The Beehive Home

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CIV 340 - L02

The ‘Hive

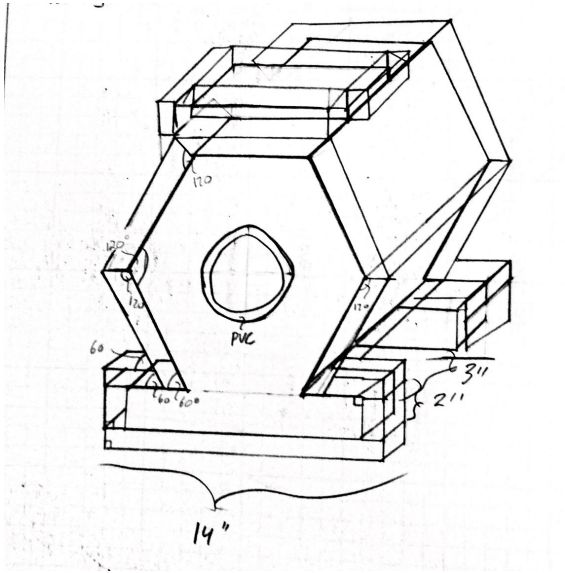
- Colorful, cozy refuge for ground dwelling birds, like the mourning dove

- Can be used by any bird small enough to build a nest in the opening

Kirby Collins – PlacesAroundFlorida.com

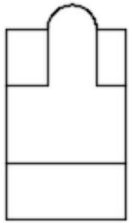
Cephas - Wikipedia

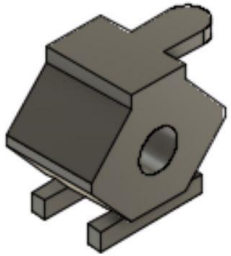
Schematic

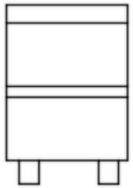


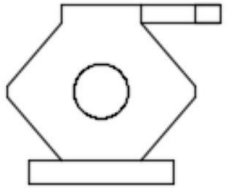
Initial Design
Volume = 0.3158 ft^3

Final Design



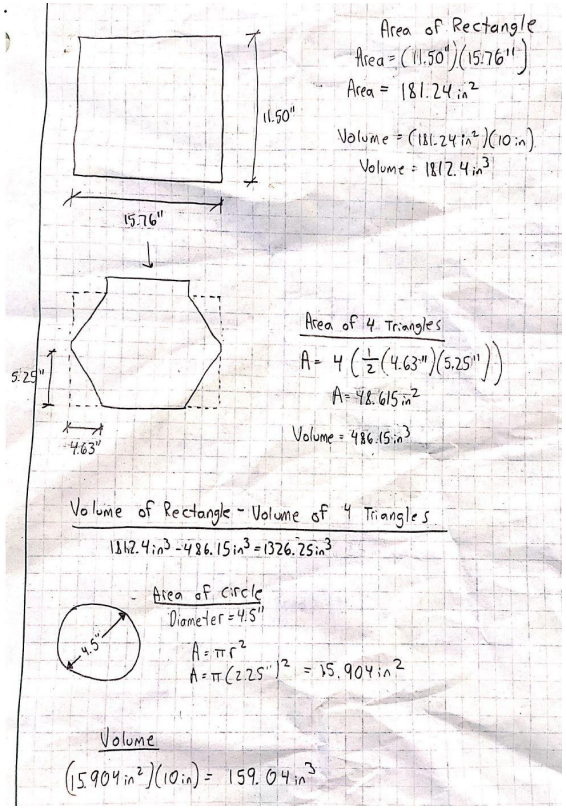


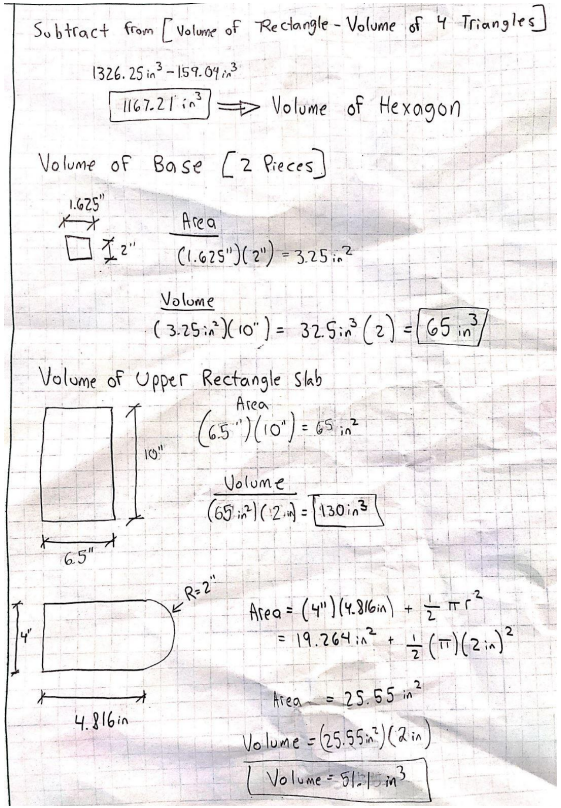


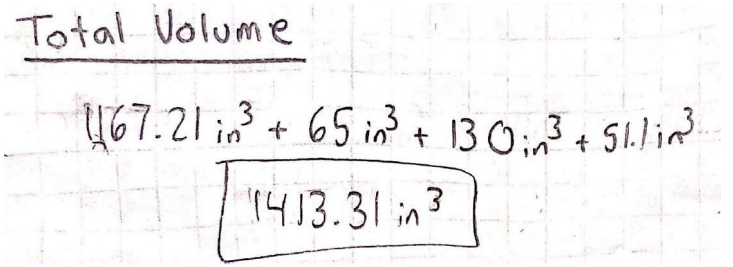


Final Schematic
Volume =0.817 ft^3

Final Volume Calculations



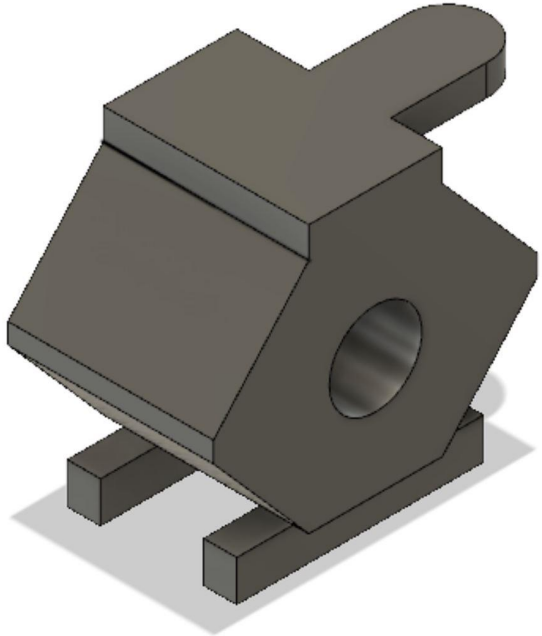




Final Schematic
Volume =0.817 ft^3

Component Stresses

- Normal Stress
  - Caused by load of own self weight
- Shear Stress
  - Large amount of shear in the connection between the wing and the top of the hive
- Bending induced Normal Stress
  - Main body is on two supports and acts as a simply supported beam
- Torsion induced Shear Stress
  - Asymmetric load on the top causes a torsion

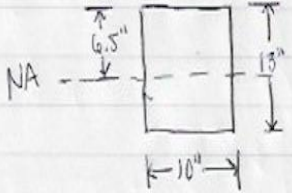


Normal Stress Due to Bending

* Assume density of 150 lb/yd³

$$\text{Density} = 150\ \frac{lb}{yd^3}\left(2.14\times10^{-5}\ \frac{yd^3}{in^3}\right) = 0.003215\ lb/in^3$$

* Assume rectangular cross-section
  ⇒ Cross Section



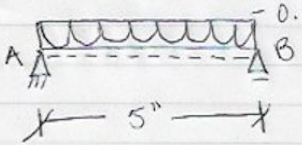
$$A = 10" \times 13" = 130\ in^2$$

$$I = \frac{1}{12}bh^3 = 1830.83\ in^4$$

* Assume uniform distributed load

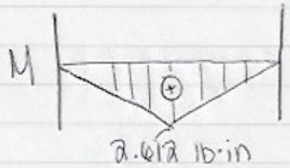
$$\text{Distributed Load} = (130\ in^2)(0.003215\ lb/in^3) = 0.41795\ lb/in$$

* Assume hive acts as a simply supported beam



$$R = 0.41795\ lb/in\,(5\ in) = 2.08975\ lb$$

$$\therefore A_y = B_y = 1.045\ lb$$



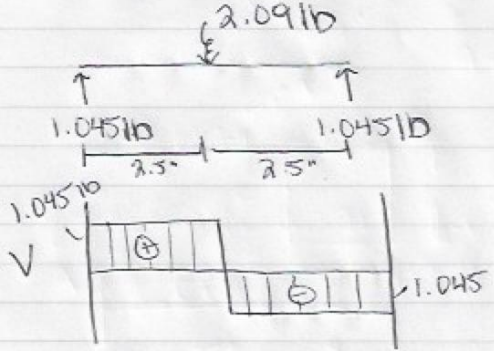
⇒ Stresses induced by bending

$$\sigma = -\frac{My}{I}$$

$$\sigma = \pm\frac{2.612\,(6.5)}{1830.83} = \pm 0.0093\ psi$$

Normal Stress

From moment calculations ...



⇒ Shear along the beam (hive) will cause normal stress in the column (stand)

Cross-section for stand →

$A = 2" \times 2" = 4in^2$

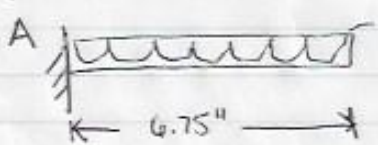
$$\sigma = \frac{P}{A} = \frac{1.045lb}{4in^2} = 0.26\ psi$$

Shear Stress

* Assume wing is a rectangular prism

$A = 2" \times 1.5" = 3 in^2$

$q = (3 in^2)(0.003215\ ^{lb}/_{in^2}) = 0.009645\ lb/in$



Shear @ Connection

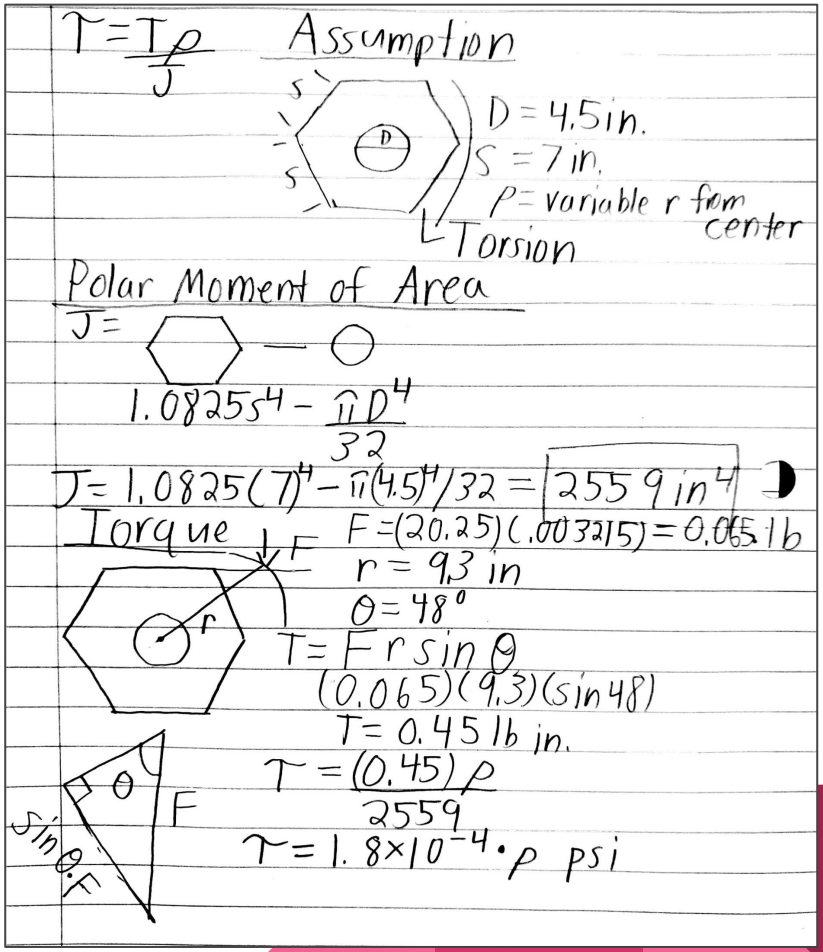
$V = 0.009645\ ^{lb}/_{in}\ (6.75\ in)$

$= 0.065\ lb$

Shear Stress Due to Torsion

- Our model's cross section was did not include top rectangle for ease of calculating polar moment of inertia J.

- Variable rho(ρ) represents the radius at which the shear stress occurs. It shares a linear relationship with torsion induced shear.



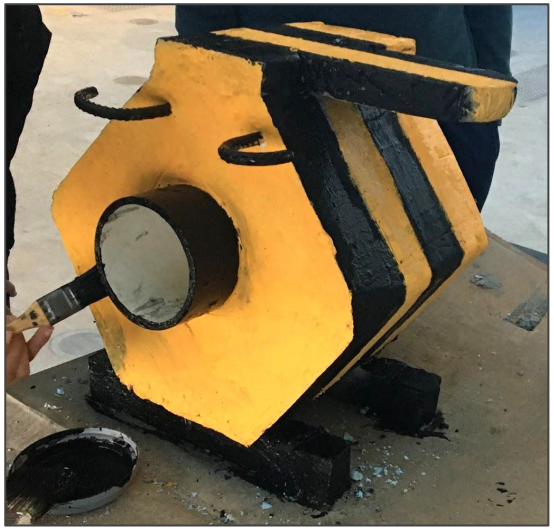
Mix Design

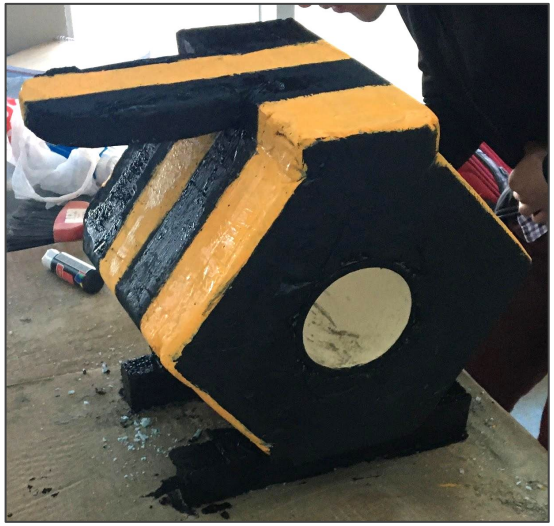
- A slump of 3 - 4” was chosen due to the small nature of our mold’s elements
  - A larger slump makes the mix more workable, allowing us to move the concrete into the small crevasses of our mold
- ⅜” maximum aggregate size
  - Aggregate must be smaller than the holes in the chicken-wire used as reinforcement (¾”)
- 3000 psi compressive strength
  - Ensures the stands can support the large volume of concrete above it
  - The hive will be placed outdoors and may be subjected to large amounts of snow

Mold Design

- Polystyrene Foam boards was used for the base of the mold
  - We were not able to cut large angles into wood with the tools provided, so foam boards were used instead
- Each piece of foam was cut individually and hot glued together
  - We also used pieces of wire to connect more vital pieces of the mold for support
- Duct tape was used to cover the gaps between the foam pieces and prevent leaking of concrete and smoother edges

Finished Product





Ideas for Improvement

- Mold
  - Foam
    - Invest in a slimmer knife or cutting tool that can make larger angles than 30 degrees
    - Find a softer foam, allowing for easier cutting to create sharper angles that are less rounded at the cut
  - PVC in the center did not come out due to concrete shrinkage
    - Option One: Cut PVC so that it becomes flush with the Beehive
    - Option Two: find a more viscous oil so it won't drip to the bottom, or be washed by the mix that has a higher water concentration
    - Option Three: Forego the PVC pipe, and make the hive hollow
- Design Mix
  - Coarse Aggregates
    - The coarse aggregate size limited the minimum size of the house, leading to a very large structure

Ideas for Improvement cont’d

- Curing Plan
  - Foam
    - The foam allowed the excess water in the mix to drain out, allowing the concrete to cure nicely
  - PVC
    - While curing attempt to slowly turn the PVC pipe to unlatch it from the concrete as it cures, and use a spray bottle to keep the concrete moist while doing so to prevent cracking
- Tensile Reinforcement
  - Wing Reinforcement
    - Finding smaller wires, or utilization of Grace Microfibers can increase the tensile strength in the wing where it is difficult to place mesh or rebar

Future Designs

- Make the birdhouse smaller and lighter
  - Will allow the structure to be hung from a tree
- Incorporate wood within the structure for post molding attachment
- Create a more hollow center to create more room for the bird

https://www.pinterest.com/pin/278589926918952455/