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Design and fabrication hazard stakes golf course polymeric foam material empty bunch (EFB) fiber reinforced

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Abstract. A golf course with obstacles in the forms of water obstacle and lateral water obstacle marked with the stakes which are called golf course obstacle stake in this study. This study focused on the design and fabrication of the golf course obstacle stake with a solid cylindrical geometry using EFB fiber-reinforced polimeric foam composite materials. To obtain the EFB fiber which is free from fat content and other elements, EFB is soaked in the water with 1% (of the watre total volume) NaOH. The model of the mould designed is permanent mould that can be used for the further refabrication process. The mould was designed based on resin-compound paste materials with talc powder plus E-glass fiber to make the mould strong. The composition of polimeric foam materials comprised unsaturated resin Bqtn-Ex 157 (70%), blowing agent (10%), fiber (10%), and catalyst (10%). The process of casting the polimeric foam composit materials into the mould cavity should be at vertical casting position, accurate interval time of material stirring, and periodical casting. To find out the strength value of the golf course obstacle stake product, a model was made and simulated by using the software of Ansys workbench 14.0, an impact loading was given at the height of 400 mm and 460 mm with the variation of golf ball speed (USGA standard) v = 18 m/s, v = 35 m/s, v = 66.2 m/s, v = 70 m/s, and v = 78.2 m/s. The clarification showed that the biggest dynamic explicit loading impact of Fmax = 142.5 N at the height of 460 mm with the maximum golf ball speed of 78.2 m/s did not experience the hysteresis effect and inertia effect. The largest deformation area occurred at the golf ball speed v = 66.2 mm/s, that is 18.029 mm (time: 2.5514e-004) was only concentrated around the sectional area of contact point of impact, meaning that the golf course obstacle stakes made of EFB fiber-reinforced polymeric foam materials have the geometric functional strength that are able to absorb the energy of golf ball impact.

1. Introduction

1.1 Background

In general stakes golf course is used (figure 1) is made of wood, bamboo, metal pipe or using materials pseudoplastis (survey: Arun Golf Club - Lhokseumawe). Technically the election stakes conventional materials do not meet the standards, as well as on other aspects of the design have not provided better visibility.

Figure 1. Hazard stakes golf course

To rectify this deficiency, and the rift Impact Research Center (Impact and Fracture Research Center) USU Mechanical Engineering Department, in collaboration with PTPN-III golf course designed stakes new model uses a polymeric foam material reinforced Empty Fruit Bunch(EFB).

Model design tailored to function on its placement on the golf course, in order to obtain the product look elegant, economical, aesthetic and visual appeal. To determine the stress distribution due to impact of golf balls, golf stakes made modeling using software ANSYS workbench 14.0, then simulated.

1. Formulation of the problem Limitations of this research:
2. Design and fabrication stakes golf course.
3. Model design and mold-making molds election materials.
4. Treatment EFB into fibers.
5. Composites process materials.
6. Time integration with a time of fabrication processes.
7. ANSYS workbench 14.0 simulation.

1.2 Research Objectives
The general objective of this research is the design and fabrication hazard stakes golf course new models are more robust against the possible impact and have high economic value, resistant to tropical situations, and easily moved or removed.

1.3 Special Purpose:
1. Design and fabrication hazard stakes golf course polymeric foam material.
2. Utilization of waste fibers EFB as polymeric foam composite material.
3. Analysis of stress distribution due to impact loading (ANSYS workbench 14.0).

1.4 Research benefits:
1. Scientifically development of new technologies in the model memfabrikasi stakes golf courses of polymeric foammaterial.
2. EFB commercial waste at palm oil mills can produce new products (sustainable).
3. Reducing deforestation and environmental impact.
4. Allows for the birth of new patent products.

2. Literature
2.1 Conceptual design and fabrication.
This phase is the most creative. Broadly speaking, the products are designed to fulfill its function (DeGarmo,1998). Typically, golf stick swing speed of 100 mph (using a 11 ° lofted driver, golf clubs head weight of 200 grams, 0.825 COR, and punches perfectly on center hit), then the ball speed reached 148 mph (Bishoy Emmanuel,2006).

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Parameters of tensile properties, tensile strength of polyester 55-175 MPa. Izod Impact 10-30 J/25 elongation 3%, while the tensile strength of polyurethane is 1 MPa - 70 MPa, 30 J/25 Izod impact has not been broken and the elongation 100-1000%. Differences in the characteristics of the formulation ingredients in polymerization reactions must generate its own advantages (Purwanto and Sparringa, 1998).

Table 1. Blowing agent vs Resin variation,

B.Agent	20%	30%	40%	10%	0
Resin	60%	50%	40%	70%	80%
EFB	10%	10%	10%	10%	10%
Mekpo	10%	10%	10%	10%	10%
ρ kg/m³	***1097***	***945***	***936***	***1022***	***1124***

Sources: Data Research Zulfikar, 2010.

Resin material variation 70%, 10% Blowing Agent, 10% fiber, 10% catalyst, ρ = 1022 (kg/m3), Mechanical properties with the following specifications:

a. Tensile strength = 7.427 MPa.
b. Modulus elasticity = 288.8759 MPa.
c. Elongasi = 2.571%.
d. Syt (MPa) = 7.427.
e. Regangan = 0.02571 mm / mm.

Results of experimental testing of high-speed impact of the specimen material fiber reinforced *polymeric foam* EFB fracture stress occurs at 13.41 MPa (Zulfikar, 2010). Mechanical strength of the fiber diameter EFB an average of 0.4 mm have a price elasticity modulus of 11.88 GPa with tensile stress max. 156.3 MPa (Gunawan, F.E., et al). Aim of the composite are:

1. Improve the mechanical properties and / or certain specific properties.
2. Simplify the design that are difficult to manufacture.
3. Flexibility in design, save cost.
4. Make lighter materials.

3. Methodology

3.1 Place and Time Research

3.1.1 Place

1. Survey in Arun Golf Club.
2. Design and fabrication in Impact dan Fracture Research Center of Mechanical Engineering USU Medan.
3. Simulated of software ANSYS 14.0 in (IC-STAR) USU Medan.

3.1.2 Time

Started since the approval of the proposal until the completion of the study.

3.2 Criteria design process

1. Loading of force capacity.
2. Mechanical analysis of the specific strength (strength and density, modulus of elasticity).
3. Optimizing the design and consider the cost implications.

3.3 Construction Planning Stake Stakes Golf Courses.

Design models is a factor of attraction for application use products stakes golf course.

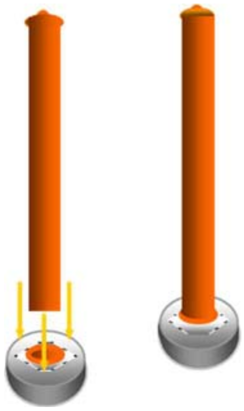


Figure 2. Design model

Fabrication stakes golf course is formed from compound materials:

a. Resin unsaturated poliester (orthophtalic 157 BQTN-EX)
b. Blowing Agent (polyol and isocyanate)
c. EFB fiber.
d. MEKPO (Metyl Ethyl Kethon Peroxide).

3.3.1 Tools and Methods

Table 2 List of Test Equipment and Tools.

Instrument	Variable
ANSYS 14.0	Distribution of stress due to impact loads.
PRODUCTION EQUIPMENT	
Mould - PVC pipe - Talc powder, resin, E-glass	Making molds stakes golf course.
Chemical equipment - Scales - Measuring cup	Chemical equipment - Scales - Measuring cup - Composities materials

3.4 Research Design

3.4.1. Design of mold model.

Mold base polymer material can be made of wood, which has been reinforced plastic, plates, gypsum materials. Factors in planning the pattern:

1. Shrinkage
2. Excess material
3. Draft angle
4. Distortion
5. Pating line

This research used permanent mold type for fabrication, it's superiority also can be used for refabrication.

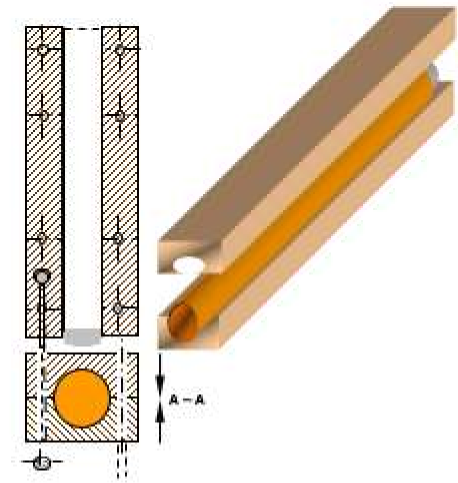


Figure 3. Planning model of mold.

Materials used: Talc powder: 2 kg, Resin BTQN-Ex 157: 2 litre, Mekpo: 2%, E-glass fiber: 3 piece, Materials mold: PVC pipe d=2½ inc, length 90 mm.

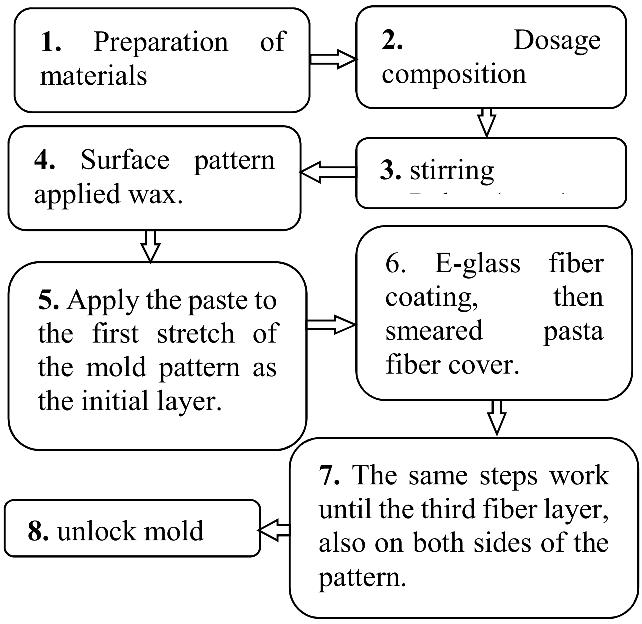


Figure 4. Flowchart of making mold

3.4.2. Reconstruction of mold fabrication

To make the mold into two symmetrical parts then, in the middle of the slab given separator pattern of paper materials.

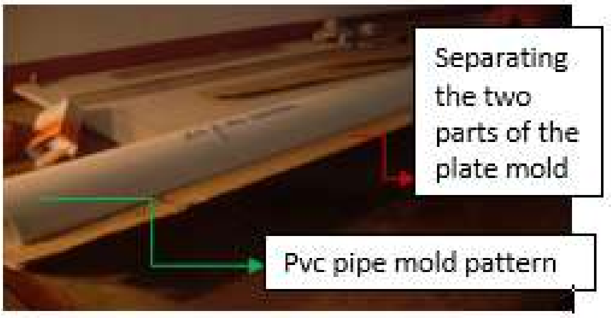


Figure 5. Mold making

Giving mirror glaze (Figure 6) aims to facilitate the separation of the pattern material with cast product.

Figure 6. Mirror glaze coating.

3.4.3 Workmanship molding composition.
Talc powder and resin and catalyst in the ratio 1: 1: 1% mixed evenly in the container until it becomes a paste can be seen in Figure 7.

Figure 7. Stirring composition

Surface pattern that has been smeared with pasta included E-glass fibers to the third layer (Figure 8) and dry for 24 hours.

Figure 8. *Hand and lay-up* mold pattern.

Figure 2. Hazard stakes golf coursea disease can be tested through a blood test, one of which can be seen from the form of red blood cells. The normal and abnormal morphology of the red blood cells of a patient is very helpful to doctors in detecting a disease [2]

3.4.4 Construction mold.

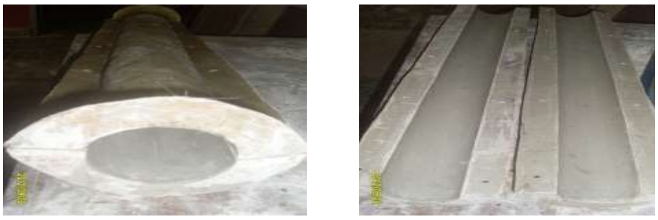


Figure 9. Mold when closed and opened.

Variabel observed in the fabrication process:

1. The time interval stirring composite materials to the casting time.
1. Distribution of composite materials in the field of mold cavity (fluidity).
2. Geometry and structural products.
3. **T**oughness products.

3.4.5 Fabrication for base stakes.
The proportion of portland cement mortar materials: cement, sand and water, 1: 2: 0.5. specification SNI 03-6882-2002. Central point graphic is void d = 25 mm, a depth of 4 mm hole.

Figure 10. Produce of base

3.5 Computer Simulation
The height of the impact point was 460 mm, the trajectory of the golf ball elevation angle of 30 ° using a 11 ° driver golf ball is lofted speed, v: 66.2 m / s, 70 m / s, 78.2 m / s (velocity USGA research, speed of a golf ball).

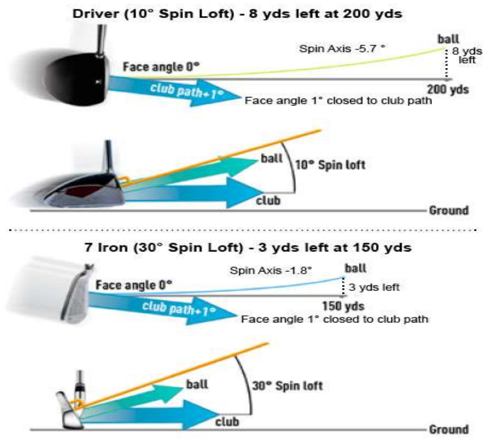


Figure 11. Driver golf ball

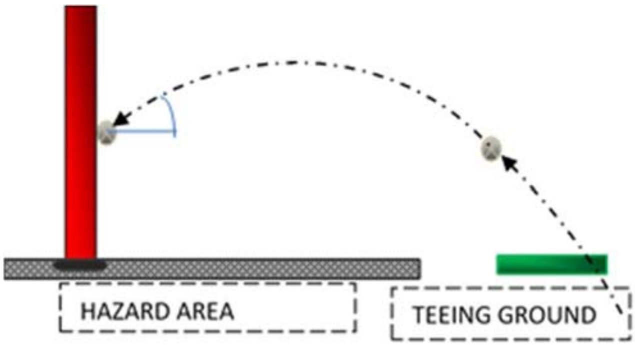


Figure 12. Impact Simulation scheme.

Golf ball with an initial velocity v_o and 30° elevation angle α_o the initial velocity component in the X-axis, vox, and the Y-axis, $v_o y$ then when v = 66.2 m / s:

$$v_0x = 66{,}2 \cos 30 = 57{,}33 \text{ m/s} \quad (1)$$

$$v_0y = 66{,}2 \sin 30 = 33{,}1 \text{ m/s} \quad (2)$$

Moment of inertia which occur on the hazard stakes golf course is:

$$\sigma = \frac{Mc}{I} = \frac{F.l.\frac{1}{2}d}{\frac{\pi}{64}d^4} = \frac{32F.l}{\pi d^3} \quad (3)$$

Creating 3D objects to stakes golf courses, as follows:

1. Open ANSYS Workbench 14.0 as shown in (Figure 13, select the Geometry tab Component System.

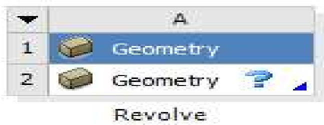
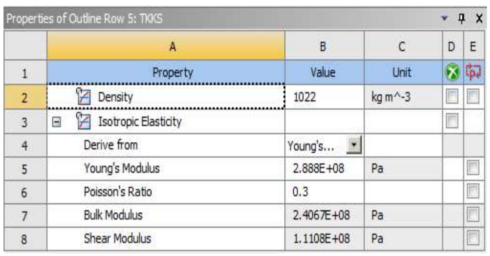


Figure 13. *Start* ANSYS.

2. The exchange into mode sketching and select line.
3. Click on Data Engineering (Figure 14).


Properties of Outline Row 5: TKKS

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	1022	kg m^-3		
3	Isotropic Elasticity				
4	Derive from	Young's...			
5	Young's Modulus	2.888E+08	Pa		
6	Poisson's Ratio	0.3			
7	Bulk Modulus	2.4067E+08	Pa		
8	Shear Modulus	1.1108E+08	Pa		

Figure 14. Engineering Data.

1. *Meshing* (Figure 15),→ *Generate Mesh*.

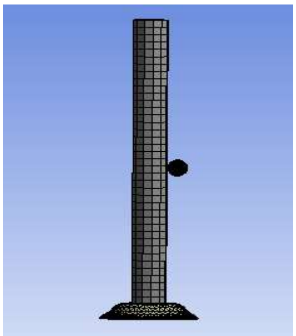


Figure 15. *Meshing*.

2. Right click on *solution* (Figure 16) → *Deformation* → *Total Deformation*.
3. *Solve.*

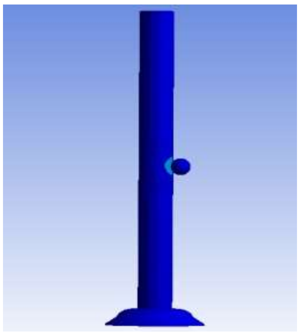


Figure 16. Simulation result.

3.6 Flowchart of Research

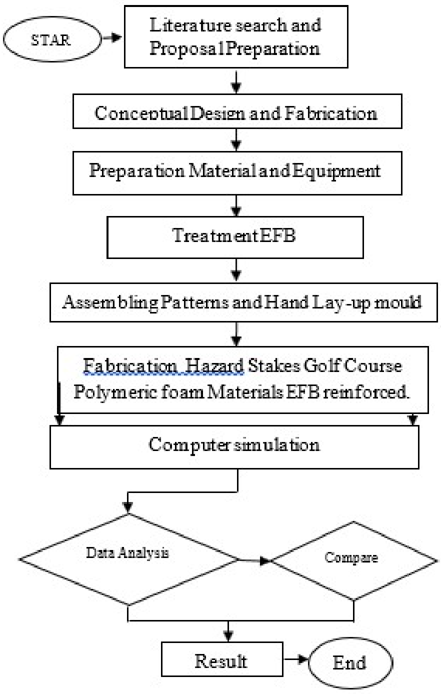


Figure 17. Flowchart of Research

3.7 Variable Research
Variables observed in this research:
1. Design of product models.
2. Treatment of EFB into fibers.
3. Selection of materials and process engineering hand lay-up mold.
4. Dimensional of geometric mold.
5. Kompositas engineering polymeric materials EFB fiber reinforced foam.
6. Kompositas the time interval until pouring into molds.
7. Stress distribution / computer simulation.

4. Results and Discussion

4.1. Treatment of Oil Palm Empty Fruit Bunch.
The addition of 1% NaOH while soaking can reduce the fat content and acid, eliminates odors resulting yarn is soft fibers. Fiber size in dry conditions after crushed by crusher machine with a mesh size of 0.8 mm diameter fiber length obtained 2 mm - 5 mm.

4.2. Component Fabrication procedure Stakes.
1. Container I: Compound Resin and EFB fiber stirred evenly over time 0:00:24.
2. Pour catalyst into the firs tcontainer and stirred for a time 0:01:07.
3. Stirring polyol and isocyanate in containers II during a time 0:00:15.
4. Compounding the container material is poured into the container I to container II, during the time of 0:02:30.
5. Pouring into molds at a time 0:03:20

Figure 18. Fabrication circle.

Stirring time blowing agent effective: 10-15 seconds, the time on the verge of blowing agent to foam the granules begin to harden, these events may lead to material failure (Figure 19).

Figure 19. failure of the mechanical properties.

4.3 Fabrication Process observation.
Form in proportion to the conceptual design is obtained, if:
1. Engineering choosing the right materials.
2. The accuracy of dosing material.

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3. The time interval composition is right.
4. Understand that the integration process with interval compotition rapid pouring in a record short time.

Base Type Model:
Tipe I=2407 gr, Tipe II=1942 gr, **Tipe III=1549 gr.** Proporsi Mortar 1:2:0,5 (SNI 03-6882-2002).

Figure 20. Base Type Model.

Fabrication yield components assembled as shown in Figure 21

Figure. 21 Fabrication results (weight 1550 g).

4.4. Simulation result

4.4.1. Impact point height 460 mm.

Simulations show that the stress distribution caused by impact force with the lowest values occur at v = 18 m / s as shown in Figure 22. Total deformation of 8.7461 mm, maximum strain of 0.08099 mm / mm, maximum stress (von-Mises) at 48.863 MPa, and the normal stress (X - axis) of 14.006 MPa (time: 4.6952 E-004).

Table 3. Stress response of the impact point 460

V VELOCITY (m/s)	Force (KN)	Total Deformasi (mm)	Eq.Elastic Strain (mm/mm)	Eq.von-mises Stress (MPa)	Normal Stress (x Axis) (Mpa)
18	14,842	8,7461	0,08099	48,863	14,006
35	31,982	10,186	0,13073	101,63	53,625
66,2	42,881	18,029	0,2617	262,24	41,219
70	41,225	16,786	0,33499	336,61	46,276
78,2	46,450	9,0478	0,96072	727,39	119,04

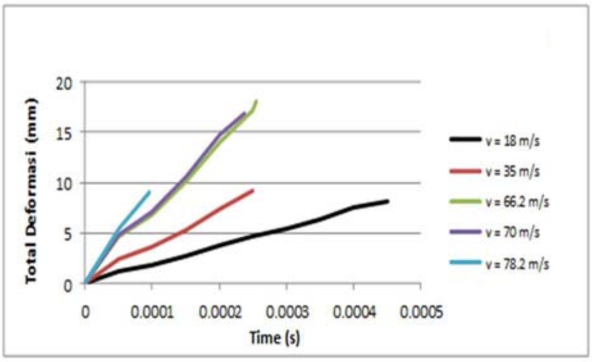

Figure 22. Time vs. Deformasi

Figure 23 shows the elastic strain when v = 78.2 m / s and impact loading, F = 46.450 KN increased strain, ϵmaks = 0.96072 mm / mm, at the time (time: 2.3922 E-004). $Strain_{min}$ occurs at, v = 18 m / s, ϵmin = 0.8099 mm / mm over time (time: 4.2635 E-004).

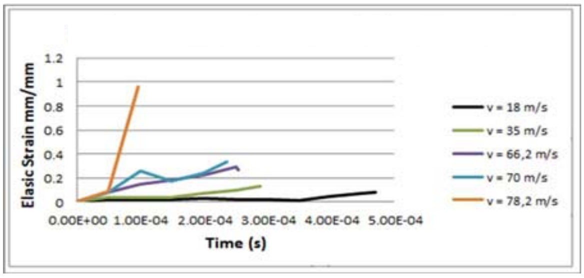

Figure 23. Time vs. Eq.Stress.

Figure 24 shows Normal stress min. = -57.947 MPa and a maximum of 58.609 MPa (time: 2.8474 e-004) occurs at a constant velocity, v = 66.2 m/s.

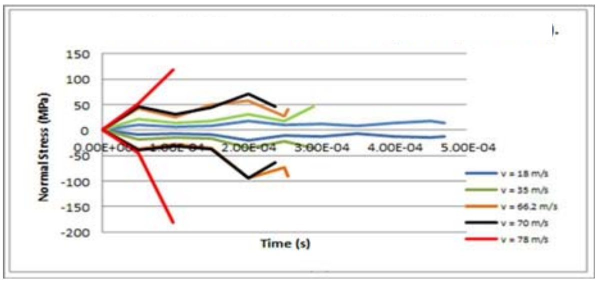

Figure 24. Time vs. Normal stress.

5. Conclusion

1. Design product model has been developed using solid work 2010.
2. Permanent mold type (permanent mold) using paste material: resin, talc powder and E-glass fiber reinforced.
3. Soaking TKKS using NaOH 1% of the volume of water for 48 hours can reduce the fat content of the resulting fiber TKKS approximately 9% - 10% to 1.5% - 2%.
4. Thoroughness and accuracy intervals stirring up the process of casting material into the mold cavity (cavity mold) on a periodic basis (mixing resin, blowing agent, catalyst and fiber is 00:02:30, pouring into molds 00:03:20).
5. Simulation results: area deformation and strain is concentrated at a point about cross-sectional area of impact loading. Impact simulation on height 460 mm, v = 78.2 m / s, an explicit dynamic

loading style, Fmaks = 119.34 KN yield stress (von-Mises) maximum, σ_{maks} = 727.39 MPa, ϵ = 0.960 mm / mm , the normal stress σn = 119.04 MPa, stress distribution is concentrated around the cross point impact, do not experience the effects of hysteresis and inertia, meaning that stakes golf course has the toughness of a geometric functional which is able to absorb impact energy.

Suggestion

1. Research needs to be supported by equipment golf game simulator.
2. EFB should still fresh pressure is applied using a hydraulic press before soaking the fiber treatment.
3. Need further research to design creative models and maximum formative.

References

[1] Bergstrom J S 2006 Advanced Finite Element Modeling of Polymer Foam Component *ABAQUS Conference*
[2] Syam B, Weriono, Rahmawati 2009 Analysis of Concrete and Rubber Alas of Traffic Cone Subjected to Impact Loading (accepted to be presented in the 6th Conf. on Numerical Analisys in Engineering, Lombok Island, Indonesia)
[3] Hermiati E 2007 Efforts to Reduce Dirt and Extracts on Oil Palm Bunches by Washing (UPT Balai Litbang, LIPI)
[4] Stewart J 1998 Calculus, Fourth Edition (By: A Division of International Thomson Publishing Inc)
[5] Syam B, Weriono, Rahmawati Analysis of Concrete and Rubber of Traffic Cone Subjected to Impact Loading