Campground Cabin

PROJECT DESCRIPTION

The senior design team was challenged with designing a cabin that would comfortably sleep up to 16 campers, provide efficient heating and cooling, use sustainable materials, require low maintenance, be cost-efficient, and have a rustic appearance. The design process included four students, one faculty mentor (P.E.), the sponsor, and a licensed architect. The cabin design included architectural, structural, mechanical, electrical, and plumbing engineering.

ARCHITECTURAL DETAILS

The architectural floor plan is a 24-foot by 32-foot cabin with an eight-foot front porch. The plan includes a small closet space for an electrical panel and supplies, a partitioned counselor's room, an open floor plan for the main room with bunk beds and accompanying dressers, and windows for natural light and ventilation. The cabin also has a restroom that includes ADA-compliant grab bars, sink, and toilet, as well as adequate wheelchair space. In addition, the cabin includes an ADA-compliant entrance and egress. The cabin exterior has a board and batten finish and an exposed truss system, giving it a rustic appearance and open feel. Green, corrugated metal panels will be used for the roof.

MULTIDISCIPLINARY PARTICIPATION

ARCHITECTURAL DESIGN:
- Floor plan and finish products and materials
- Bathroom features according to ADA standards

STRUCTURAL ENGINEERING:
- Design of truss system and purlins
- Wall framing (custom end walls):
  - Design wind pressure ~ 28 psf
  - 2"x6" wood studs @ 24" O.C. (or custom)
- Floor framing:
  - 2"x8" wood joists @ 16" O.C.
  - Girders built up of (4) 2"x8" wood members
- Stepped footing and CMU foundation wall with interior piers and front concrete porch

MECHANICAL ENGINEERING:
- Heating and cooling calculations
- Contacting PTAC unit dealers
- Placement of PTAC equipment in coordination with client requests
- Bathroom ventilation served by wall fan

ELECTRICAL ENGINEERING:
- Lighting plan, receptacle, and panel board layouts
- Communicating with suppliers for choice of optimal lighting products and receptacles for PTAC units and water heater
- Dimmable switches for corresponding lights and exterior lights

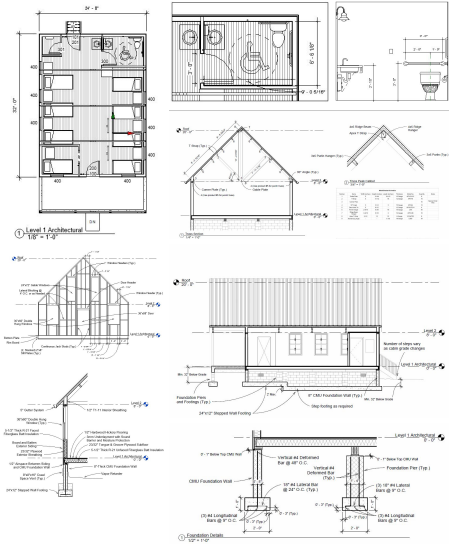
PLUMBING DESIGN:
- Gravity fed sanitary drainage system
- Toilet and sink placement for optimal supply and drainage pipes
- Pipe layout and riser diagrams
- All ADA-compliant vanities and amenities

SUSTAINABLE DESIGN

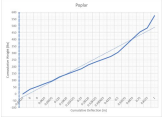
Wood used to construct the cabins will be sourced from forestland on the campground, with exception of the interior wall sheathing and pressure-treated elements, such as the sill plates and porch posts. The wood will be cut, kiln-dried, milled, and finished on site. White Oak and Red Oak species will be used for the trusses and Poplar for the floor and wall framing. Hickory sourced on site will be used for hardwood flooring. Other wood products will be sourced on site of unidentified species, such as the board and batten exterior siding and the continuous ceiling boards. This sustainable design practice significantly reduces material costs and reduces carbon emissions from shipping lumber from off site.

RENDERINGS:

PLANS AND DETAILS:



TESTING AND VALIDATION:



KNOWLEDGE AND SKILLS GAINED

SOFT SKILLS:
- Collaboration:
  - Interdisciplinary
  - Sponsor, architect, and faculty P.E.
- Project leadership, scheduling, teamwork, and task delegation
- Constructive dialogue through public speaking and feedback

TECHNICAL SKILLS:
- Autodesk Revit: 3D modeling and construction document organization, setup, and detailing
- Wind analysis and design, including consideration of wind loading on discontinuous end walls
- Gravity load analysis and design, including dead, snow, and live loads on truss, column, floor, and foundation members
- Thermal load analysis and design
- Electrical load analysis and design
- Mechanical and electrical detailing
- Standard construction of residential-type buildings
- Written reports
- Cost estimating
- Generating material/product options and approving design decisions
- Experimental analysis and design validation

TESTING AND VALIDATION

The experimental testing process began with research of the ASTM standards for wood materials testing. After receiving three wood samples from the campsite (one for each species to be used in structural components: Red Oak and White Oak for the truss system and Poplar for the wall and floor framing), the team physically tested the load capacity of the White Oak and Poplar samples against their deflection levels. Taking load duration and lumber type (species and grade) into account, the resulting capacities were compared with the required loads applied throughout the cabin, and wood strength was back-calculated to confirm equivalent or higher grade than that assumed for design.

HEALTH, SAFETY, AND WELFARE

The cabin design is to be a secure and comfortable space for relational development between students, mentors, teachers, and friends. In regard to material, the cabin will be constructed with wood that is forested on land. This sustainable practice will be repeated with the numerous cabins built from this standard design. Finally, the cabin is expected to withstand varying and harsh conditions due to the completion of wind loading analysis, heating and cooling analysis, truss design and analysis, and more structural calculations to ensure a successful and reliable design. The public welfare is also enhanced by a successful HVAC and lighting design. The cabins and later developed campground may also encourage participation in outdoor activities and lifestyles.

REFERENCES

- American Concrete Institute
- American Disabilities Act
- American Society for Testing and Materials
- American Society of Civil Engineers
- American Society of Heating, Refrigerating, and Air Conditioning Engineers
- International Building Code
- International Residential Code
- *Mechanical and Electrical Systems in Buildings*, by Richard R. Janis and William K.Y. Tao
- National Design Specification for Wood Construction
- National Electrical Code
- Ohio Building Code
- *Structural Analysis*, by R.C. Hibbeler (Tenth Edition)