# Flowstate Knee Brace Supports

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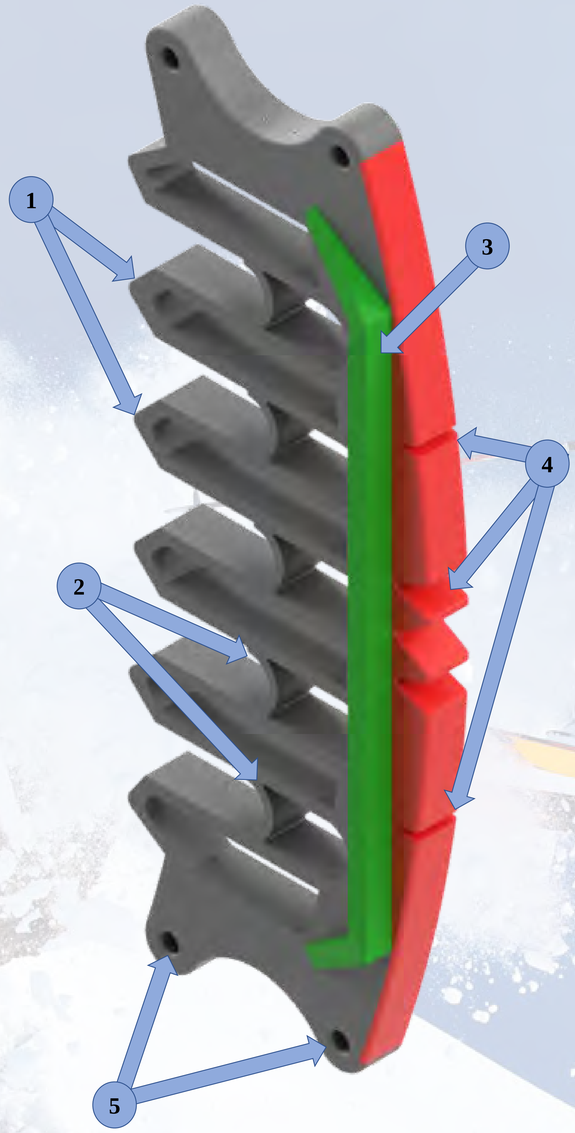
## Introduction:

Many people experience knee problems and require time to recover after an injury or surgery. Physical therapists can recommend a knee brace to help prevent further injury, but many available knee braces are bulky, uncomfortable, and uncooperative. Having poorly fitting knee braces can increase recovery time and prevent people from living an active lifestyle.

## Goal:

Our side supports address the problems that arise in knee injury and recovery from osteoarthritis: swelling, pain, and instability. The design factors account for are lateral support, walking forces, and knee flection. Incorporating these design factors will aid support on the knee.




## 1 Tooth Design:

The teeth on the design add a dampening to the bend of the knee to help users fluidly bend. Accomplished by having the teeth increase stiffness when bent; by hitting each other. The teeth points are angled to bend acutely in full flexion, seen in the image below.

## 2 Tooth Connections:

The connections arcs on the teeth allow for a spring-like bend while keeping each tooth from splaying and crossing each other. Seen in the image below.

## 3 Lateral Support:

The added support on the lateral face of the side support is based on an I beam, creating lateral stiffness in the knee brace; without adding bending stiffness. The first iteration would collapse on itself when too much flexion was present, seen in the FEA 1 image. The added lateral support reduced the buckling and increased the lateral stiffness.

## 4 Living Hinge:

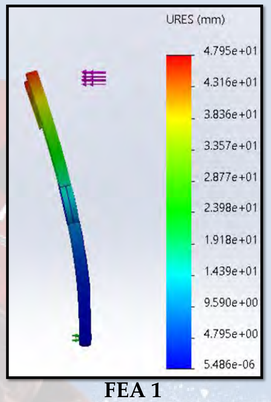
The five cuts allow for a natural bend to complement the elastic behaviors of the posterior teeth that act as a spring; the three largest cuts in the center aid natural knee movement.

## 5 Mounting Method:

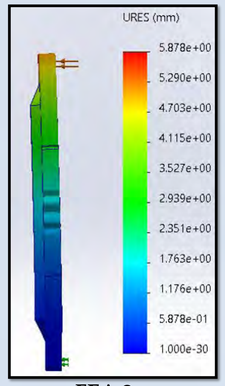
Adaptable mounts fit #10 bolts using quick-releasing wing nuts. Spaced 2" apart, they can mount to a customizable leg band, seen below.

## Testing:

**Finite Element Analysis (FEA):** During a preliminary a motion capture (MOCAP) study the maximum lateral force found was 18 Newtons. We minimized lateral displacement force on our finalized design through finite element analysis, resulting in a displacement of 5.8 mm, FEA 2 of displacement compared to 4.8 cm on first iterations, FEA 1.




FEA 1




FEA 2

**Preliminary Motion Capture (MOCAP):** In the preliminary MOCAP study knee brace side supports designed by a third-party engineering company, High Rustler, was tested to get a base line forces on the knee. This testing consisted of participants doing three sets of squats three times per set. The participants would have each foot on a different force plate. The MOCAP study found that the braced leg had higher force readings, meaning participants favored the braced leg.

**Second Study:** In the second MOCAP study, testing was repeated the same as the preliminary study with the side supports shown. Resulting in equal ground forces on each leg, with improvements on vertical offloading, while not hindering natural movement.

## Conclusion:

Our knee brace support will aid the consumer by offloading the knee, providing lateral support. The knee brace side support will allow for stabilized knee motion.

## Future Work:

The knee brace side supports in the future will be incorporated with a thermal system. The knee brace and thermal system will be integrated together into a neoprene sleeve for added compression. The future side supports should include stronger material