

HydraSafe Brake

Seismic FEA

2024/03/25



Industrial Design

Mechanical Engineering

Electrical Engineering

Software Development

Materials

Structural Steel Components

A36 Yield Strength: 36,000psi

Caliper Casting Component

A352 LC2-1 Yield Strength: 91,000psi

Source: www.makeitfrom.com

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Seismic Load Requirements

Using ASME A17.1-2022

Calculations and FEA will be done according to 8.4.5.2.2(a) for seismic zone 3 or greater.

Calculations specific to IBC, NBCC, or stress-allowable designs can be performed with additional inputs about the building and location, such as:

- S_{DS} – 5% damped design spectral response acceleration
- F_a – acceleration-based site coefficient (per NBCC)
- $S_a(0.2)$ – 5% damped spectral response acceleration value (per NBCC)
- D – Dead Load

SECTION 8.4 ELEVATOR SEISMIC REQUIREMENTS

8.4.5 Guiding Members and Position Restraints

8.4.5.2 Design

8.4.5.2.2 Position restraints and their attachments to car frames or counterweight frames shall withstand one of the following horizontal seismic forces:

(a) $0.5W_p$ (for zone 3 or greater)

(b) $0.25W_p$ (for zone 2)

(c) F_p as defined in 8.4.14

(d) component force levels as defined in 8.4.13

Seismic Load Requirements

We'll be using a 4610 lbs sideways loading with yield being considered a failure

$$W_p = \text{car weight} + 40\% \text{ capacity}$$

$$W_p = [\text{empty car weight} + \text{HydraSafe units (2x)}] + 40\% \text{ capacity}$$

$$W_p = [7530 \text{ lbs} + 290\text{lbs}] + 40\% (3500\text{lbs})$$

$$W_p = 9220 \text{ lbs}$$

Zone 3 or greater

$$0.5W_p$$

4610 lbs

8.4.13.1 In United States jurisdictions with building codes not referencing seismic zones and prior to IBC

Zone(s)	Affected Peak Velocity Acceleration, A_v
0 and 1	$A_v < 0.10$
2	$0.10 \leq A_v < 0.20$
3 and 4	$0.20 \leq A_v$

SECTION 8.4 ELEVATOR SEISMIC REQUIREMENTS

8.4.15 Component Operating Weight, W_p

The component operating weight, W_p , shall be one of the following:

(a) for support or restraint of specific components, the component operating weight [N (lb)] will be used (i.e., counterweight, controller, etc.)

(b) for support or restraint of an elevator, the component operating weight [N (lb)] will include car weight plus 40% capacity (i.e., guide rails)

8.4.5.2 Design

8.4.5.2.1 The design weight for

(a) the counterweight shall be W_p as specified in 8.4.15(a)

(b) the car shall be W_p as specified in 8.4.15(b)

8.4.5.2.2 Position restraints and their attachments to car frames or counterweight frames shall withstand one of the following horizontal seismic forces:

(a) $0.5W_p$ (for zone 3 or greater)

(b) $0.25W_p$ (for zone 2)

(c) F_p as defined in 8.4.14

(d) component force levels as defined in 8.4.13

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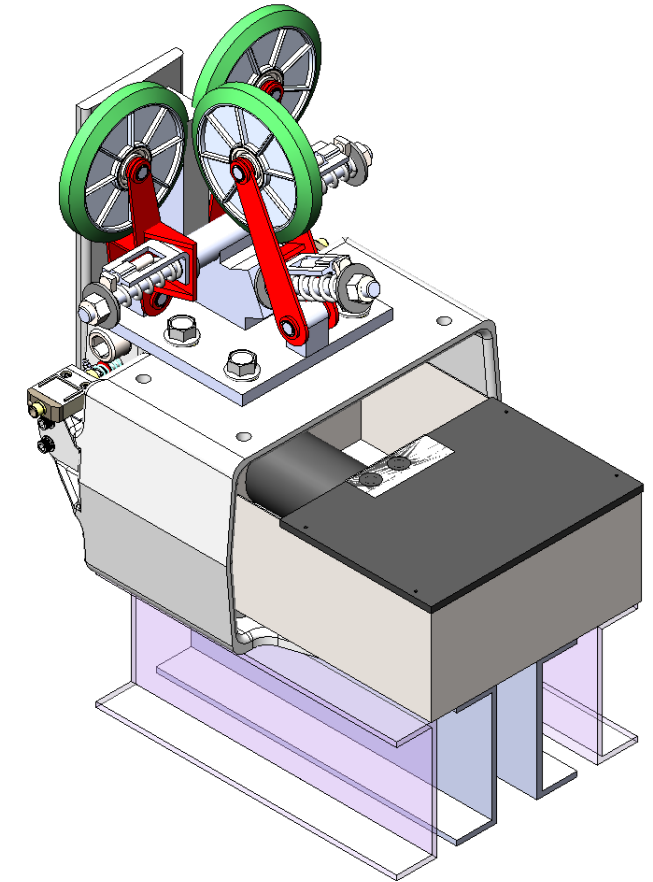
Setup – Seismic Load from Roller Guide

A seismic load of 4,610lbs is used. It is applied as a remote load from the contact point of the roller guide, to the holes that mount the roller guide, to make sure the roller guide will not break off the brake casting. Setup is for the roller guide pictured to the right.

The model is a ½ section, but it's conceivable that, in a seismic event, only one rail contacts on one side, thus, the full 4,610lbs is used

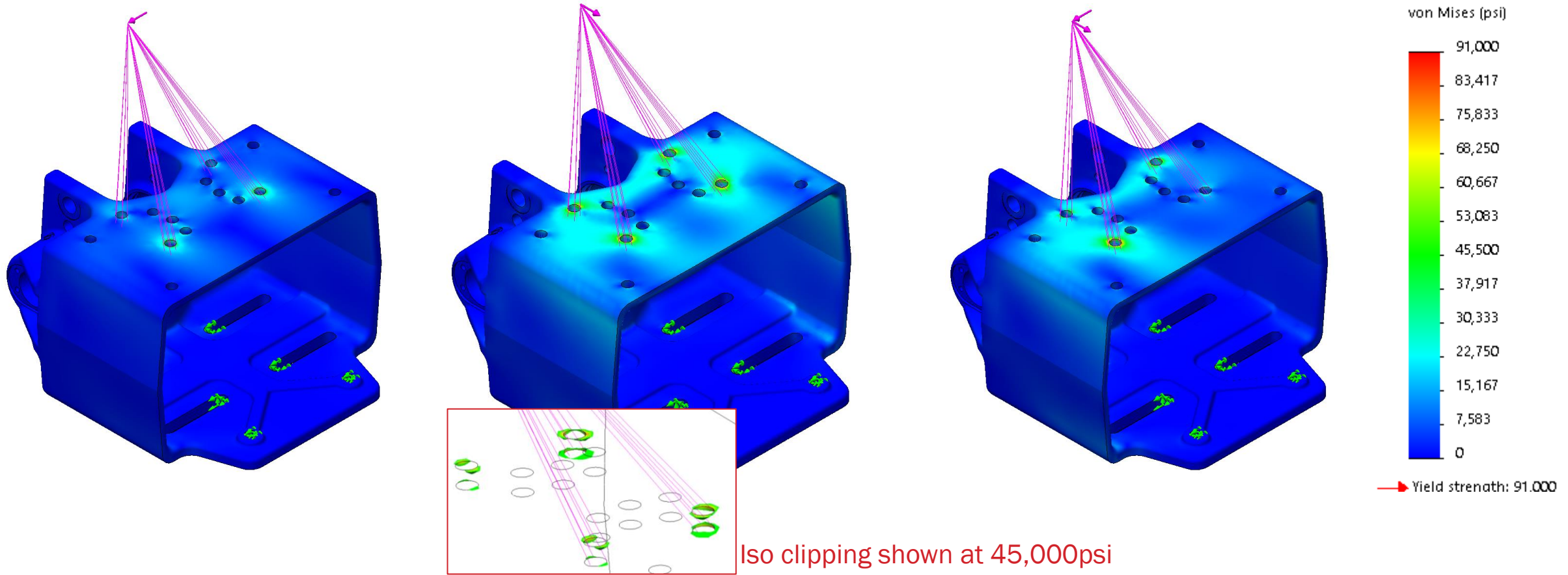
We tested 3 setups, with the force applied:

- From the roller guide, sideways into the casting
- From the roller guide, towards the center of the car, into the casting
- 45-deg diagonal of the above 2 setups (same total force)



Stress Results – Seismic Loads from Roller Guide

Casting does not yield; max stress in this case is ~45,000 psi and localized to where the force is applied at the holes
Note, different stress scale than other FEAs to better show effect on stronger A352 LC2-1 casting material



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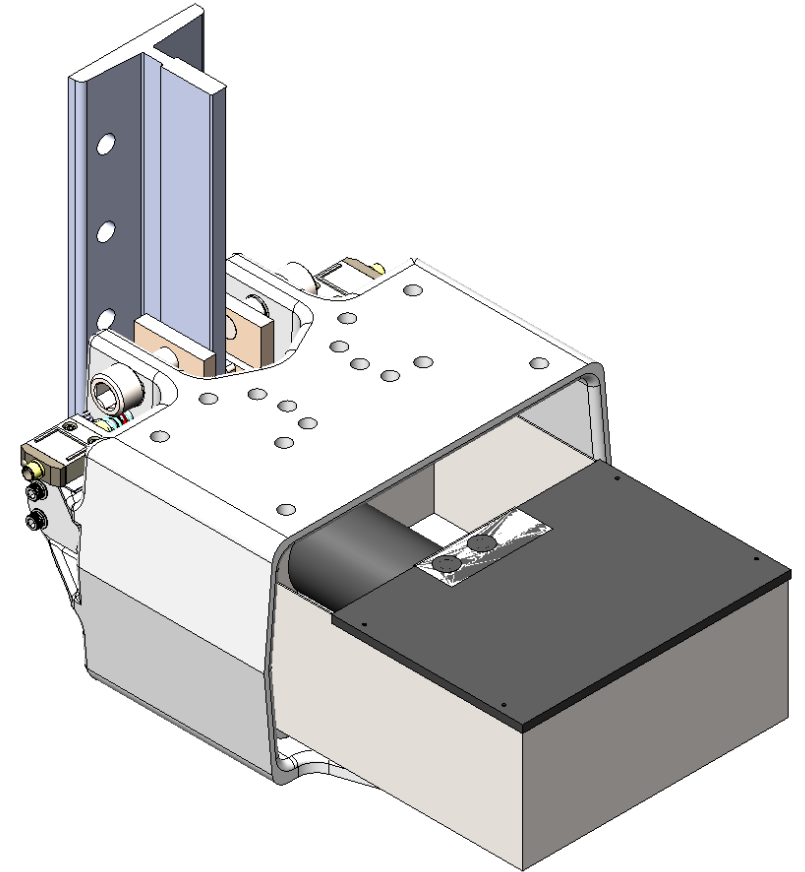
Setup – Seismic Load from Rail

A seismic load of 4,610lbs is used. It is applied as a remote load from the contact point of the brake pads, to the holes that mount the brake pads. Setup is pictured to the right.

The model is a ½ section, but it's conceivable that, in a seismic event, only one rail contacts on one side, thus, the full 4,610lbs is used

We tested 4 setups, outlined on the next slides:

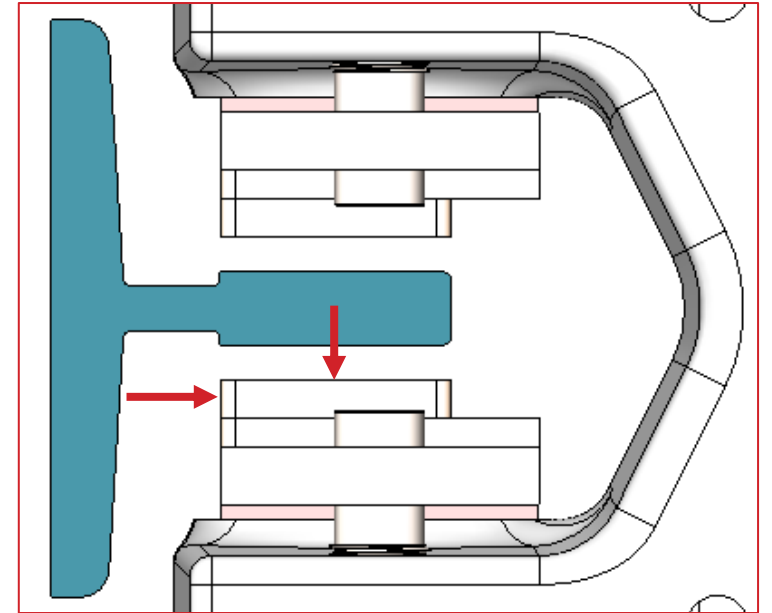
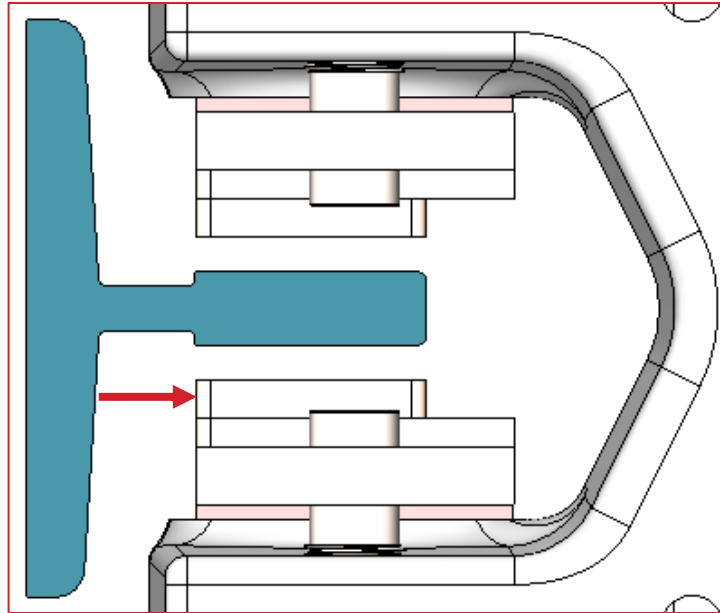
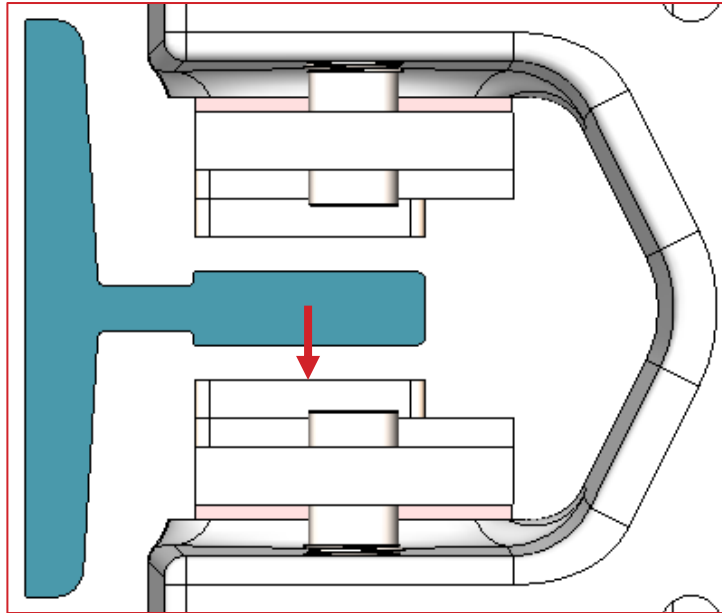
- 3 setups for rail hitting the brake pad
- 1 setups for the rail hitting the casting directly



Setup – Seismic Load from Rail to Brake Pad

For this scenario, we tested 3 setups, with the force applied:

- From the brake pads, sideways into the casting
- From the brake pads, towards the center of the car, into the casting
- 45-deg diagonal of the above 2 setups (same total force)

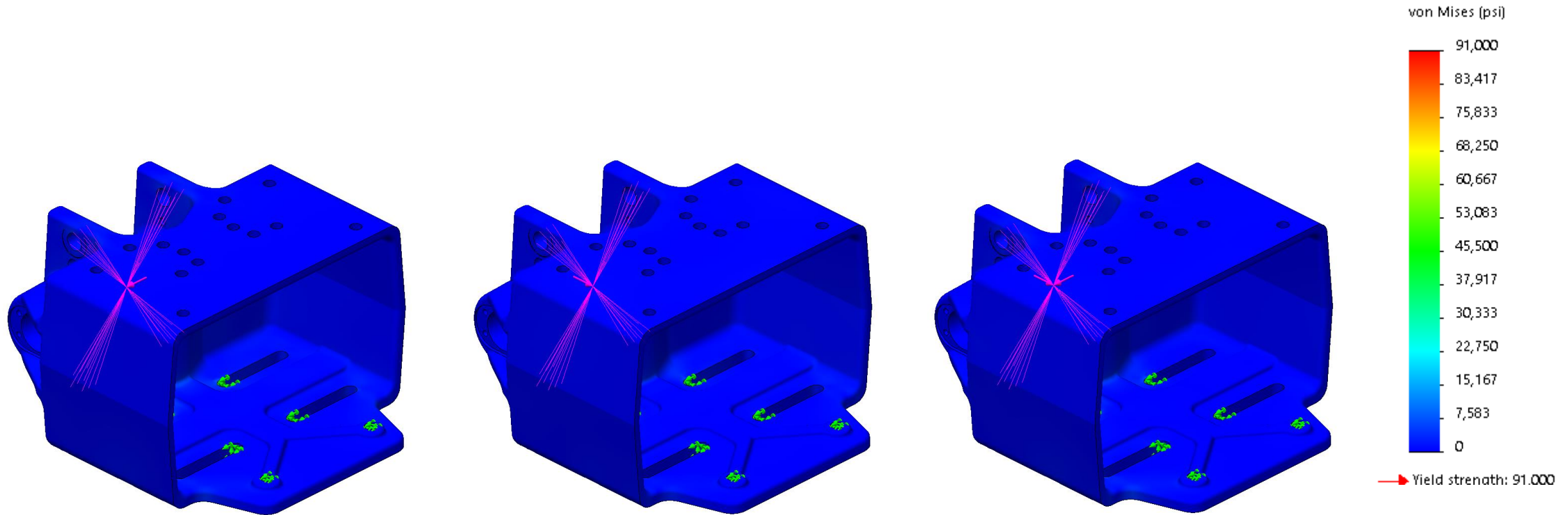


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Stress Results – Seismic Load from Rail to Brake Pad

Casting does not yield; max stress is any case is <9,000 psi

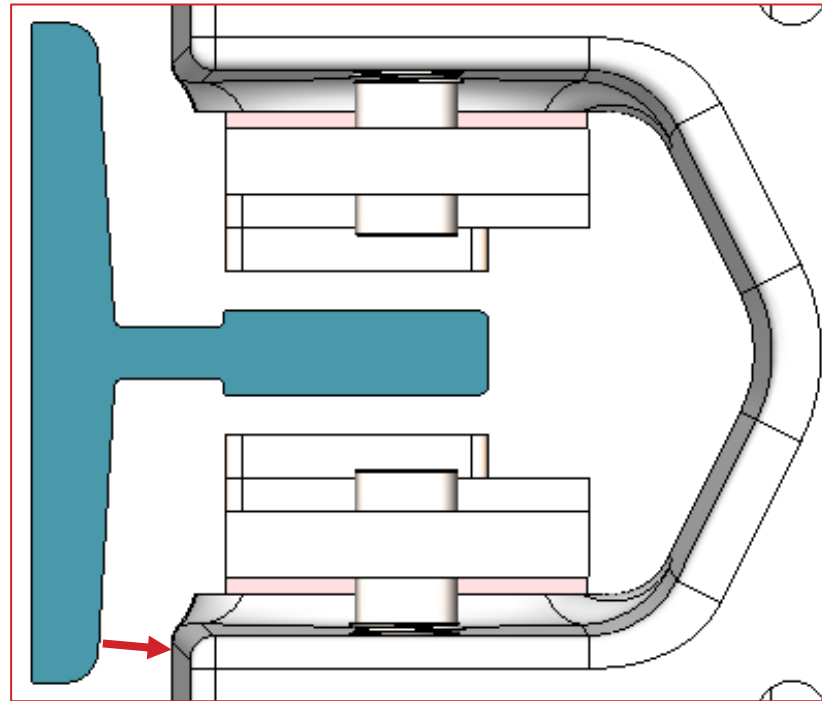
Note, different stress scale than other FEAs to better show effect on stronger A352 LC2-1 casting material



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Setup – Seismic Load from Rail to Casting

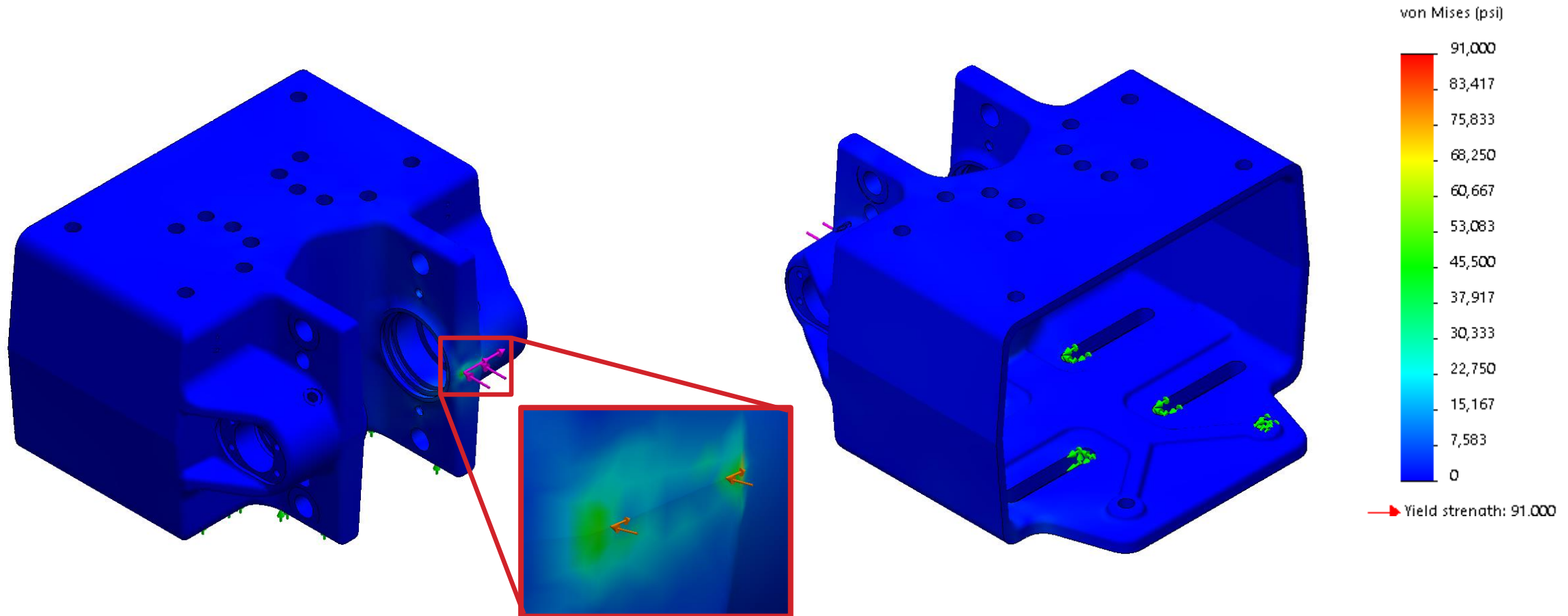
For this scenario, we tested 1 setups, with the force applied from the rail, normal to the profile of the rail, into the casting



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Stress Results – Seismic Load from Rail to Casting

Casting does not yield; max stress in this case is ~30,000 psi and localized to where the force is applied at the edge
Note, different stress scale than other FEAs to better show effect on stronger A352 LC2-1 casting material



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