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Simple Building Using Laminated Plate

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Abstract

Laminate plates are not only as the base material but also as the main structure. What is meant by the main structure is something that is able to withstand moments, shear and axial. Due to the lightness of the material, it makes us easier for dealing with air transportation and Installation. Besides, it is very cheap, easy and fast for a simple building, so it is suitable for building a simple house to protect us from heat or rain and is able to withstand the smaller earthquake (a smaller earthquake following the main shock of a large earthquake). The components of Simple Building materials for earthquake resistance which use laminate plates are badly needed because it is for the completion of an alternative Conventional heavy walls into light walls, so that the horizontal force that is proportional to the vertical force is reduced; there will be no continuous fondation under the wall anymore; the other Horizontal Load, which is detained by the columns (column dimensions become large) will be reduced because this component can also receive Horizontal load, so the column dimensions will become smaller.

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Keywords: Laminate plate ; simple building; earthquake , Horizontal Load; component of simple Building

1. Introduction

We need foundation for building conventional walls, while for Glass Fiber walls we do not need any foundation as glass fiber is relatively very light. The foundation is only required at any connections of the columns. Thereby it will reduce the cost of the installation of the foundation constantly. In terms of transportation, we can use air transportation where loads carried by the plane can carry walls of glass fiber relatively in a large quantity/a lot compared with a conventional wall so that we can install more numbers of units in a short time. Fiberglass wall is not only relatively light but it can also withstand the Horizontal Force, so the columns do not require a large dimension. The other Horizontal Force, which are detained by the columns (column dimensions become large), will be reduced because this component can also receive the Horizontal load to make the column dimension smaller. Meaning to say, we can use air transportation for delivering the materials, so that we can get time efficiency and get more amounts of materials that will be installed.

2. Problem

A simple building is a -one, two or three floor- building and is resistant to the earthquake. It is able to hold the horizontal force as well as the lightweight materials and to make the building mass reduce so the effect of horizontal force is reduced as well. Thus, the lightweight material is needed.

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Fiber glass and sponge is a lightweight material, making it suitable to be used in this research. Due to the use of these two different materials, both materials are then combined or termed composite. This composite material is as one of the component of the building materials:

a) the ability of building material component to bending due to wind force.

b) the ability of the axial component of building materials due to the weight of the roof and also is own weight.

c) the ability of the building material components to the shear force due to the wind force of an earthquake.

d) the condition of joints between the panels. The "I" connection: between straight panels (panel to panel), The "T" connection: between panel to panel, also perpendicular to the panel. The " L" connection : between the panel with the panel perpendicularly. The " +" connection : between the panel and the other panel, also upright and perpendicular to the panel.

e) In addition to the ability of the experimental component of building materials, the formula of mathematical calculations is also necessary (as the comparison between experimental and analytical).

3. Objectives

Daxu Zhang(2007), Ji,Wooseok (2008), Mohammadi,M.(2011), Nanda, Namita (2008), Paolo Foraboschi (2007), Qiao, Pizhong (2010), Suprobo, Priyo (2011) , Vaidya, A. (2010), Weaver(2007), this research is needed to determine : Physical properties of each component of the composite, Material properties of each component of the composite, Ability of the components of the composite towards slide, axial and bending experimentally, The ability of the components of the composite towards slide, axial and bending analytically. Therefore, by knowing the physical properties and material properties in the composite, we can also know the ability of the components of the composite in analytical methods of research.

4. Scope

Materials used with three layers where "n" are odd. Numbers of material layers (m) = n/2 (in ascending round off). The Material positions are symmetric (start from side edge to the middle, the same material). Material made available to the market conditions. The tight glue between the layers of the material is greater than the tight of each material itself.

5. Background Theory

5.1 FSDT (First-order Shear Deformation Theory)

According to H.R. Ovesy (2011), First-order Shear Deformation Theory (FSDT) was applied to the analysis formula. FSDT assumption is:

$$\bar{u}(x,y,z) = u(x,y) + z\emptyset_x$$
$$\bar{v}(x,y,z) = v(x,y) + z\emptyset_y$$
$$\bar{w}(x,y,z) = w(x,y) \qquad (1)$$

where *u , v, w* are the displacement component in general point,

$$\bar{\varepsilon} = \varepsilon + z\psi \qquad (2a)$$

where :

$$\varepsilon = \begin{Bmatrix}\varepsilon_{xx}\\ \varepsilon_{yy}\\ \varepsilon_{xy}\end{Bmatrix} = \begin{Bmatrix}\frac{\partial u}{\partial x} + \frac{1}{2}\left(\frac{\partial w}{\partial x}\right)^2\\ \frac{\partial u}{\partial y} + \frac{1}{2}\left(\frac{\partial w}{\partial y}\right)^2\\ \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial x}\frac{\partial w}{\partial y}\end{Bmatrix}$$

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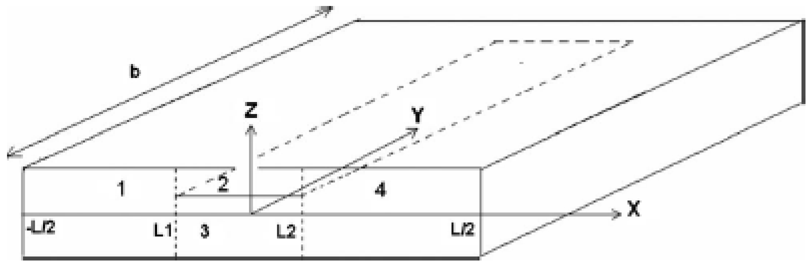
$$\psi = \begin{Bmatrix} \psi_{xx} \\ \psi_{yy} \\ \psi_{xy} \end{Bmatrix} = \begin{Bmatrix} \frac{\partial \emptyset_x}{\partial x} \\ \frac{\partial \emptyset_y}{\partial y} \\ \frac{\partial \emptyset_x}{\partial x} + \frac{\partial \emptyset_y}{\partial y} \end{Bmatrix}$$

$$\gamma = \begin{Bmatrix} \gamma_{xz} \\ \gamma_{yz} \end{Bmatrix} = \begin{Bmatrix} \frac{\partial w}{\partial x} + \emptyset_x \\ \frac{\partial w}{\partial y} + \emptyset_y \end{Bmatrix} \quad (2b)$$

$$\begin{Bmatrix} \bar{\sigma}_{xx} \\ \bar{\sigma}_{yy} \\ \bar{\tau}_{xz} \\ \bar{\tau}_{yz} \\ \bar{\tau}_{xy} \end{Bmatrix} = \begin{bmatrix} \bar{Q}_{11} & \bar{Q}_{12} & 0 & 0 & \bar{Q}_{16} \\ \bar{Q}_{12} & \bar{Q}_{22} & 0 & 0 & \bar{Q}_{26} \\ 0 & 0 & \bar{Q}_{44} & 0 & 0 \\ 0 & 0 & 0 & \bar{Q}_{55} & 0 \\ \bar{Q}_{16} & \bar{Q}_{26} & 0 & 0 & \bar{Q}_{66} \end{bmatrix} \begin{Bmatrix} \bar{\varepsilon}_{xx} \\ \bar{\varepsilon}_{yy} \\ \bar{\gamma}_{xz} \\ \bar{\gamma}_{yz} \\ \bar{\gamma}_{xy} \end{Bmatrix} \quad (3)$$



$$\begin{Bmatrix} N_x \\ N_y \\ N_{xy} \\ M_x \\ M_y \\ M_{xy} \\ Q_x \\ Q_y \end{Bmatrix} = \int_{-h}^{h} \begin{Bmatrix} \bar{\sigma}_x \\ \bar{\sigma}_y \\ \bar{\tau}_{xy} \\ z\bar{\sigma}_x \\ z\bar{\sigma}_x \\ z\bar{\tau}_{xy} \\ \bar{\tau}_{xz} \\ \bar{\tau}_{yz} \end{Bmatrix} dz \quad (4)$$

In equation above, the total thickness of laminate = $2h$, N_x, N_y, N_{xy} = normal stress/length, Q_x, Q_y = shear stress/length and M_x, M_y, M_{xy} = bending stress and torque/length.

6. The Effect of Slimness

The effectiveness of the slenderness ratio, $\bar{\lambda}$, is evaluated based on the tensile stress, according to Luible and Crisinel(2004) from C. Amadio and C. Bedon(2011).

$$\bar{\lambda} = \sqrt{\left(\frac{\sigma_R}{\sigma_{CR}^E}\right)}$$

With σ_{CR}^E = Euler buckling stress

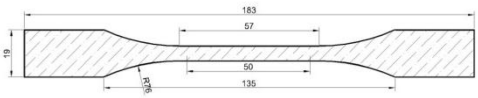
$$\sigma_{CR}^E = \frac{\pi^2 E}{\lambda^2}$$

Where : $\lambda = \frac{L_0}{\sqrt{\frac{J}{A}}}$

Asumptions :
GLASS tensile stress σ_R = 17 MPa (European Committee of Standardisation,2000)
$J = bt^3/12$ Moment of Inertia of the total cross section with the assumption: , $t = t_1 + t_{int} + t_2$
A= is the total cross-sectional area of the LG(Laminated Glass).
The formula used $A = A_1 + A_{int} + A_2$

7. Discussions

TYPE A



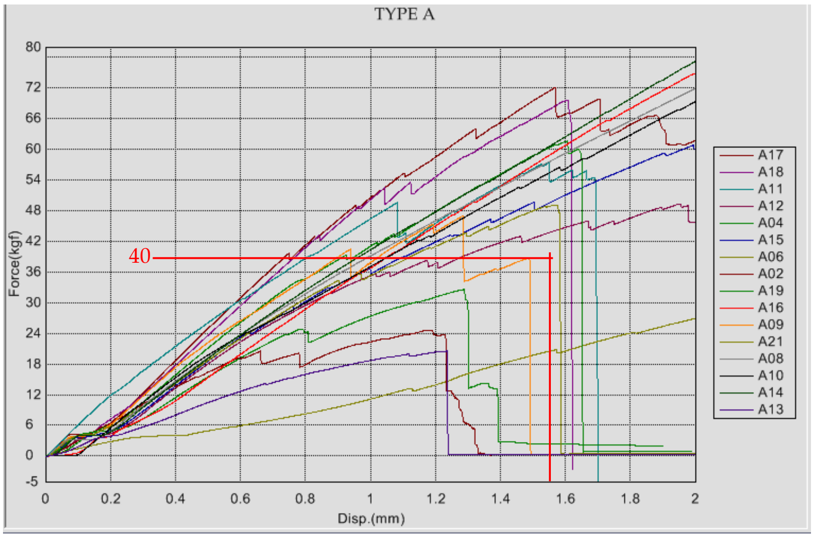


Fig. 1. Type A (0^o - 14^o)

Fig. 1. shows the angle between the fiber 0-14º , Average Max = 40 kg , Displacement = 1.2 mm

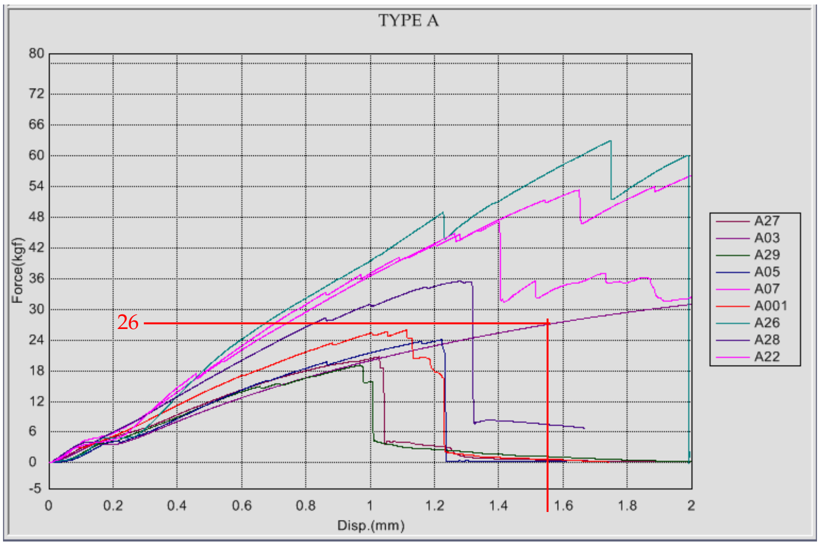
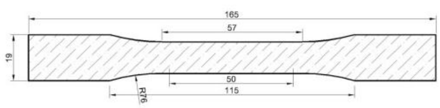


Fig. 2. Type A (17^o - 25^o)

Fig. 2 shows the angle between the fiber 17^o-25^o and Average Max = 26.44 kg, Displacement = 1.2 mm

TYPE B



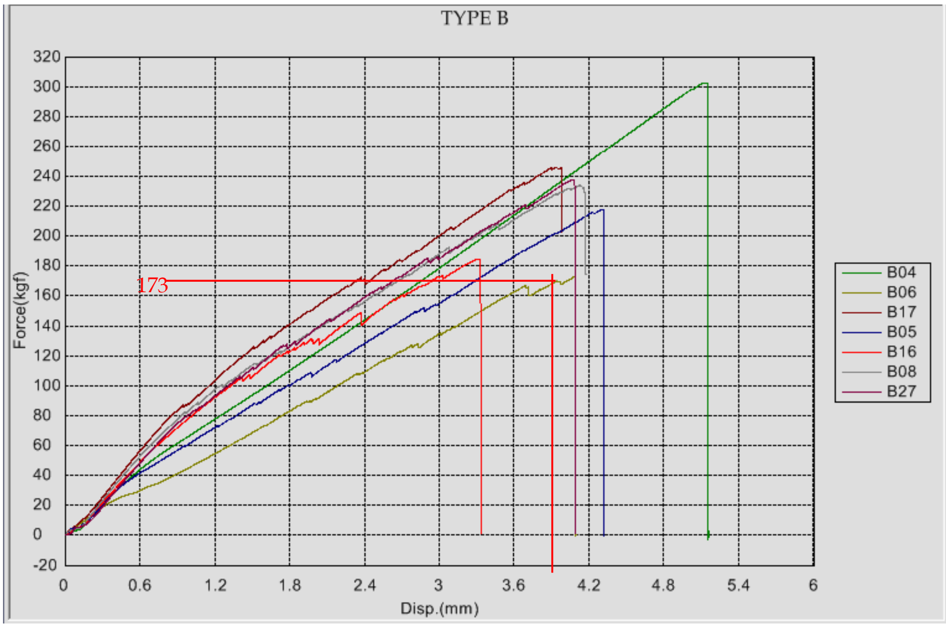


Figure 3. TYPE B fiber Angle between 0-7º

Fig. 3 is shown Type B Angle between 0-7º , Average Max = 173 kg , Displacement = 3 mm

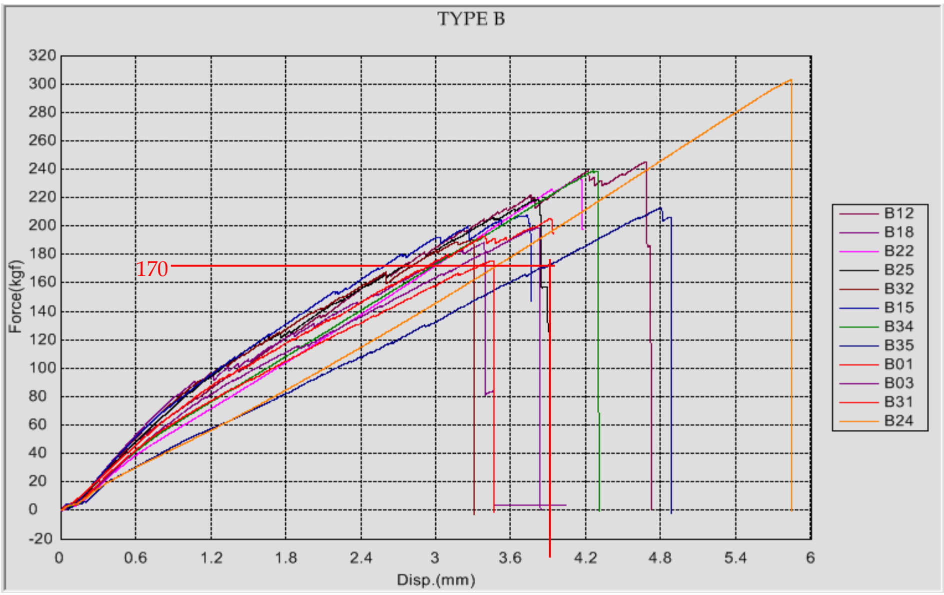


Figure 4: TYPE B fiber Angle between 8-17º

Fig. 3 is shown Type B fiber Angle between (8-17); Average Max = 170 kg ; Displacement = 3 mm

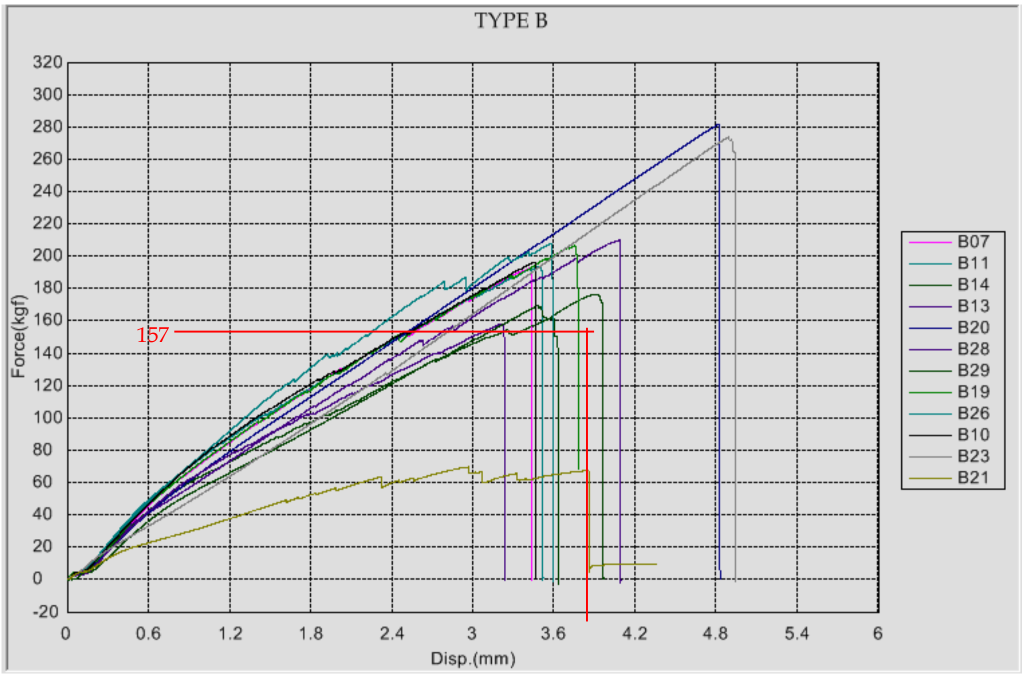
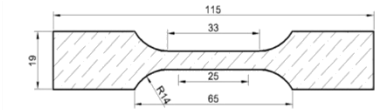


Figure 5. Type B fiber Angle between 18-27º

Fig 5. Is shown Type B fiber Angle between 18-27º Average Max = 157 kg , Displacement = 3 mm

TYPE C



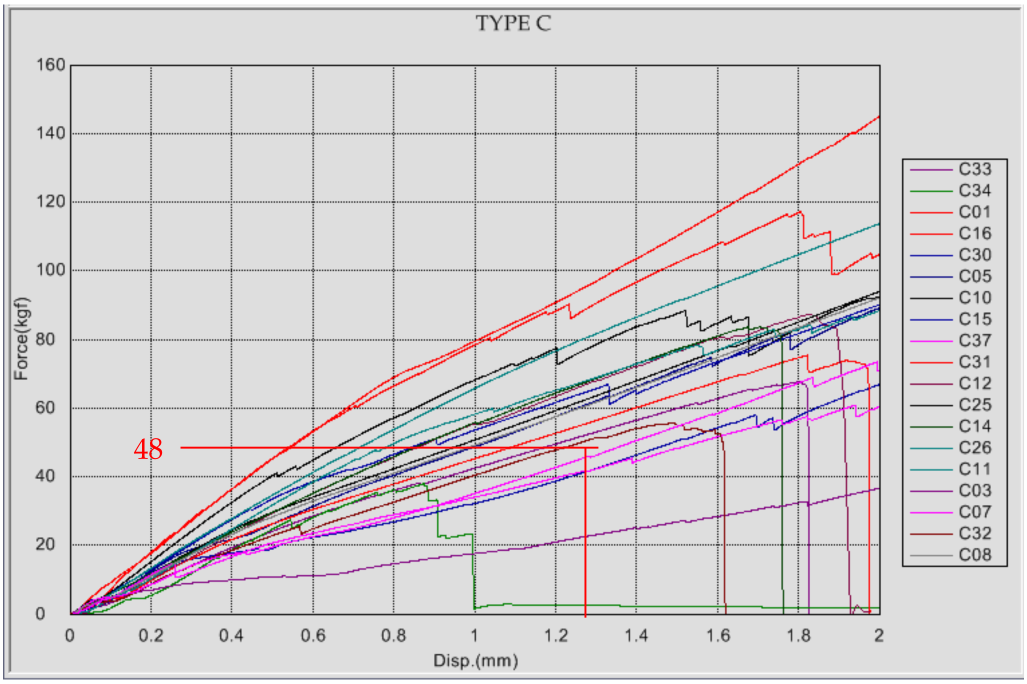


Fig. 6. TYPE C fiber Angle between 0-7º

Fig.6 is shown Type C fiber Angle between 0-7º; Average Max = 48.29 kg ;Displacement = 1 mm

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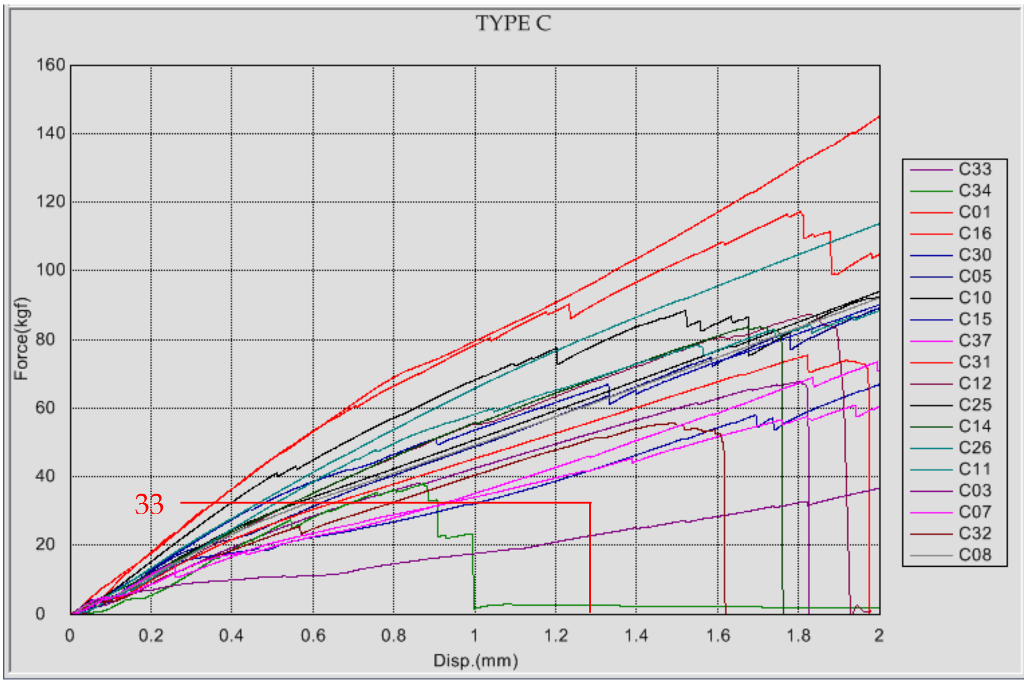
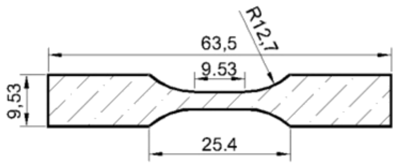


Fig. 7. TYPE C fiber Angle between 8-15º

Fig.7 is shown Type C fiber Angle between 8-15º; Average Max = 33 kg ; Displacement = 1 mm

TYPE D



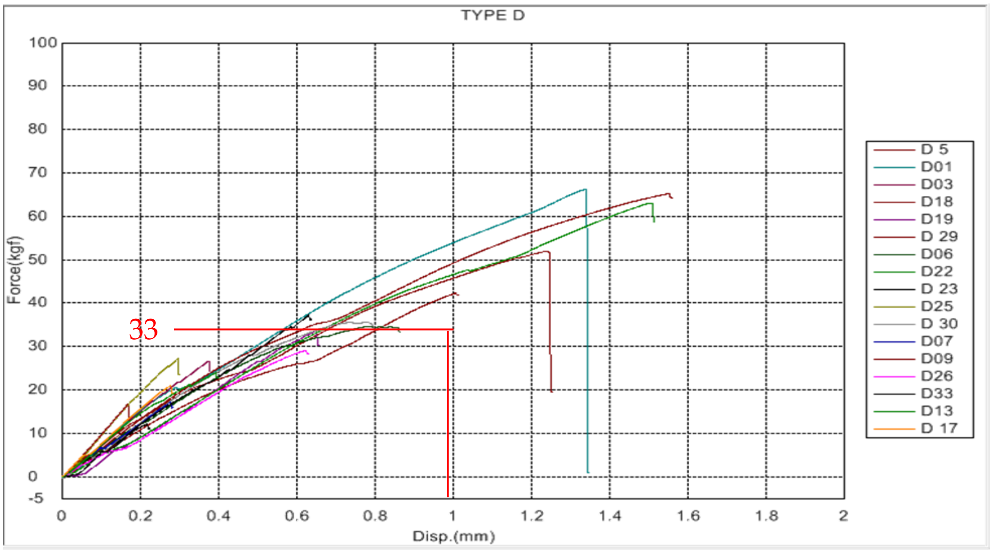


Fig. 8. Type D fiber Angle between 0-5º

Fig. 8. shows Type D fiber Angle between 0-5º ; Average Max = 33.17 kg ; Displacement = 0.7 mm

8. Conclusions

TYPE A (α = 0-14º). Average Max = 40 kg . Displacement = 1.2 mm
TYPE B (α = 0-17º). Average Max = 170 kg. Displacement = 3 mm
TYPE B (α = 18-27º), Average Max = 157 kg . Displacement = 3 mm
TYPE C (α = 0-7º), Average Max = 48 kg. Displacement = 1 mm
TYPE C (α = 8-15º), Average Max = 33 kg. Displacement = 1 mm
TYPE D (α = 0-5º), Average Max = 33 kg. Displacement = 0.7 mm

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