WELCOME

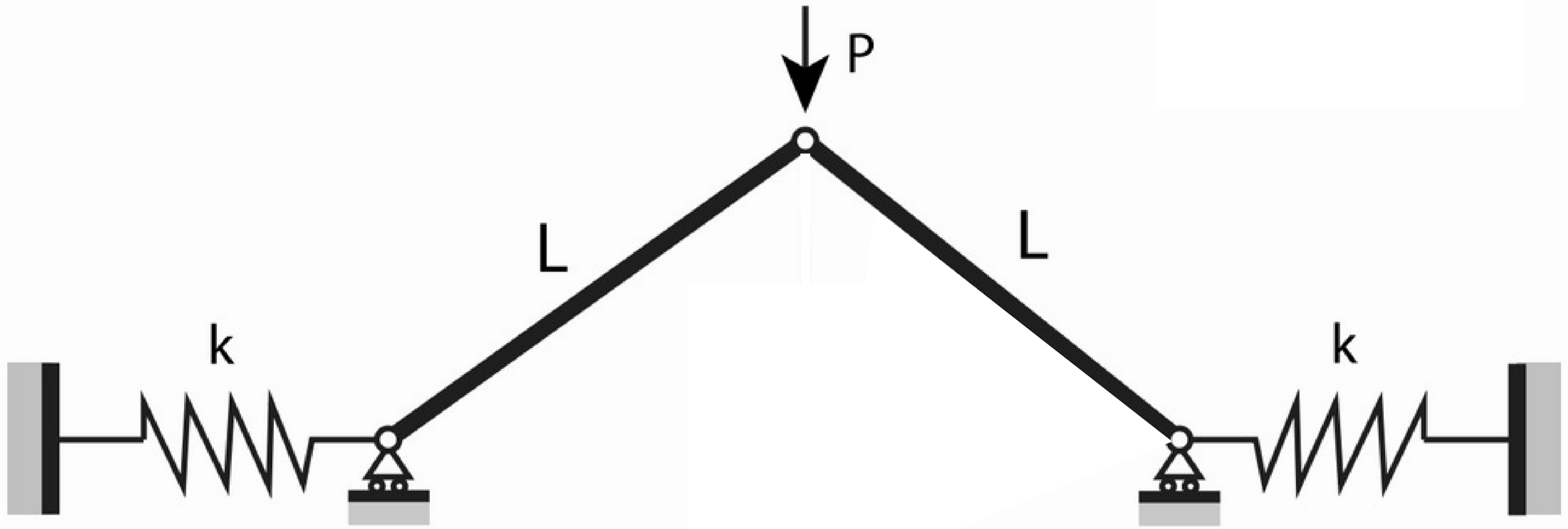
AS2070 PROJECT

GROUP B (a.k.a. Back Benchers)

AE23B011, AE23B031, AE23B045,
AE23B051, AE23B107

TOPIC

Snap-Through Buckling in Link Model Arch

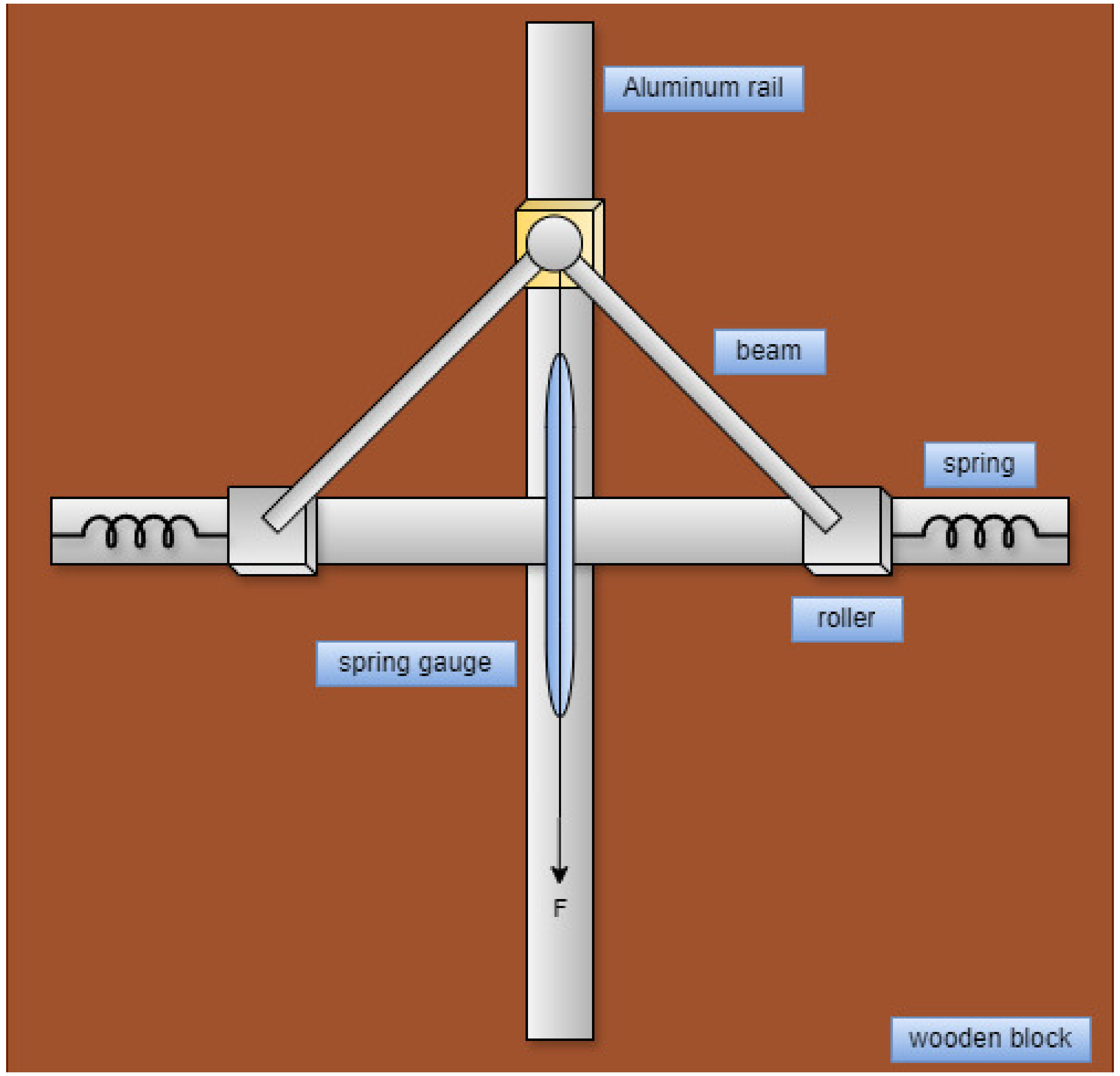


AIM

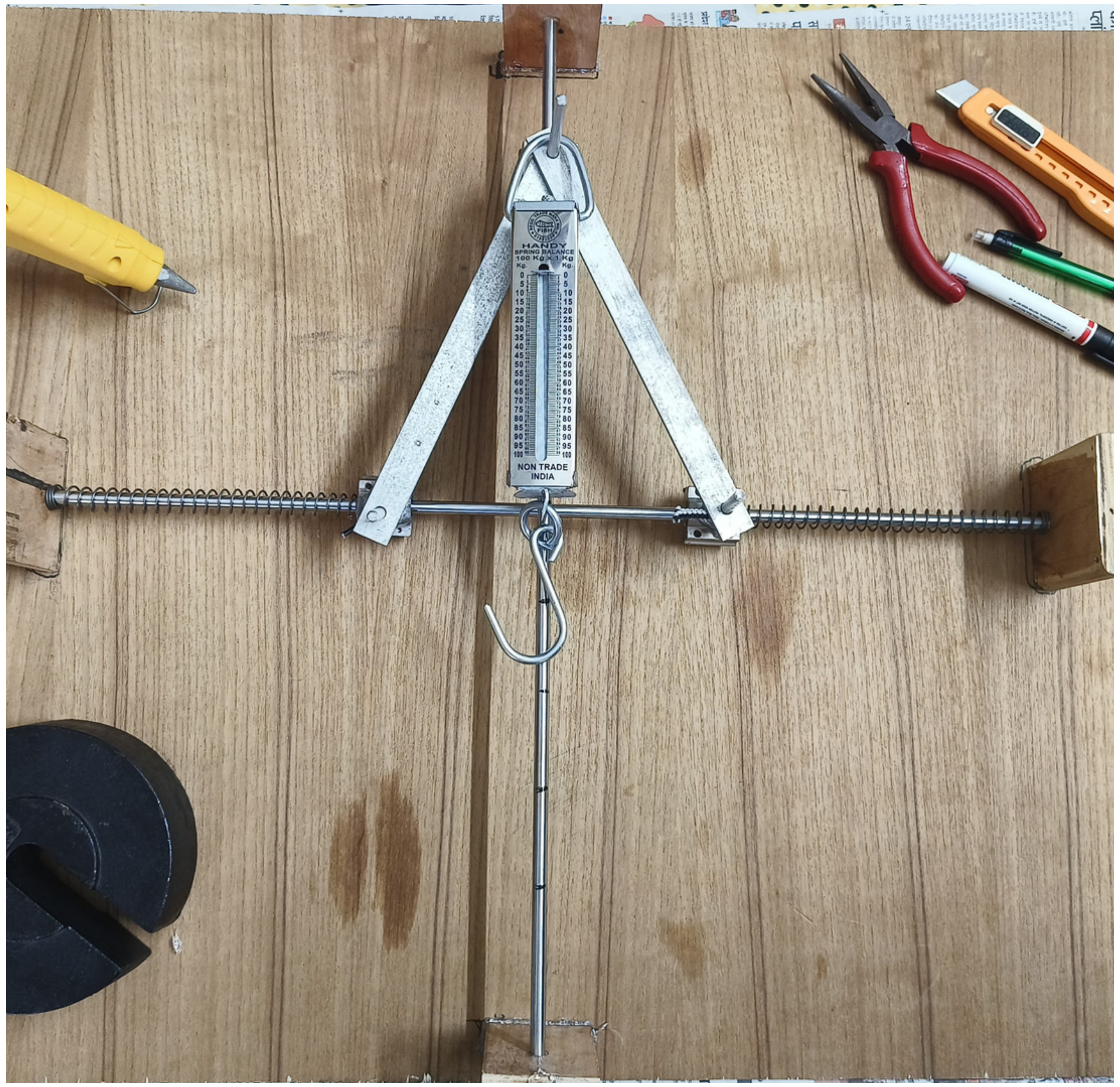
This project examines how a SDoF link-model arch behaves under increasing applied force.

The focus is on the sudden snap-through, a rapid transition from one stable state to another, when the applied force reaches a critical point.

SETUP

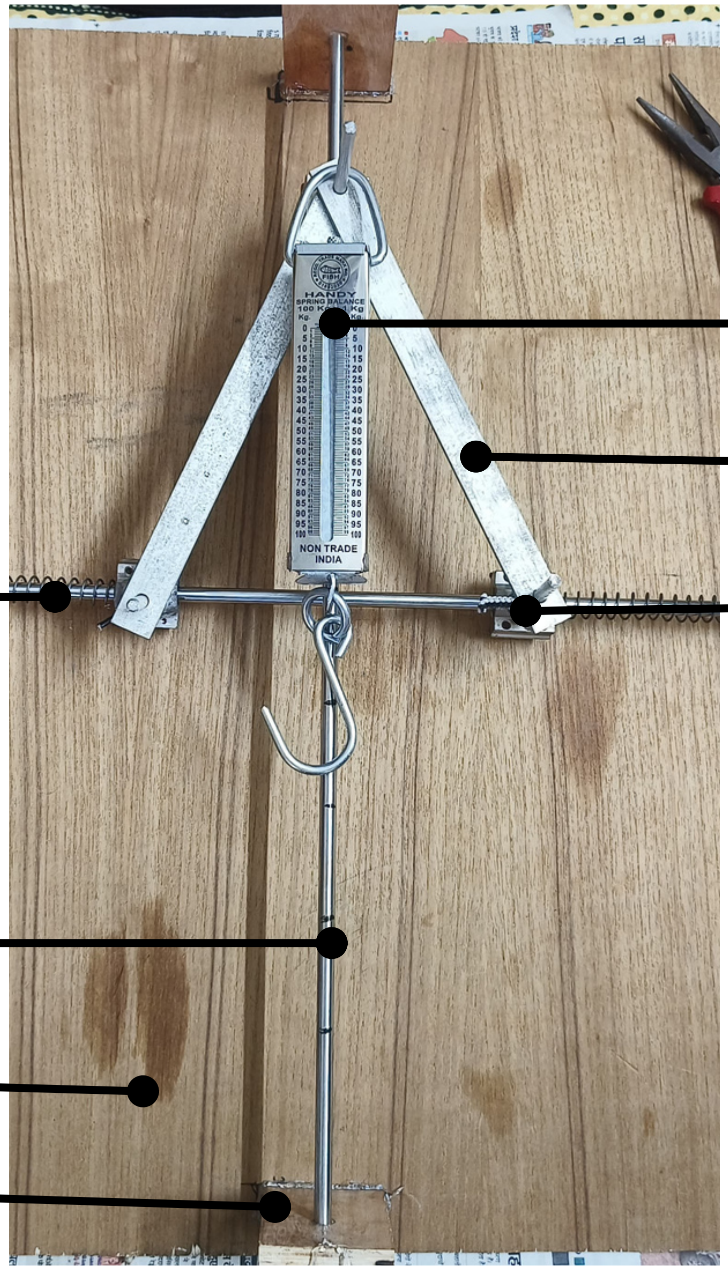


Schematic



Experimental Setup

APPARATUS


spring guage
aluminimum beams(x2)
spring (x2)
roller (x3)
steel rod (x2)
wodden base
wodden side support(x4)

EXPERIMENT OUTLINE & PROCEDURE

The experiment involves plotting the applied force F against the vertical displacement y.

Starting from a positive displacement (y_o = 21.5 cm) , the force is gradually increased until the arch snaps to a negative displacement.

Force and displacement readings were taken at mutiple points between intital displacement and snap through (for both positive and negative inital setup).

THEORY

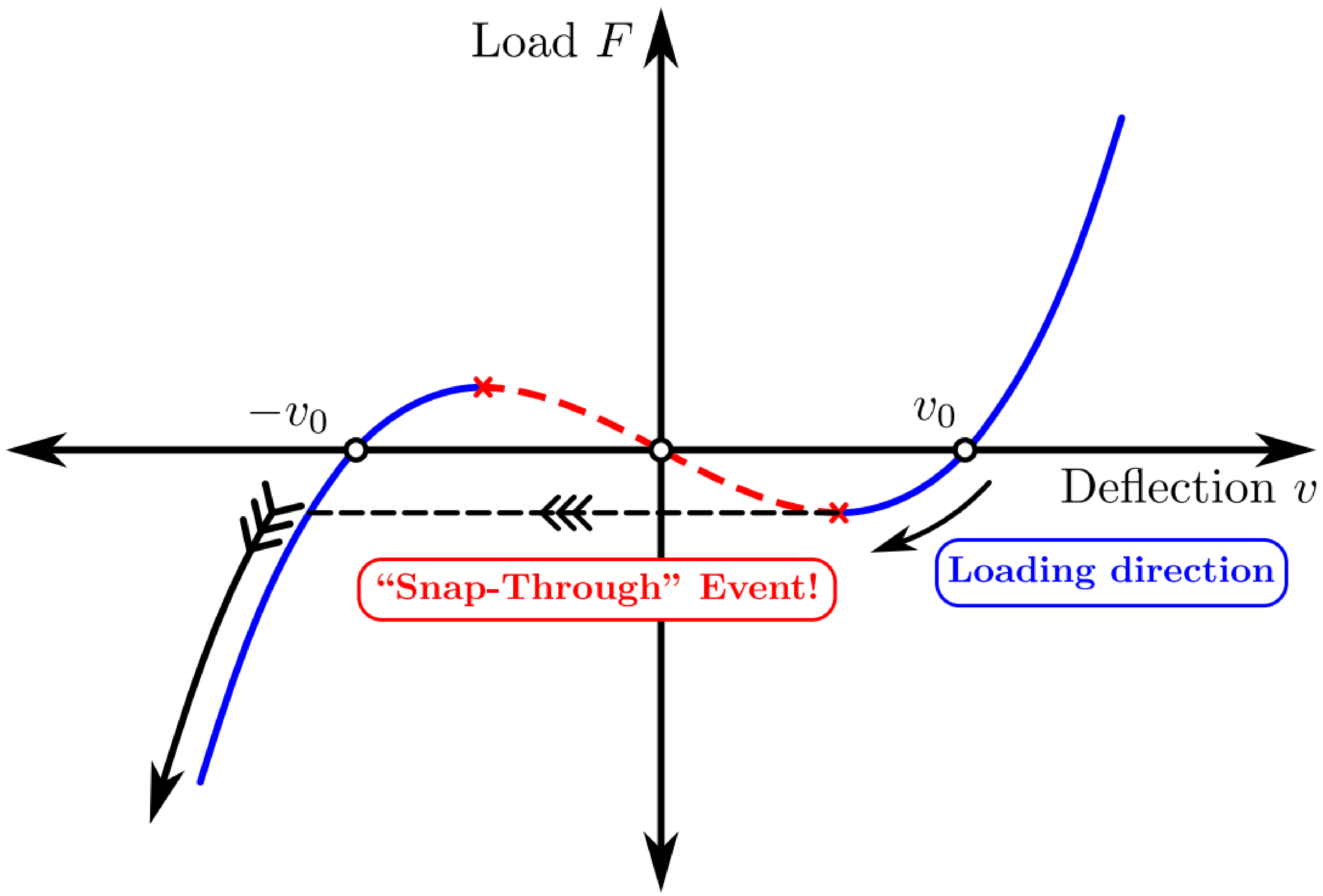
$$V(y) = k\left(\sqrt{L^2 - y^2} - \sqrt{L^2 - y_0^2}\right)^2 + Py$$

differentiating this w.r.t. y gives:

$$P_{equil} = 2k\left(1 - \frac{\sqrt{L^2 - y_0^2}}{\sqrt{L^2 - y^2}}\right)y$$

- Snap-through buckling is a nonlinear instability where a structure suddenly jumps from one equilibrium position to another when a critical load is reached
- In the link arch model, two rigid links are connected by a hinge and supported by springs, forming a shallow arch.
- This behavior is characterized by a distinctive S-shaped load-displacement curve, showing a sudden drop in load at the snap-through point
- The system can have two stable configurations, which defines the bistability of t0he configuration.

THERORETICAL CURVE



EXPERIMENT PROCESS

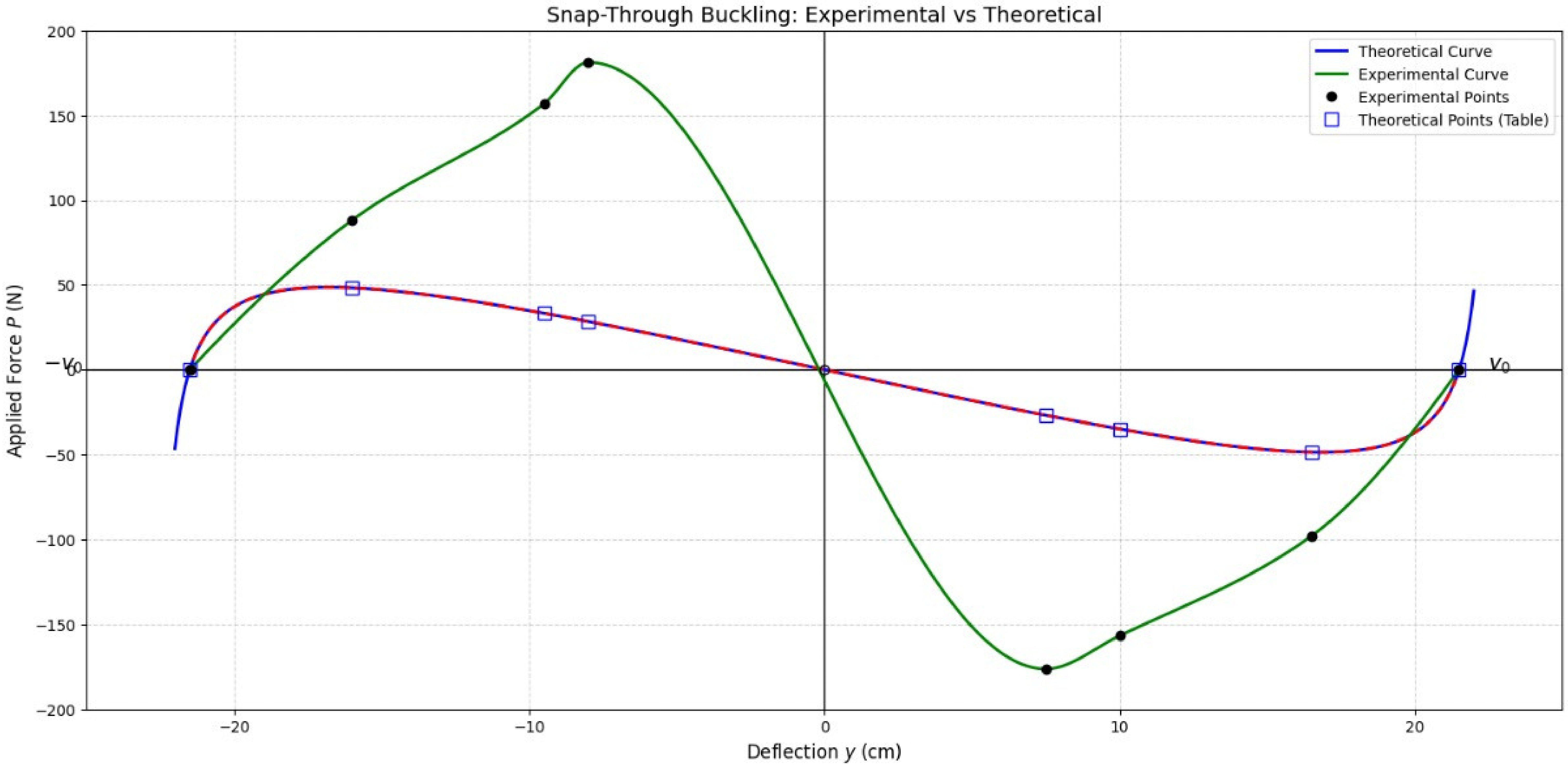
EXPERIMENTAL DATA

Table 1: Experimental and Theoretical Force-Displacement Data

Disp. y (cm)	Applied Force (N)	Theoretical Force (N)	Difference (%)
16.5	-98	-48.6	50.4
10.0	-156.8	-34.9	77.7
7.5	-176.4	-26.8	84.8
-8	181.3	28.5	84.3
-9.5	156.8	33.3	78.7
-16	88.2	48.3	45.2

Applied force was measured using spring guage

EXPERIMENTAL PLOT



SOURCES OF ERROR

Measurement Accuracy: The spring gauge has limited precision, which affects the accuracy of force measurements, especially at critical points like near the equilibrium points.

Friction Effects: There was friction in the system, due to absence of ball-bearings in sliders, affecting the horizontal movement of the beam ends and altering the force-displacement relationship.

Alignment Issues: Misalignment of components due to heavy force needed, particularly the central hinge and end rollers, introduced the additional constraints for the model.

Readings: During snap-through, the displacement changes rapidly, making it challenging to capture the exact behavior with manual measurements.

CONCLUSION

- The experimental setup demonstrated bistability with two distinct equilibrium configurations, with a snap-through between these two stable equilibrium positions.
- The force-displacement relationship showed qualitative agreement with theory, with both forces increasing with decreasing displacement, though quantitative discrepancies were observed.

IMPROVEMENTS IN SETUP

- Reducing the friction effects in the model using better rollers
- Use digital spring gauge instead of manual weight stacking or incremental loadings
- Use of less stiffer spring so that the required load for snap through could be decreased, hence keeping whole setup stable
- Use of proper hinges at the joints.

ACKNOWLEDGMENTS

We would like to thank

- TA Senthil : For his feedbacks and inputs for setup and experiment,
- Central Workshop: For helping us with drilling and welding required for assembly of setup,
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- Prof. Nidish: For his guidance (~~hopefully good grades as well~~)

THE END
THANK YOU