# Portable Shelters for Rehabilitation Using Bakelite Sheets

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***Abstract*** - Since childhood, we are encountering problems during disasters; it may be natural or even manmade. Whatever the reasons maybe, but the thing resulted all over the time is helplessness and homelessness. In year 2018, India faced such a problem in Kerala, due to heavy rainfall. Rainfall didn't induce any flooding action, but all the gates of all of the 5 Water Reservoirs were opened. The situations lead Kerala to condition of cloudburst, which in the next, became the cause of floods. And floods resulted into loss of life, property and place of shelter i.e. home. Whenever there is danger overhead, we always rescue ourselves, and take shelter in our homes. But what if the danger snatches our shelters and makes us homeless. This thought gave us an idea to develop the portable shelters. We reviewed many research papers, journals, articles. Some of them provided very useful information about portable shelters. They helped us with requirements imposed and characteristics required for the shelters to live in. We got an outline of factors affecting the performance and quality of the shelter. Redefining environmental conditions and climatic effects, proper material must be selected

***Keywords -*** Disasters, Shelters, Bakelite Sheets, assembly, Durable, Open Spaces.

## I. Introduction

There is need of shelter whenever there is disaster, it may be Natural or Man-made. But during disaster period there is huge loss of life and property. Hence thereby the need of the shelter increases a lot. Thus, we need a place to help the victims to help them to rehabilitate. But the place where we rehabilitate them, is the area where there is already a population residing over there. So to avoid the disturbance in the routine of the population of other area, we need to help the victims to rehabilitate in the open grounds. We need the shelter made of some light weight material. Usage of Bakelite sheets will satisfy all the required conditions. Bakelite is a material based on the thermosetting phenol formaldehyde resin, Polyoxybenzylmethyleneglycolanhydride developed in 1907 Formed by the reaction under heat and pressure of phenol (a toxic, colourless crystalline solid) and formaldehyde, generally with wood flour filler, it was the first plastic made from synthetic components. . A common disinfectant, with formaldehyde, it formed a hard, insoluble material that ruined It was used for its electrically nonconductive and heat-resistant properties in radio and telephone casings and electrical insulators. The material is light enough, impermeable, and highly heat resistant. It doesn't change its shape when temperature rises.

## II. Literature Review

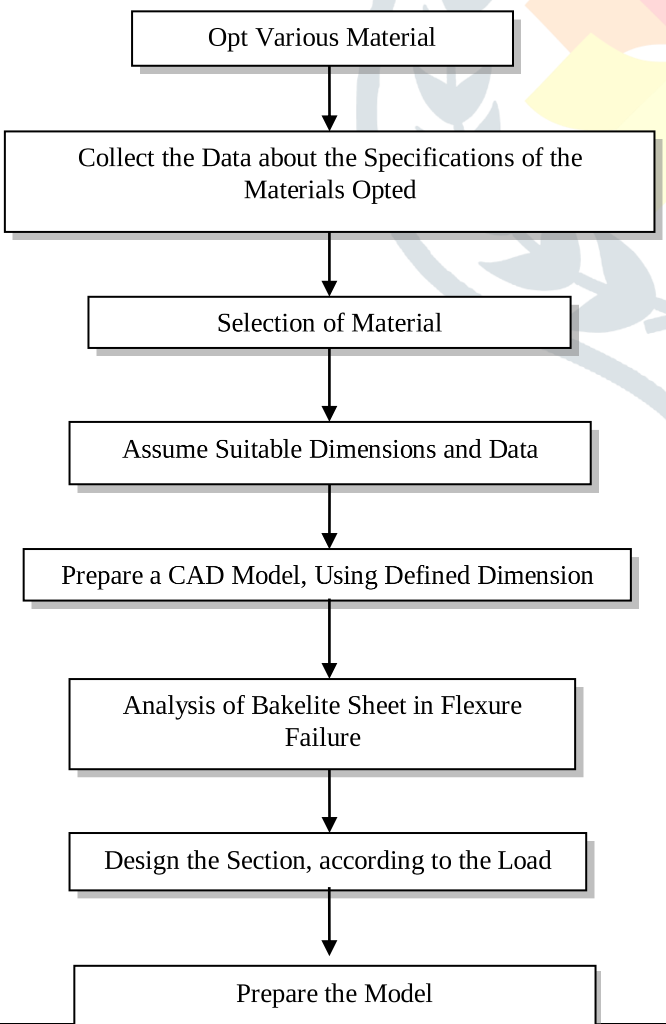
Sinan M. SENER, M. Cem ALTUN(2009): In the context of preparations in the pre-disaster period, the research project "Mob ARCH" is set aiming to develop a post-disaster temporary shelter system to overcome the temporary "homelessness" situation. In designing the temporary shelter unit, the main goals can be listed as follows; taking user requirements under extraordinary circumstances into consideration, temporary and multiple use of the unit. Although the design process has a "methodological" approach, it is allowing "creative leaps". The methodology of the design process is given together with its application on the temporary shelter unit design. The design process of the temporary shelter unit comprises mainly three sub-processes; setting design objectives, developing design criteria and the "final" design.

Abdulrahman Bashawri, Stephen Garrity and Krisen Moodley( 2014): DR shelters are used to provide private and secure places for people to live who have left or lost their usual accommodations as a result of some form of disaster. DR shelters not only provide immediate and short-term shelter for the victims of a disaster, but they also help them to recover from the trauma of a disaster as well as provide a base to start the process of rehabilitation. A lack of adequate consideration with regard to climatic conditions, locally available materials and skills, cultural and social issues, delays, cost constraints, and poor location selection for DR shelters have each been identified as sources of poor performance. Moreover, there seems to be a lack of sufficient consideration with regard to the design of DR shelters for future storage and re-use. The principal aim of this research is to examine the extent to which environmental, economic, technical, and socio-cultural criteria affect the provision and performance of DR shelters.

Akkerman, M.K. Brouwer, E.R.P. Cox, M.G.D.M. van Egmond, E. L.C(2007): Disasters cause tremendous material and immaterial damage to people and their habitat. During the first days after the disaster the victims have to be provided with food, shelter, security, health care and registration. For sheltering, depending on the local circumstances, tents are often used for a short period of time but often we often see them used for a longer time. However tents are not always the best solution. Although industries have developed new materials and building systems, not all of them are suitable to provide for an appropriate response as desirable for application in shelters. In order to improve this situation, various aspects were presented and discussed during an International Symposium held at the Eindhoven University of Technology (TU/e) in November 2007 under the auspices of Red Cross organizations, universities, NGO's and private companies. As a result the TU/e has embarked on a research project on various approaches for sheltering in close cooperation with the Netherlands Red Cross.

Laijun Zhao 1, 4, 5, Huiyong Li 2,*, Yan Sun 1, 5, Rongbing Huang, (2017): Extreme natural hazards threaten cities more than ever due to contemporary society's high vulnerability in cities. Hence, local governments need to implement risk mitigation and disaster operation management to enhance disaster resilience in cities. Transforming existing open spaces within cities into emergency shelters is an effective method of providing essential life support and an agent of recovery in the wake of disasters. Emergency shelters planning must identify suitable locations for shelters and reasonably allocate evacuees to those shelters. In this paper, we first onsider both the buildings' post-disaster condition and the human choice factor that affect evacuees' decision, and propose a forecasting method to estimate the time-varying shelter demand. Then we formulate an integrated location-allocation model that is used sequentially: an emergency shelter location model to satisfy the time-varying shelter demand in a given urban area with a goal of minimizing the total setup cost of locating the shelters and an allocation model that allocates the evacuees to shelters with a goal of minimizing the total evacuation distance.

## III. Methodology




## IV. Materials

*Bakelite*:

Bakelite is a thermosetting plastic. It is used for making the buttons of electric boards. It is a type of brittle material and an impermeable material. It is a bad conductor of electricity that is it is an insulator and can resist heat and electricity. It have much higher flexural strength so can be used as a shelter material. Just the thing is it is brittle and may induced cracks on application of point load or impact load with a small pointed object. So there is a need to apply a layer which can resist its cracking property while in all other directions it is advantageous and fruitful. We are going to use Bakelite sheets as a covering on the lateral surface area of the shelter. After comparison with many other materials, we have concluded that Bakelite is the best suitable material for the Shelters. It is easily maintained and replaceable. From its properties you can understand that it needs a very high temperature to deform. In its process of manufacturing, the reagents are made reacted and after processing we get a material which is in liquid form, but once it get harden, it never change the shape. It gains the property of insulation from heat and electricity. There are two types of thermosetting plastic polymers, melamine and Bakelite. But because melamine is very much costly we use Bakelite sheets. For economic purpose, we use Bakelite sheets and not the melamine sheets.


Fig. 1 Bakelite Sheets

TABLE I

Some Typical values of Properties

| Sr. | Property | Standard | Typical Value | Unit |
|---|---|---|---|---|
| 1. | Compression Moulding shrinkage | ISO 2577 0 | 45 | % |
| 2. | Compression Post Shrinkage | ISO 2577 0 | 45 | % |
| 3. | Tensile Strength | ISO 572 - 1/2 | 50 | MPa |
| 4. | Tensile Modulus | ISO 572 - 1/2 7 | 500 | MPa |
| 5. | Compressive Strength | ISO 604 | 250 | MPa |
| 6. | Flexural Strength | ISO 178 | 95 | MPa |
| 7. | Water Absorption | ISO 62 | 60 | Mg |

*Plastics Wrap*:

There are many various plastic sheets available in the market. But for our ease and convenience, we use packaging plastic sheets. It can be wrapped around the Bakelite sheet panels easily. It helps to resist the cracking of panels. It will help to avoid the brittle cracking of the Bakelite sheets.

Fig. 2 Plastic Sheets

Stretch wrap or stretch film is a highly stretchable plastic film that is wrapped around items. The elastic recovery keeps the items tightly bound. In contrast, Shrink wrap is applied loosely around an item and shrinks tightly with heat.

*Plywood*:

Plywood is a material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another. It is an engineered woodfrom the family of manufactured boards which includes medium-density fibreboard (MDF) and particle board (chipboard). All plywoods bind resin and wood fibre sheets to form a composite material. This alternation of the grain is also cross-graining and has several important benefits: it reduces the tendency of wood to split when nailed in at the edges; it reduces expansion and shrinkage, providing improved dimensional stability; and it makes the strength of the panel consistent across all directions. There are usually an odd number of plies, so that the sheet is balanced- which reduces warping. Because plywood is bonded with grains running against one another and with an odd number of composite parts, it has high stiffness perpendicular to the grain direction of the surface ply.

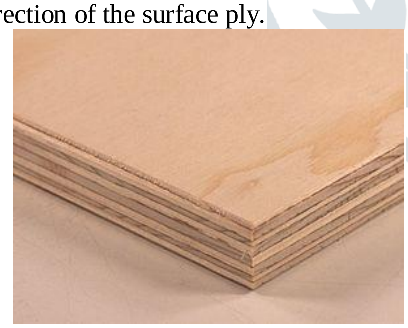


Fig. 3 Plywood Sheet

*Aluminium Casing:*

A sash window or hung sash window is made of one or more movable panels, or "sashes", that form a frame to hold panes of glass, which are often separated from other panes (or "lights") by glazing bars, also known as mountings in the US (moulded strips of wood). Although any window with this style of glazing is technically a sash, the term is used almost exclusively to refer to windows where the glazed panels are opened by sliding vertically, or horizontally in a style known as a Yorkshire light, sliding sash, or sash and case.

Fig. 04 Aluminium Casing type and material

*Plastic Roofing*:

Polyvinyl chloride, vinyl abbreviated: PVC is the world's third-most widely produced synthetic plastic polymer, after polyethylene and polypropylene. About 40 million tonnes are produced per year. It is widely used as roofing material. Thus it will be economic as well suitable.

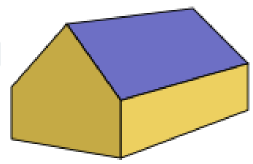


Fig. 05 Dummy Structure

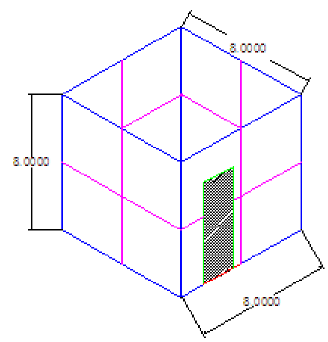



Fig. 06 Actual Dimensions of Model

## V. Analysis

We know that for testing on Sheet type of Material, we need to check the flexure strength of the sheet. Due to smaller in thickness, it fails mostly in Flexure. We have the permissible maximum flexural strength of 95 MPa Using normal climatic/weather condition we have the data that maximum wind speed=55 ($^m/_s$) and lowest =39 ($^m/_s$).

Now, planning for most severe condition and taking the required steps as follow:
Where is slope of sheeting for the design of truss the above live load may be reduced to Wind load IS 875 part 3 gives guidelines to determine wind forces on different components of buildings. If consist of the following steps. Determine basic wind speed (cl.52 and Appendix A of IS 875 part 3) for finding basic wind pressure in any place in India, IS875 part-3 divides the country into six zones. It is based on peak velocity averaged over short time interval of about 3 seconds studied over a period of 50 years. The values correspond to the speed at 10 m height aboveground level and in an open terrain. It may be observed that **highest basic wind speed is 55 m/s** and the lowest is 33 m/s

Obtain design wind speed ($V_Z$): (Cl. 53 IS 875 parts 3) the design wind speed for any site may be obtained as:
Vz=k1xk2xk3

=0.67x0.3x1x55

=11.055 m/s

Where,

$K_1$=risk coefficient;

$K_2$=terrain, height and structure size factor;

$K_3$ =topography factor;

Determine wind pressure (Pz): The design wind pressure at any height above mean ground level shall be calculated using the following expression

$P_z = 0.6Vz^2$ N/m$^2$

=0.6x $(11.055)^2$

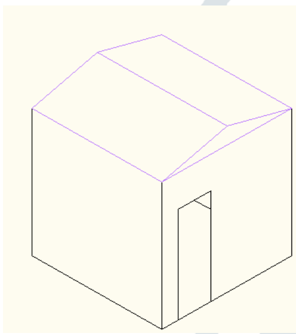
=73.32 N/m$^2$

Where,

Vz design wind velocity in m/s at height 'z';

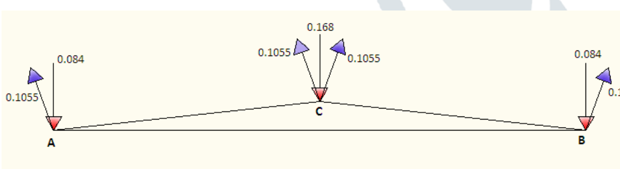
The Typical value of Flexural Strength of Bakelite sheet is 95 Mpa (95 x$10^6$ N/m$^2$). Hence, we can use the Bakelite sheets for the shelter.

## VI. DESIGN OF FRAME



For designing of truss (blue coloured in above diagram), we need to know the magnitudes of loads acting on it. The loads acting are Dead, Live, Wind loads. Calculating the intensities of all loads:

Dead load of truss = 0.334 kN; Live load= 0.002 kN; Wind load= 0.422 kN.




Resolving all the above loads, we get the following tabulation:

| Member | D.L+ L.L | W.L | 1.5(D.L + L.L | 1.5(D.L+ L.L) | 1.2(D.L+L. L+W.L) |
|---|---|---|---|---|---|
| **AB** | 0.230 | 0.616 | 0.345 | 0.857 | 1.0152 |
| **AC=BC** | -0.245 | -0.579 | -0.367 | -0.687 | -0.988 |

Amongst these combos, the most critical combination gives the extreme forces, which are:

Factored Tensile force =1.657kN

Factored Compressive force =1.483kN

Minimum Area required to overcome and bear the forces = 9.09 mm$^2$. So we provide the equal legged angle section < 30x30x3 with c/s Area = 174mm$^2$. It's Design Compressive Force = 20.029 kN and Tensile capacity = 39.545 kN.

## VII. RESULT

The results of the analysis and design shows that the Materials used will bear the entire load applied on it. Since the most severe condition has been taken into consideration, the normal conditions are easily satisfied. In the most severe condition, the maximum load, which is going to be applied is 1.0152 kN in tension and 0.988 kN in Compression. While, the Shelter have the Capacity of Compressive Force = 20.029 kN and Tensile capacity = 39.545 kN. Hence, it is much stronger, beyond the limit.

## VIII. CONCLUSION

- According to the Structural view, this shelter can bear very high wind loads as compared to the conventional shelter.
- With comparison to the conventional cloth Shelter, this Shelter protects us from Wind, Sunlight, and Rain.
- This Shelter gives home-like feeling, and makes the residers comfortable.
- The life span of this shelter is much longer than that of the conventional shelter.
- As Bakelite is light in weight, it makes it ecnomical. Because it will require the steel section, with lesser cross-sectional area.

## IX. Acknowledgment

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