European BEST Engineering Competition

Case Study

Building the perfect survival shelter

404 SNF

19th to 21st of March

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1. Introduction

Problems such as climate change, natural disasters and human conflict have been forcing people to abandon their homes and temporarily live in shelters. As such, it's of paramount importance that these shelters are able to withstand a range of harsh conditions reliably, while also being easily deployable in various specific environments.

In this work, we answer some of the most pressing challenges in the creation and maintenance of such refuges, specifically taking into account extreme weather conditions such as those in Yakutsk, Russia. The shelter will provide protection against snow, rain, and wind, insulation during the winter when temperatures dip below -50ºC, as well as proper ventilation for the summer months when temperatures have been reaching 30+ºC due to global warming. Since the site will most likely be off-grid, energy generation and water filtration were also thought out in a way that guarantees that the refugees' basic necessities are met.

2. Structure and weatherproofing

2.1. Size

Our shelter has two layers. As shown in fig. 2, the external structure is a parallelepiped without the top plus a triangular prism without the base (on top). The parallelepiped is 4m (length) by 3m (width) by 2.20m (height) and the prism is 4m by 3m by 0.5m. Moreover, the internal structure is a parallelepiped with a removable top with 3m of length, 2m of width and 2.20m of height.

fig. 1 - outer layer

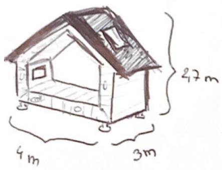

fig. 2 - outer layer dimensions

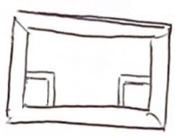

fig. 3 - inner layer

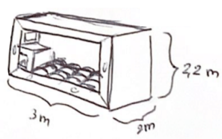

fig. 4 - inner layer dimensions and set up as sleeping room

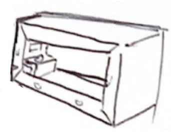

fig 5. set up as bathroom

fig. 6 - inner and outer layer

You can also observe three windows: two on the outer layer (roof and wall) and one on the inner layer (wall) (more about this on 2.2).

2.2. Constitution and weatherproofing

As Yakutsk is entirely built upon permafrost (soil consisting of earth, ice and permanently frozen rocks), the shelter must be constituted of materials that don't melt the permafrost, like wood or concrete. Taking this into account, the external layer is made of *Siberian Larch* - a waterproof, resistant to soil and environmental conditions wood, with great durability and frequent in the area. Between the wood planks, *Oakum* (tow), a type of rope, is added to make sure the shelter is entirely insulated. If this is not enough, snow can serve as a crude thermal insulator in conjunction with the rope. Each external module is elevated on metal feet that serve three purposes: protection against flooding, leveling the structure when on uneven ground, and further protecting the permafrost below.

On the other hand, the internal layer is made of polyethylene foam. It's easy to fabricate, absorbs only 0.01% of its weight in water, preventing moisture, and it's insulated (prevents loss of heat). Great for lower temperatures, characteristic of Yakutsk, but also adaptable to higher temperatures as the top is removable and there's an openable plastic window in the wall. Speaking of which, as stated on 2.1, there are two double paned windows on the external layer. The one on the top has natural lighting as its only goal. As such, it is not openable. The one on the side, directly next to the one on the inner layer, besides providing natural lighting, can be opened - allows ventilation.

One single shelter for 4 people could be constituted of 2 full modules (inner + outer layer) one of the modules could serve as a sleeping room while the other would serve as a WC.

2.3. Portability

Both the inner and outer layer are modular, allowing for scalability and ease of transportation and can be fully taken apart. The inner layer is extremely light weight, further improving portability. The seams where the modules meet must be carefully insulated when building the shelter.

3. Utilities

3.1. Water

Water, as an essential good, is used for bathing, cooking, domestic use etc...

Ice could be collected from the river and thoroughly cleaned. The ice would then be melted inside the shelter. The resulting water would be boiled and filtered using water filters. The water would then be potable and safe for domestic use.

The water we use for bathing also comes from the river, we would do it in an old fashioned way by filling water tanks.

3.2 Electricity Generation

Every shelter will need energy either to charge electronic devices, illuminate the space or power up heating and cooking appliances. As such a source of power is needed, and since oil is abundant in Russia it could be used as a way to power generators, which would then serve as the main energy suppliers.

3.3 Communication

A separate common area composed of four sections would be constructed (more on this on section 5) on site. In one of these sections a radio and fixed telephones would be available for use.

4. Social Concerns

4.1 Security, Comfort, Privacy

Security was one of our main concerns, we put all our efforts in bringing comfort to the people living in the shelter.

The shelter would be located at least 1 km away from the river and 10 meters above river level to be prepared against floods.

The shelter is protected against extreme weather conditions, and can maintain relative thermal comfort.

Last but not least, two doors (one for each layer) would be the basic security measure, the two layer design would also improve privacy as it provides better sound insulation when compared to single layer shelters.

5. Extras

- The separate area referenced in topic 3.3 would be composed of four areas (each isolated from another) the sections are as follows: bathing area, first-aid, communication, and canteen.
- The site could have a dedicated module where human waste collected from each individual shelter would be stored to later be sold as fertilizer, the money would then be used to help with maintaining the shelter.
- Every refugee would be offered a jacket that doubles as a sleeping bag, with adjustable sections and a detachable bottom.

6. Conclusion

In conclusion, the ideal shelter we came up with for 4 people in Yakutsk was designed to be welcoming for everyone. The shelter is safe, is prepared for extreme weather conditions (even future climate change conditions) and even though it's more expensive than usual (we came up with a high estimate of around 2500€ total cost per full module, but the real price would most likely be lower), we believe it's a viable solution in harsh climate zones where the bare minimum isn't enough.