Abstract
Whether used at home or in a gym, the bench press is one of the most popular exercises performed today. It is a standard piece of equipment found in nearly every fitness facility. Unfortunately, it is also one of the most dangerous. There are many associated risks with the bench press, especially if the user does not employ the help of a spotter. Men’s Fitness published an article about the Five Most Common Gym Injuries and listed the bench press as a common shoulder injury (Men’s Fitness).

Many have been injured or killed from being crushed under the weight which they are lifting. Our solution was to design and build an affordable, Self-Spotting Bench Press Spotter for an Intermediate users that will take the weight off the lifter once he/she is no longer able to lift the weight.

Background Research
❖ Analyzing forces associated with lifting
❖ Cost effective materials to be used
❖ American Welding Society Standards
❖ ASTM fitness equipment standards
❖ Types of Lifting Devices or Mechanisms
❖ Standard Bench Press design and Ergonomics

Objective
To Design, Fabricate, and Test the Self-Spotting Bench Press to minimize injury.

Conceptual Designs:
Study 1: Lifting Weights off User
❖ Pros:
  ➢ Avoids injury
  ➢ Strong
  ➢ Sensor Precision
❖ Cons:
  ➢ Critical on timing
  ➢ Complicated design
  ➢ Expensive
  ➢ Restrictive lifting

Study 2: Bench dropping below frame
❖ Pros:
  ➢ Simple design
  ➢ Avoids injury
  ➢ Lifter dictated timing
  ➢ No electronics purely mechanical/hydraulic
❖ Cons:
  ➢ Struts are the weak link
  ➢ Weight distribution on struts

Design Calculations:
Calculations: Bench Seat Free-Body Diagram
❖ User’s Body Force: 7.32 lb/in = 300 lbf
❖ Cylinder Max Allowed
  Capacity: 300 lbf
❖ Max Allowable Barbell: 242.5 lbf
❖ Failure point of Cylinder: 600 lbf (each)
❖ \( R_A = 298.8 \text{ lbf} \) and \( R_B = 243.9 \text{ lbf} \)
❖ Factor of Safety: 2

Calculations: Barbell Rest
❖ Barbell Weight: 145 lb each side
❖ Max Allowable Bench: 290 lbf
❖ \( R_A = R_B = 72.5 \text{ lbf} \)
❖ \( M_A = M_B = 344.4 \text{ lb} \cdot \text{in} \)

Conclusions/Improvements
• The design prototype was a success and eliminates the need for a spotter to avoid injury to the lifter;
• Use of hydraulic cylinders rather than pneumatic-spring cylinders for added stability;
• Reduce weight of design bench by use of lighter weight materials; and
• Minimize design dimensions

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