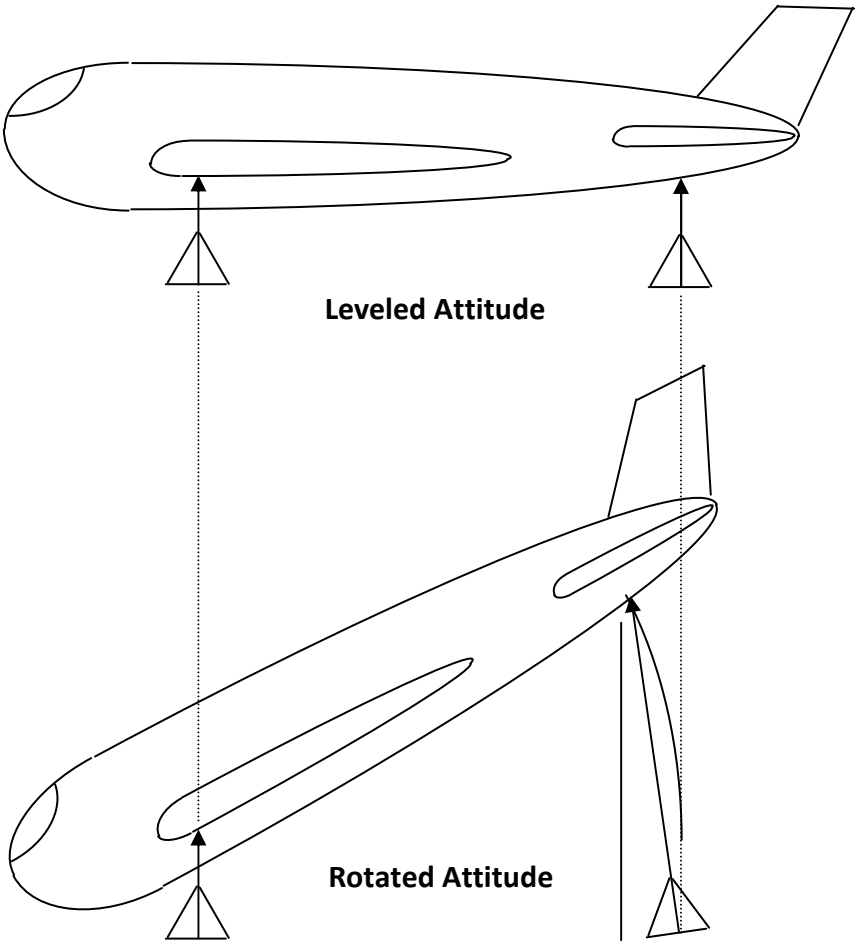
- Some airframe manufacturers only “recommend” against using tri-pod jacks.

Jacking geometry: Lateral View



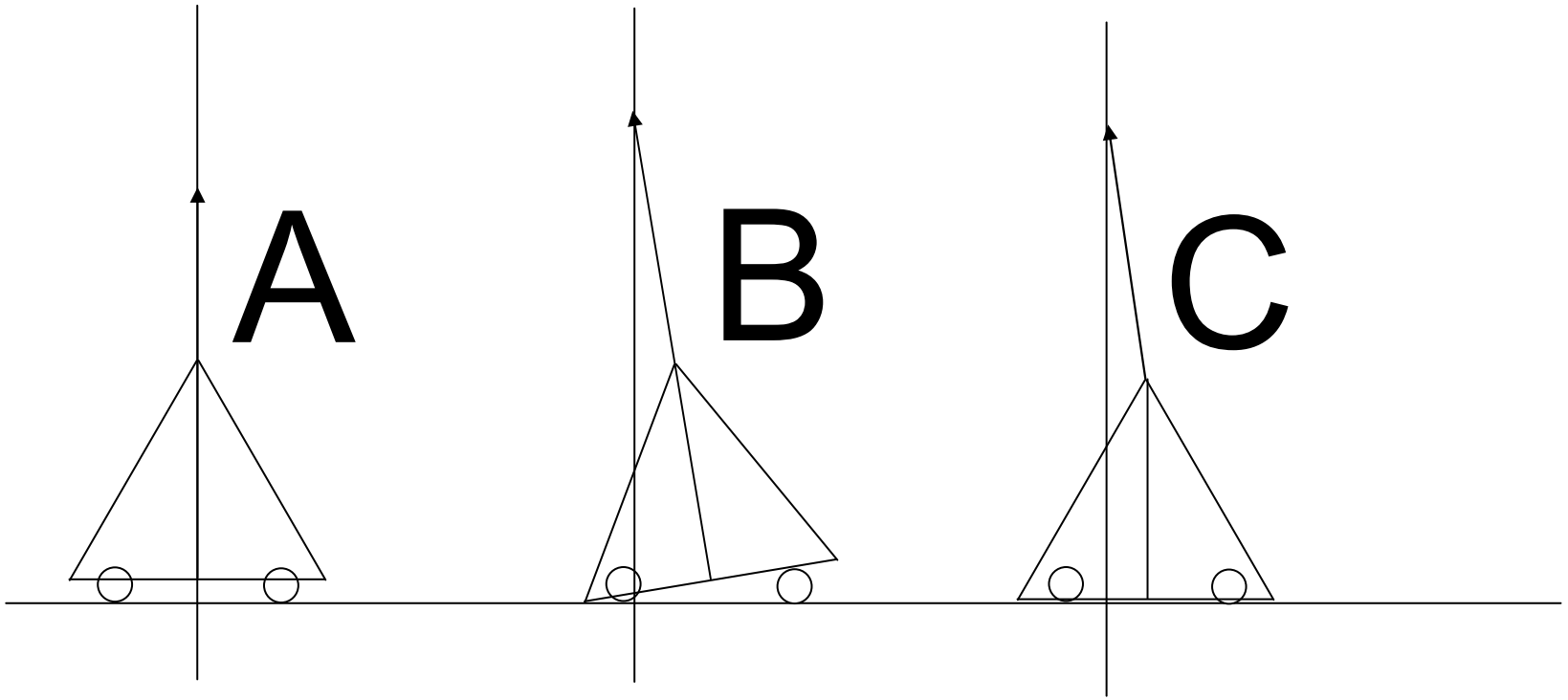
Note change in aircraft jack point locations in relation to jack base locations as aircraft is jacked up

Jacking geometry: Longitudinal View



Note change in aircraft jack point locations in relation to jack base locations as aircraft is jacked up

Spring loaded wheels can cause jack to become mis-aligned



A) Jack positioned under jacking point

B) Jack base pushed out of line as jack is extended

C) Jack base not aligned with jacking point when fully loaded