AeroBrace

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Introduction:

The AeroBrace was designed to reduce chronic pain and discomfort applied to the knees under constant loading and unloading force, particularly in skiing and snowboarding. The system created is purely mechanical, using air cylinders as a pathway to bypass the knee from the calf to the thigh. These cylinders allow for a max supporting force of 128 pounds per leg, or 64 pounds per cylinder, at pressures achievable with a handheld bike pump.

Problem Statement and Objectives:

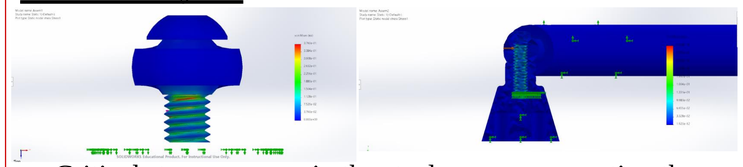
Our goal is to remove limits from individuals with chronic knee pain or injuries that might prevent them from participating in high-impact sports such as skiing or snowboarding.

To that end, the AeroBrace must:

1) Withstand loads over 400 pounds,
2) Provide over 120 pounds of supportive force, and
3) Perform at temperatures as low as -20°F,

while still being comfortable, adjustable for individual users, not too restrictive of the knee's range of motion, and affordable for potential customers.

Stress Analysis:



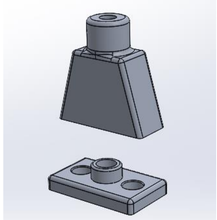
Critical stresses occur in the steel screws connecting the air cylinders to the main frame of the AeroBrace.

With a 400-pound load on the brace, FEA results indicate

Upper Button Head Max Stress: 376 psi
Lower Button Head Max Stress: 333 psi
(yield strength of 70,000 psi)

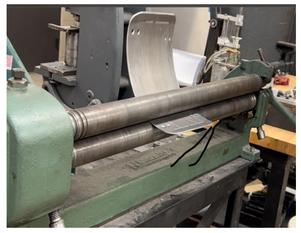
Final Assembly, CAD and Reality:

Yoke Blocks



Upper/Lower Frame & Supports

Rolling and Milling of Upper & Lower Supports



Manufacturing:

Aluminum sheet metal pieces were initially cut on the CNC plasma table.

Yoke and mounting blocks were cut out of aluminum stock using the CNC mill.

Holes and slots were cut on the manual mill and chamfered and threaded by hand.

The wire EDM precisely cut holes to press-fit bearings. The bearing shaft was cut on the lathe.

The upper frame was bent without issue on the sheet metal brake and the supports were bent in the pipe roller before being finished on the brake at over 400°F.

Final Assembly Exploded View