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The Future of the Oxfam Emergency Shelter

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Shelter SES2 is an emergency shelter designed to house refugees in disaster situations. It was developed at Cambridge University by Pete Manfield and Tom Corsellis in 1998 (5). In 1999 the prototype was tested and refined by John Howard and John Martin at Oxfam who then approved it for deployment in refugee camps (6). It has been deployed in Algeria, Turkey and El Salvador. There is no single organisation that deals internationally with shelter, unlike food (Cafod) and water (Oxfam), so funding for this type of project is sporadic. For this reason shelters must be developed up to a useable standard before organisations become interested in using them or funding further development.

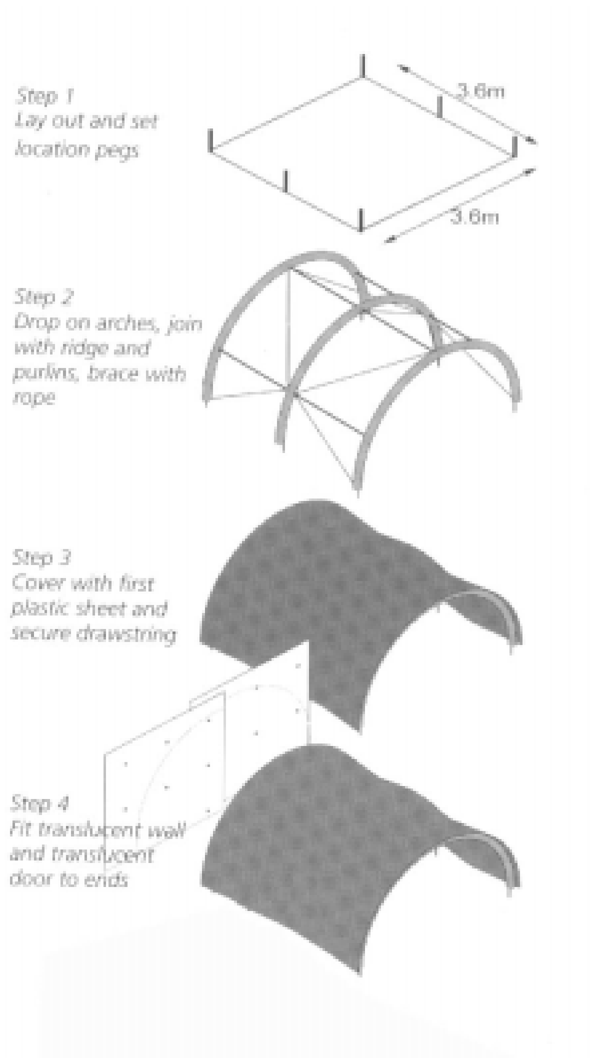


Fig. 1

The SES2 is a solution to a specific emergency refugee situation. It has been designed to be deployed after all other avenues of shelter have been exhausted. These included rebuilding existing homes, finding lodgings with relatives, staying with host families or in existing communal buildings. In the past shelter based refugee camps have sometimes stood empty because by the time the shelters have arrived, people have used these other solutions. The SES2 is designed to be a simple structure that can be supplied on demand in order to prevent a waste of resources. The materials used have been selected for their international availability as common building materials. This cuts down the lead time involved in getting the shelters to much less than that of conventional systems currently used by the UNHCR (United Nations High Commission for Refugees). These materials include MDPE piping that is used to carry water, scaffolding pole, tent poles, rope, reinforcement bar and Monarflex plastic sheeting. These can be obtained from a builder's merchant and reused or sold after the need for a shelter has passed. Materials can either be gathered in the country of need or packed up abroad and flown in. The sizes of parts in the kit-form version of the shelter are chosen to fit a 1.5m square air-freight palette. Fig.1 shows the method of construction for the on-site version of SES2 (Instructions for Kit-Form: Appendix B).

The shelter looks like a tent and shares physical characteristics with some temporary structures such as dome tents and horticultural poly-tunnels. This can be a benefit to the organisations using it because a camp made up of these will look less permanent. The shelter actually has a lifespan of at least six months before materials need to be replaced but if a camp looks temporary it is less likely to attract negative political interest (7).

The disadvantage of this design is that it can only house one family carrying out domestic activities. The smaller version is only useful for sleeping, as an adult cannot stand up inside it. The larger version accommodates standing, but large items such as salvaged furniture could make the space inside cramped.

For this reason the following experiments test a version of the SES2 made from five sections of pipe rather than four. This makes the shelter 3.6m wide but approx 4.5m long. Extra height is also gained making it 2.5m high. It is large enough to accommodate a land rover, bunk beds or considerable storage. It could also be used for communal activities such as a transit centre (refugee check –in), medical care or worship. While these experiments were being carried out, SES2 was shown to various aid organisations including UNHCR and MSF (Medicenes sans Frontiers). They are interested in using SES2 and would like larger versions to be developed.

This project involved the exploration of how to develop and communicate simple but essential design ideas. The structural nature, cost and durability of a limited palette of materials were tested. An attempt was also made to identify which stages of the construction process were essential and should therefore be included in a set of instructions to accompany a kit-form version of the shelter. This is based on Dudley's theory of explaining new technologies can be explained to those in vulnerable situations (3). He calls the essential information that must be communicated the 'Big Idea'. Without this information the technology will simply not work. In this case the 'Big Idea' is how to put the shelter up so that it protects people from the elements. The finer details of how to do this quickly and easily are 'secondary information' that may be lost in translation. For this reason secondary information should never be essential and it is very important to decide what is really needed to explain the 'Big Idea'.

Five Section Shelter Experiment#1

Aim

To build and evaluate the viability of a shelter made with five sections of MDPE pipe to create a larger version of SES2. (Specification : Appendix A) To note any problems encountered while using the existing kit in order to refine the construction process.

Hypothesis

The larger size is likely to rack more and need more rope for extra bracing. The odd number of pipe sections means that there is no of a ridge-pole. This may expose the roof to water pooling on it. The set of instructions for the SES2 will probably not need to be altered considerably to accommodate the larger size of shelter.

Method

This study uses the kit version which employs 1.5m sections of pipe rather than one 7.5m piece. For a larger shelter another section of pipe was added to each purlin frame. The sketches below show the method used to erect the five-section kit-form shelter. First 0.25m lengths of reinforcement bar are driven halfway into the ground to form the footprint (Fig. 2). A tent pole can be used to measure the distance from back to front but the side to side distance must be approximated. A 1.5m section of MDPE piping is slipped onto each of the rods (Fig. 3). Meanwhile three scaffolding pole connectors are slid into place on a tent pole. They have been drilled with special shaped holes to allow the pole through (Fig. 11).

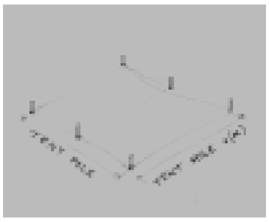
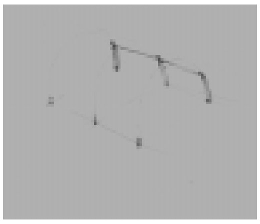


Fig. 2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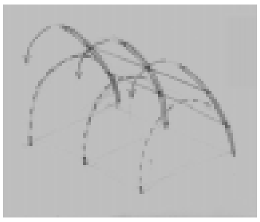
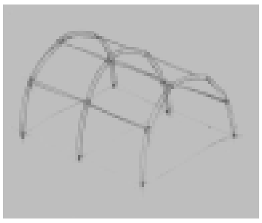


Fig. 4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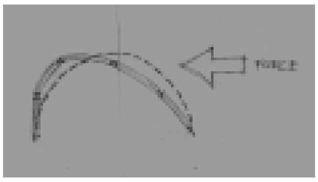
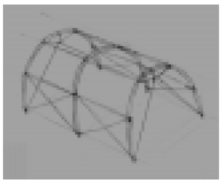


Fig. 6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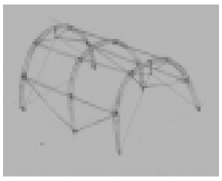
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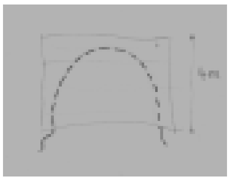
Fig. 9

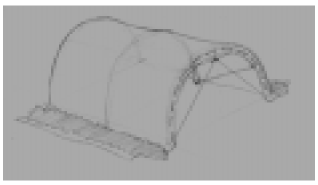
Fig. 10

Each pole has a screw in the end to stop it falling out of the connector. The end connectors are ‘blind’ so that the pole cannot go all the way through. Each connector is pushed inside a pipe so that the next section of pipe can be added. This is repeated until all five sections are in place (Fig. 4). The whole structure is then fixed in place by sliding the end pipes onto the rods in the ground (Fig. 5).

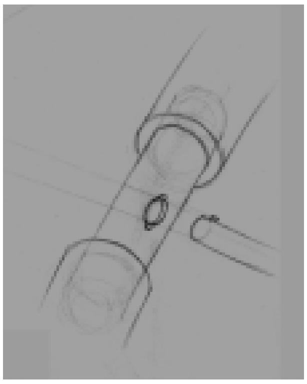

Fig.11

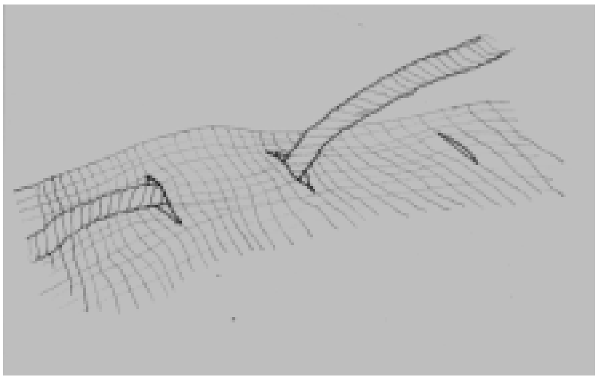

Fig.12

The extra section of pipe made the purlins very flexible and vulnerable to wind loads (Fig. 6). Rope bracing was added to counteract racking. Guy ropes are avoided as they can take up space around the shelter and can be dangerous. Simple knots in the rope can stand high loads for a long time, which makes this part of the process quick and easy. Less bracing is better in terms of cost, but also in terms of the longevity of the shelter. At joints involving many ropes, these can chafe against the Monarflex and weaken it over time (Fig.17).

Fig. 16

Fig. 17

Every point of the structure that could rack was braced initially (Fig. 7,13 +14), and then all but the essential ropes were removed (Fig. 8). The extra height and width created meant that bracing was needed across the front and back of the shelter, but this did not hamper access into the shelter. 9m of Monarflex was then threaded with rope along the edge and pulled over the structure. The ends of the rope are tied at the bottom of the outermost purlins and pulled tight, bunching the plastic over the pipe.

Fig. 13

Fig. 14

The extra width means that the Monarflex could not be used widthways to provide a back covering. Ways of cutting the Monarflex diagonally were explored, but this caused too much waste and could be a complicated idea to communicate. The solution was to turn the Monarflex 90º, stitch the rope through in a semi circle (Fig. 9) and push it under the main skin until the stitching could be seen inside. Quite a long skirt is left at the bottom to trench in. On hard ground the skirt can be weighed down with rocks or sand bags (Fig. 10).

<u>Results</u>

<u>Day 1: Construction</u>

There was approx 2” of snow on the ground with sleet falling throughout the day. Although the shelter is for hot climates, it is worth noting that it was more difficult to put up in cold and wet conditions. Monsoons are expected in some of the countries where the shelter would be used so rain is a relevant factor. The materials were slippery and the MDPE had become stiff making the whole process slower.

Marking out the footprint squarely can be inaccurate because it has to be done mostly by eye. A squint footprint can contribute to unequal stresses on parts of the structure. Some tools, extra to the kit, were needed to erect the shelter. A knife or lighter is needed to make holes or cut rope and some sort of hammer if the ground was too hard to push the re-bar in by hand.

Once all five sections of pipe had been connected the structure was heavy and unruly until the last pipes were slid onto the ground rods. Once in place, the purlins were quite unstable so extra bracing was added. After being knotted, the ropes at the bottom of the pipes could be trapped underneath the pipes to stop them undoing. However, this type of detailed technique is secondary information could become superfluous to a simple set of instructions.

The most difficult part of the construction process was pushing the tent poles into the holes of the end connectors. During construction, the poles had to be twisted around to line them up with the slots while being pulled in different directions. The erratic movements of the half built structure caused the poles to become bent. However, they could be bent back with some effort. Once the rope had been attached, this held the poles in place.

Fig. 18

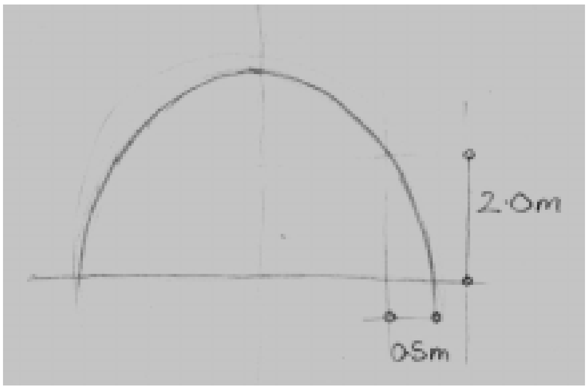

Fig. 19

The pipe tends to be stored rolled up. This causes it to develop a curve. This small deformity can take its toll on the overall shape of the structure if repeated in many of the pipes (Fig. 18 +13). Starting from one side to put the parts together seemed to cause the structure to become asymmetrical as the pipes own weight was being carried along an irregular shape.

The overall size of the structure made it difficult for somebody under 6ft to put it up alone but it proved to have useable proportions with plenty of head height and storage space (Fig. 19).

Fig. 20

Day5:

After some days of rain, water had pooled on the skin between the top tent poles. The weight of the water was pushing the structure down and the pipes were deforming (Fig. 20). Some of the rope had become slack due to this deformation. The skin had not left the structure and all the re-bar was still fixed into the ground. At this point no attempt was made to adjust the structure in any way.

Day8:

The weight of the water had caused a total collapse. The MDPE pipes had become permanently curved and could not be used to rebuild the shelter (Fig. 21+22). The shelter had had to support a volume of water at least equivalent to an average bath (Fig.23).

Fig. 21

Fig. 22

Fig. 23

Conclusion

The shelter holds together well once constructed, but can be quite unstable during construction. The small number of elements causes them to rely on each other to hold the shelter together, rather than standing alone at each stage. It also means that there are many variables that could affect the overall performance of the shelter because each part is so vital to the transmission of forces. This necessitates speedy construction and suggests that more than one person should build it together. The extra bracing would only add very little to the kit cost and is therefore a viable solution to racking. The amount of Monarflex used was also acceptable as it was proportional to the extra usable space gained.

The connection between the tent poles and the connectors was the most critical but also the most difficult. It is vital that the poles and connectors do not come apart before the rope is tied on. At present this connection is machined, which adds to the lead time so there is still scope for different methods to be suggested.

The collapse seems to have occurred for two reasons. First, the water pooling was caused by the lack of a ridge pole and the skin not being held down at the sides. The water was heavier than any force this type of shelter was designed to withstand. The structure failed because the MDPE pipes, in a semicircular configuration of this size, were not strong enough.

The purlins bent from the bottom causing the whole structure to deform. If the lower pipes could be made stronger, this would lessen the chance of collapse. If they could be made to stay straight, a parabola would be created, allowing the forces to travel in a more efficient way (Fig. 24).

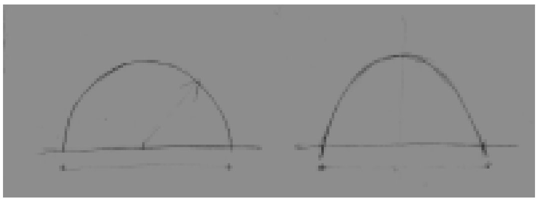

Fig. 24

Five Section Shelter Experiment#2

Aim

To prevent water pooling on the skin and to make the structure stronger. To time the construction process as carried out by an average sized woman or short man and test other ways of joining the structure together.

Method

This time I wanted to see how simple and easy it would to erect the shelter alone. The re-bar used was 1m long in order to strengthen the lower pipes (Fig.25). Ideally they would be 1.2m long, but the re-bar comes in 6m lengths, easily cut into 1m long pieces.

Fig. 25

Fig. 26

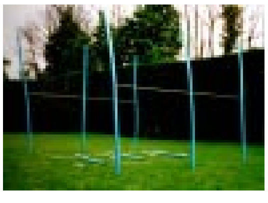

Fig. 27

Fig. 28

This time a different technique was used to build the structure to try to avoid an asymmetrical result. Both sides were built up at the same time. Each side becomes very tall quickly as the first pipe is as tall as eye level and the next pipe brings the level up to that of an average ceiling. The re-bar begins to pull the turf up as the structure leans under its own weight (Fig. 28). At this point one side has to be leant against the other to prevent it falling over (Fig. 29). Putting the last section of pipe in proved impossible, as both junctions were too high to reach. This method was abandoned and the structure was built again from one side as before.

Fig. 29

Fig. 30

Fig. 31

Fig. 32

Once the re-bar, poles and pipes are in place, the top of the shelter is too tall to reach so a box was used to stand on. This makes tying on the bracing and pulling on the skin much easier (Fig.33+34).

Fig. 33

Fig. 34

The skirt of Monarflex is held down on all sides by heavy timber planks to keep it as taught as possible (Fig.35+36).

Fig. 35

Fig. 36

Hypothesis

The re-bar is expected to strengthen the structure against deforming at the base. If the timber is heavy enough, it will prevent too much water being held on the Monarflex.

Results

Day 1: Construction

As detailed in the method, the process took one person two hours to complete the shelter.

Day 4:

Unfortunately the second prototype also collapsed. At first glance, it appears that the tent poles have come apart and caused the structure to fail. (These tent poles lacked the spring-ties that would be present in the kit poles, so they came apart more easily). The skin had come off completely and had thrown off the timber planks on the left hand side (Fig.37, 38, 39, 40).

Fig. 37

Fig. 38

Fig. 39

Fig. 40

The front purlin had come away totally from the rest of the structure causing it to pitch forwards. (Fig. 41+42)

Fig. 41

Fig. 42

Fig. 43

The shape of the structure is still reasonably symmetrical despite the collapse.

(Fig. 43) Every knot of the bracing was also still intact (Fig. 44)

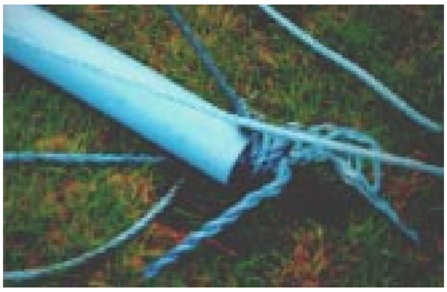

Fig. 44

Fig. 45

On closer inspection it became clear that the rebar on the left hand side had all come completely out of the ground (Fig.45+46). The right side was still standing, still secured in the ground and still holding together. (Fig. 47)

Fig. 46

Fig. 47

Fig. 48

Fig. 49

Fig. 50

The skin had remained threaded onto the rope which was still tied in place. The timber planks had moved half a metre along the back of the shelter but had remained in place on the right hand side (Fig. 48, 49, 50).

Conclusion

The cause of the collapse could have been aggravated by wind lifting the skin and pushing against the timber from the inside. A more likely cause is more water pooling. The water weighing down on the Monarflex could not crush the pipes this time because of the extra strength provided by the re-bar. The longer re-bar was very successful creating a good strong and even shape. Instead the skin was gradually pulled down, causing it to slide off the structure. The timber was not strong enough to keep the skin taught in order to prevent the build up of water, or to keep it in place with the weight of the water on the skin. The asymmetrical force of the water on the structure caused it to rotate, pulling the left hand side out of the ground. In an area with hard ground where no trenching can be carried out, there is no guarantee that material heavy enough could be found to weigh down the skirts. The materials used in their present configuration do not provide an adequate solution to the problem of a larger shelter. However, if the problem of water pooling could be solved, a larger shelter would be possible. This size of shelter has the disadvantage of being made with an odd number of pipe sections so that no ridge-pole is present. This appears to be critical to preventing water pooling. It would be a worthwhile exercise to try a six-sectioned version of the shelter to test this. Other methods of directing the water could be attempted such as using the bracing to form drainage channels. It may be possible to use the form of conventional dome tents that cross their poles to prevent pooling.

The next step could possibly be a model making exercise to find a simple structural shape that avoids pooling and then another prototype test at full size to confirm that the shape can be made to work with a basic kit of parts. The ‘Big Idea’ behind this size of shelter needs to be carefully redesigned so that it works before a set of instructions can be produced for it.

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