

## 3DP optimized buckle

 aiber

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### Summary

partially parameterized, 3DP optimized, dovetail style buckle

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Tags: [buckle](#) [center](#) [release](#) [3dp](#) [dovetail](#) [optimized](#)  
[parameter](#)

### Prior art

- a lot of 3DP buckles I found still required supports, often because they were simply side release buckles, whose typical design require

supports & work better with the better (relatively speaking) isotropy afforded by injection molding

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- even the **robust buckles model** still requires support

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- this **design** doesn't require support, but I had some doubt about the strength – by appearances, a bunch of load goes through layer

adhesion across a relatively small perimeter (unless printed at 100% infill, in which case it's a relatively small cross section)



- this **center release buckle** is a lot better than the previous, but still relies on layer adhesion for strength
  - note: at some point there is sufficient layer adhesion that it is no longer the limiting factor in strength





## Summary

- this design was intended to be more of a thought experiment & as of 2024-04-01, I have no real plans to print & test it
- [related design of mine, terminating in a hook](#)
- all versions prior to V2 are very exploratory & probably not functional

## Considerations

- provisions for webbing, much like this other [design of mine](#)
- ease of release & connection
  - this is doubly important for connecting straps under tensile load, where a twist lock could be very cumbersome
  - [twist lock example](#)



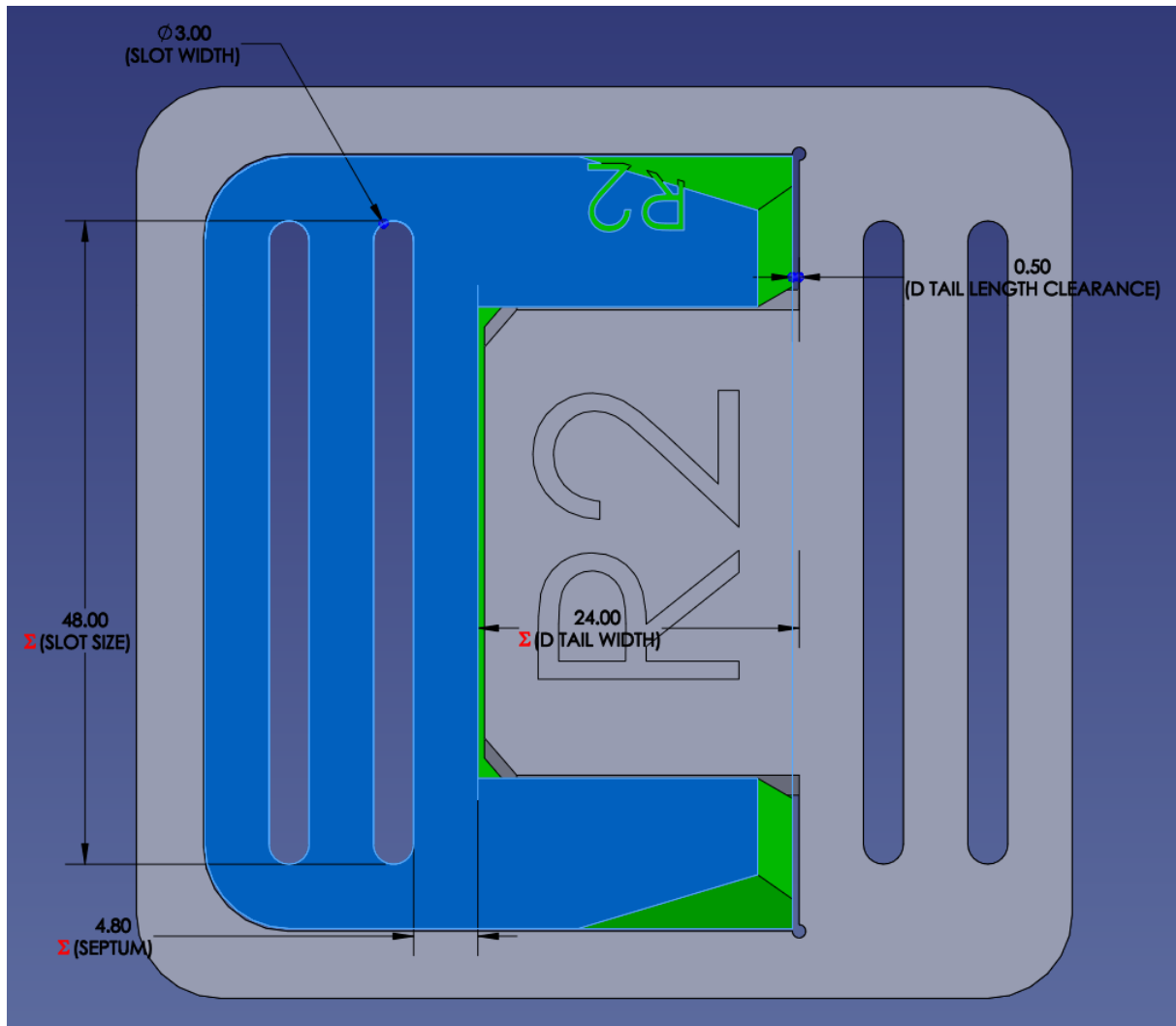
- 3D print optimized
  - no supports
  - strength
    - stresses should be located in favorable scenarios
    - snaps & flexures tend to work much better in plane – flexures should be printed parallel to print bed
- parameterized
  - design largely driven from few dimensions

## Parameterization

- revisions 1-2, at least, use the slot length as the principle driver for nearly all other dimensions

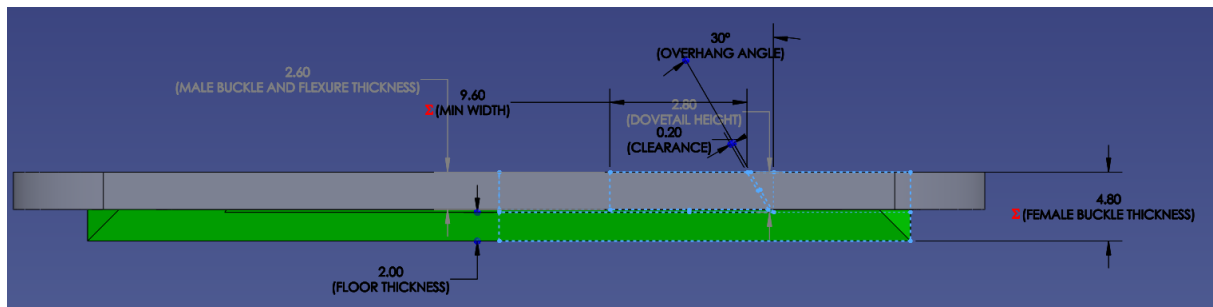
## Revision 2

- note the 0.5 mm D TAIL LENGTH CLEARANCE on both sides ensures the snap latches over (later discussed)
- inspiration for this design borrowed from my previous work [here](#)



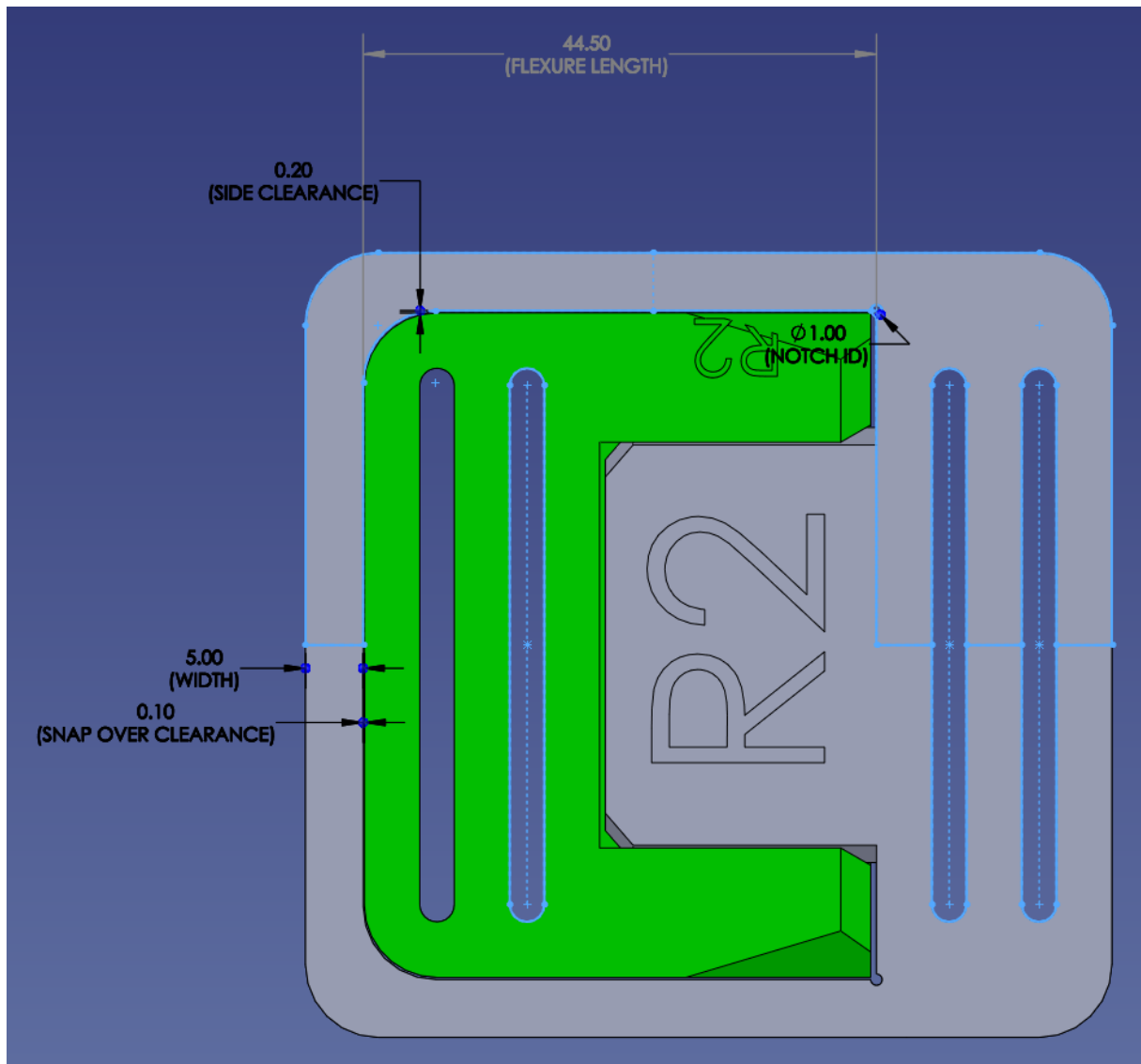
## Dovetail profile

- to fasten the 2 parts together, we need to immobilize all 6 degrees of freedom
- dovetails are a great, very strong way to immobilize 5 DoF
- furthermore, dovetails don't require supports
- in this embodiment, 30 deg overhang angles are used



## MALE plate

- the last DoF, translation, is locked by the use of a loop snap fit
- the flexure length is 44.5 mm, as shown below
- in this way, the stress is tensile when the joint is loaded normally
- this is advantageous because little bulk is required to achieve considerable tensile capacity for typical 3DP filaments
- the clipped end is held in shear relative to the 2 legs which form the loop
- the compressive stress borne by the FEMALE plate is across a large face that must exist anyways to achieve the basic function of connecting to webbing
  - in thinking about this problem, pretty much any other method of retention requires an abrupt change in cross section across the thickness of either plate, which then means layer adhesion carries a more significant fraction of the load
- releasing this buckle is as simple as flexing the “latch”



## Challenges with side release architecture

- I eschewed side release buckles for a number of reasons
  - snaps being released by squeezing (like the typical side release buckles) concentrate stress across small lands of adhered layers

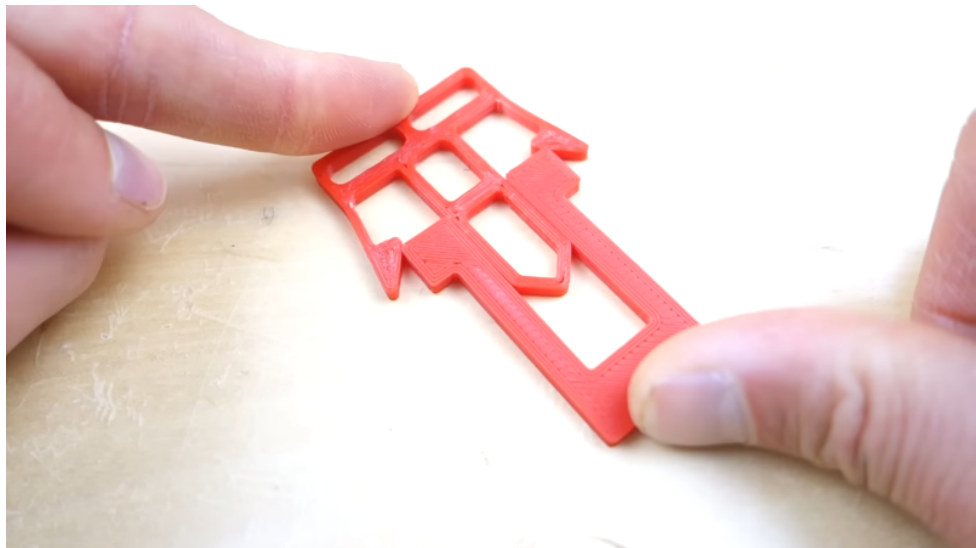
& require supports to develop the enclosed cavity which immobilizes the same 5 DoF as dovetails do

■



- snaps released by spreading suffer from a usability problem: it's no longer a 1 handed affair to spread the snaps to disengage – example [here](#)
  - without some other mechanism to make it a 1 handed affair (which could be more parts & complexity), ease of use is quite poor

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## Future improvements

- male & female plates are not uniformly thick & consequently webbing sits at different heights under tension
- ease of connection
  - the layout as shown presents the flexure first, then the dovetail second
  - it would be best to present the dovetail first immobilize more DoF sooner
  - still not as good as an injection molded side release buckle



- a lot of side release buckles are symmetric in that either side can be rolled 180 deg (about the axis of connection/disconnection) & still latch correctly
  - this buckle, as of 2024-04-03, given the way the webbing is supposed to route, precludes the latch from working in both orientations

## Model files



**REV 1**

3 files

**buckle-center-release\_r1.sldprt**

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**buckle-center-release\_r12.sldprt**

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**buckle-center-release\_r11.sldprt**



**REV 2**

3 files

**buckle-center-release\_r2.sldprt**

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**buckle-center-release\_r2.sldprt**

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**buckle-center-release\_r2\_2\_v.stl**

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