The 2nd ICST 2017

Lombok - Indonesia. August, 23rd - 24th 2017

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The 2nd International Conference on Science and Technology

"Joint International Conference on Science and Technology in The Tropic"

at University of Mataram
West Nusa Tenggara, Indonesia

August, 23rd - 24th 2017

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Prof. Ir. H. Sunarpi, Ph.D.

The 2nd ICST 2017
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2nd ICST 2017
THE EMERGENCE OF SCIENCE FOR HUMAN PROSPERITY AND HEALTH

Dr.rer.nat. Lalu Rudyat Telly Savalas

2nd ICST 2017

THE EMERGENCE OF SCIENCE FOR HUMAN PROSPERITY AND HEALTH

Joint International Conference on Science and Technology in The Tropic

Organized by:
University of Mataram, Indonesia and University of Malaya, Malaysia

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Keynote Speaker 1	**Prof. Ir.H. Sunarpi,Ph.D** (University of Mataram,)	**Indonesia**
Keynote Speaker 2	**Prof. Dr. Dato' Azizan Abu Samah** (University of Malaya,)	**Malaysia**
Keynote Speaker 3	**Prof. Franl Lavigne** (Universite Paris)	**France**
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Keynote Speaker 7	**Prof. Dr. Akihiro Hazama, MD** (Fukushima Medical University)	**Japan**
Keynote Speaker 8	**Dr. Wenjia Hu** (Third Institute of Oceanigraphy)	**China**
Keynote Speaker 9	**Prof. Julian Heyes** (Massey University)	**New Zealand**

PREFACE

Bismillaahirrahmaanirrahiim
Assalaamu'alaikumwarahmatullaahwabarakaatuh.
Peace be upon us.

Praise always we pray to God Almighty for giving us the abundance of grace, guidance and inayah, so that we all can meet here in the "2nd International Conference on Science and Technology (ICST) 2017". The theme of this conference is "The Emergence of Science for Human Prosperity and Health" where this conference is joint international conference between Mataram and Malaya University.

First of all, I would like to welcome you all to West Nusa Tenggara Province specially Lombok Island, "the Island of Thousand Mosques", which is famous to its many natural resource and beautiful tourism destinations where you can enjoy them while attending the conference. This conference will be held for two days, from 23rd to 24th August 2017, and took place in campus of the University of Mataram.

So far, we received one hundred fifty papers from various universities and research institutions in Indonesia and from overseas. The paper have been selected and grouped based on the similarity of the research field, which then are presented and discussed. Presentation of the papers will be held in seven parallel classes and poster presentation. The Selected papers will be published in Malaysian Journal of Science (Special Issue) which index by Scopus, and the rest will be published in the Conference Proceedings. Additionally, selected paper in aquaculture have the opportunity to be published in Jurnal Akuakultur Indonesia.

At this moment, the organizing committee would like to express our gratitude to all of you for your participation on this conference, especially to the all keynote speakers, presenters who have submitted for both oral and posters presentations and also to all participants. Our special gratitude also goes to the Rector of the University of Mataram and Vice Chancellor of Malaya University, who have been highly supporting this conference. Critics and suggestions on the implementation of this conference will be appreciated and as much as possible we will improve the next ICST. Last but not least, the organizing committee would like to thank to all of you who have supported this conference.

Have an enjoyable conference.
Wassalamu'alaikum warohmatullahi wabarakatuh.

Chairman of 2nd ICST 2017

Dr.rer.nat. Lalu Rudyat Telly Savalas, M.Si.

OPENING SPEECH - RECTOR THE UNIVERSITY OF MATARAM
The 2nd International Conference on Science and Technology 2017

Joint International Conference on Science and Technology in The Tropic Beetwen Mataram and Malaya Universiti

Respected Guests,
Keynote speakers,
Conference participants,
and all other participants.

On Behalf of all staffs of the University of Mataram, I welcome you all to Lombok, a beautiful island in West Nusa Tenggara Province, where the University of Mataram is located. Lombok is known for its natural and cultural diversity where you can enjoy traditional cuisines, beaches, waterfalls, mountain, traditional villages and handicraft of many ethnics including Sasak, Samawa, Mbojo, Balinese, Chinese, Arabic, and many others.

As the Rector of the University of Mataram, it is a great honour for me to address the opening of "The 2nd International Conference on Science and Technology" here at the University of Mataram, which will be held from 23rd to 24th August 2017, with a theme "The Emergence of Science for Human Prosperity and Health". The main aim of this seminar is to gather scientist from all over the world to share their ideas, knowledge and experiences and to build network for possible future collaboration.

As we are aware that sharing knowledge and experiences from speakers are extremely valuable in a conference, therefore I would like to express my high appreciation, first, to the keynote speakers from overseas and from Indonesia for their willingness to come to Lombok to share their acknowledged works. Your effort and contribution to this conference are absolutely valuable. Second, my high appreciation also goes to the national speakers and all other participants, including the speakers from University of Mataram and local universities in West Nusa Tenggara Province, your participation in this conference not only will give incredible share of ideas, skills and knowledge that you have, but also will improve the academic environment that we are developing in this university. I hope this conference will be a good forum, not only for communicating and sharing ideas, knowledge and experiences, but also for building networking for future collaboration.

I would also like to take this opportunity to express my appreciation to the sponsors which have given some contribution to this conference. Last but not least, I would like to thank the organizing committee as well as all other supporters and participants, without their effort, commitment and hard work, this conference will not run well.

Finally, I wish you most successful conference, enjoy Lombok Island and hope to see you again in other forum here at the University of Mataram.

Rector of the University of Mataram

Prof. Ir. Sunarpi, Ph.D

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Finite Element Modelling Of Creep Glued-Laminated Bamboo

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Abstract

Glued-laminated bamboo is classified as a viscoelastic material because it possesses properties that are common to both perfect solids and liquids. Under long term constant loading the glued-laminated bamboo will causing creep deformation. Creep behaviour is well known as one of the primary structural behaviours to be understood for the development analysis and design of glued-laminated bamboo structures. There are three methods can be used to describe the creep behaviours of viscoelastic material. One method of predicting the creep response of some viscoelastic materials is by mechanical model, where the long term creep deformation represented by a set of springs and dashpots. The well accepted mechanical model to predict creep of glued-laminated bamboo is the four solid elements, usually called Burger model. In this manuscript, the constitutive equation Burger model is converted into relaxation shear modulus of prony series in ABAQUS finite element software.

***Keywords*:** glued-laminated bamboo, creep, finite element, burger model, prony series

1. Introduction

In recent years, bamboo has been widely used to replace timber as building material. The bamboo can typically be harvested in less than 3 - 4 years, renewable and sustainable material, mechanical properties similiar with timber (Sharma et al., 2015; Ni et al., 2016). The originally bamboo cross section is hollow and has limited dimension. By using laminated technology, the rectangular elements of bamboo glued together will product new material called glued-laminated bamboo. Its have been applicated to many members of building structures such as beam, column and truss.

Glued-laminated bamboo is classified as a viscoelastic material because it possesses properties that are common to both perfect solid and liquid. Under long term constant loading the glued-laminated bamboo will causing creep deformation. Creep behaviour is well known as one of the primary structural behaviours to be understood for the development analysis and design of glued-laminated bamboo structures (Holzer et al., 1989; Gottron et al., 2014). Usually, three methods can be used to describe the creep behaviours of viscoelastic material. One method of predicting the creep response of some viscoelastic materials is by mechanical

model, where the long term creep deformation represented by a set of springs and dashpots (Findley et al., 1976). The well accepted mechanical model to predict creep of glued-laminated bamboo is the four solid elements, usually called Burger model. This model has been proved in many creep tests, it not only can be applied to describe the creep phenomenon but also can be used in the program of finite element method conveniently. In this manuscript, the constitutive equation Burger model is converted into relaxation shear modulus of prony series in ABAQUS finite element software.

2. Burger Model of Creep

Burger model is derived by assembling Kelvin and Maxwell bodies in parallel configuration (Fig. 1). The model capable to predict both primary and secondary creep.

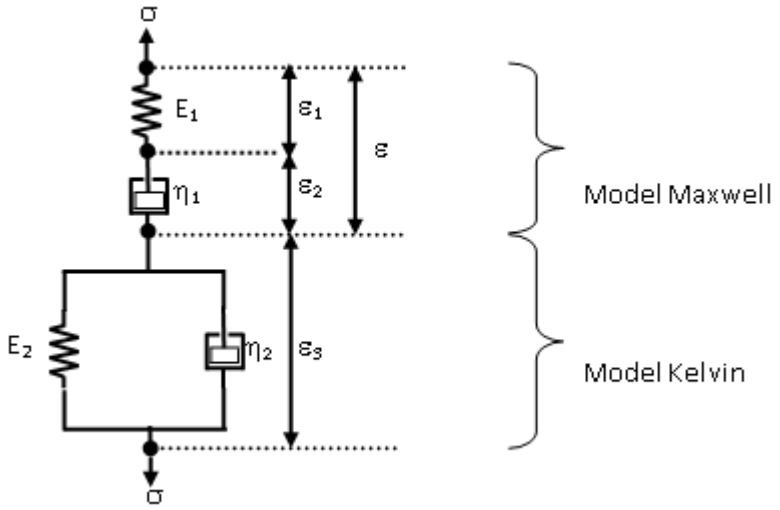

Figure 1. Mechanical Element of Burger Model (Findley et al., 1976)

Kon and Yuan (2010) have been converted Burger model to prony series. Constitutive equation of Burger model can be expressed as

$$\sigma + p_1\dot{\sigma} + p_2\ddot{\sigma} = q_1\dot{\varepsilon} + q_2\ddot{\varepsilon} \tag{1}$$

p_1, p_2, q_1, q_2 expressed by elastic modulus then

$$p_1 = \frac{\eta_M E_M + \eta_M E_K + \eta_K E_M}{E_M E_K}, p_2 = \frac{\eta_M \eta_K}{E_M E_K}, q_1 = \eta_M, q_2 = \frac{\eta_M \eta_K}{E_K} \tag{2}$$

If $E_M = 2G_M, E_K = 2G_K, \eta_M = 2\eta'_M, \eta_K = 2\eta'_K$, so

$$p_1 = \frac{\eta'_M G_M + \eta'_M G_K + \eta'_K G_M}{G_M G_K}, p_2 = \frac{\eta'_M \eta'_K}{G_M G_K}, q_1 = 2\eta'_M, q_2 = 2\frac{\eta'_M \eta'_K}{G_K} \quad (3)$$

where,

$$G_M = \frac{E_M}{2(1+\mu_M)}, G_K = \frac{E_K}{2(1+\mu_K)}$$

$$\eta'_M = \frac{\eta_M}{2(1+\mu'_M)}, \eta'_K = \frac{\eta_K}{2(1+\mu'_K)} \quad (4)$$

If the deformation of viscoelastic bulk ignored, where $\mu_K = \mu'_M = \mu'_K = 0{,}5$

Convert Burger model into Laplace transform

$$\bar{Y}(s) = \frac{q_1 s + q_2 s^2}{s(1 + p_1 s + p_2 s^2)} = \frac{1}{p_2}\left\{\left[\frac{q_1}{(s+\alpha)(\beta-\alpha)} + \frac{q_1}{(s+\beta)(\alpha-\beta)}\right]\right.$$

$$\left. + \left[\frac{q_1\alpha}{(s+\alpha)(\alpha-\beta)} + \frac{q_1\beta}{(s+\beta)(\beta-\alpha)}\right]\right\} \quad (5)$$

$$\alpha, \beta = \frac{p_1 \pm \sqrt{p_1^2 - 4p_2}}{2p_2}$$

Then Laplace inverse transform is applied to the last expression, so

$$Y(t) = \frac{G_M}{(\alpha-\beta)}\left[(\alpha - \frac{q_1}{q_2})e^{-\alpha t} + (\frac{q_1}{q_2} - \beta)e^{-\beta t}\right] \quad (6)$$

Relaxation shear modulus is requested in ABAQUS, substitution Eqs (2 - 3) into (5).

$$G(t) = \frac{G_M}{(\alpha-\beta)}\left[(\frac{G_K}{\eta_K} - \beta)e^{-\beta t} + (\alpha - \frac{G_K}{\eta_K})e^{-\alpha t}\right] \quad (7)$$

In prony series form,

$$G(t) = G_\infty + \left(\sum_{i=1}^{n} G_i G_0 e^{(-t/\tau_i)}\right) \quad (8)$$

Eqs (8) the series can be expanded into two items (n = 2),

$$G(t) = G_\infty + G_1 e^{(-t/\tau_i)} + G_2 e^{(-t/\tau_2)} \quad (9)$$

where

$$G_\infty = 0, G_1 = \frac{G_M}{(\alpha-\beta)}\left(\frac{G_K}{\eta'_K} - \beta\right), G_2 = \frac{G_M}{(\alpha-\beta)}\left(\alpha - \frac{G_K}{\eta'_K}\right), \tau_1 = \frac{1}{\beta}, \tau_2 = \frac{1}{\alpha}$$

If,

$$g(t) = \frac{G(t)}{G_0}$$

$$G(t) = G_\infty + G_0(g_1 e^{(-t/\tau_i)} + g_2 e^{(-t/\tau_2)}) \quad (10)$$

where

$$G_0 = G_M, g_1 = \frac{1}{(\alpha-\beta)}\left(\frac{G_K}{\eta'_K} - \beta\right), g_2 = \frac{1}{(\alpha-\beta)}\left(\alpha - \frac{G_K}{\eta'_K}\right)$$

$E_M, \mu_M, g_1, g_2, \tau_1, \tau_2$ are parameters of Burger model which can be used in ABAQUS software.

3. Finite Element Modelling Creep

The 3D model of the glued-laminated bamboo beam was created and analysed with finite element software ABAQUS. Properties creep data that used for modelling in this manuscript was provided by Li and Xiao (2015). They were measured compression and tension creep of glued-laminated bamboo under normal indoor condition at Hunan University, located in Changsha during one year (365 days). According to the Burger model, data creep test then evaluated resulting some parameters viscoelastic material of glued-laminated bamboo such as $E_1 = E_M$, $E_2 = E_K$, $\eta_1 = \eta_M$, $\eta_2 = \eta_K$ showed in Table 1 and conversed in prony series showed in Table 2. The model glued-laminated bamboo beam according Eratodi (2014), showed in Fig 1, with different load level P = 10 kN, 20 kN, 30 kN respectively

The procedures are modelling creep of glued-laminated bamboo as follow (i) create geometry of glued-laminated bamboo; (ii) input the material properties and creep parameters; (iii) use element type C3D20R (20-node quadratic brick, reduced integration), the mesh consist of 2280 elements; (iii) apply the constant loading under various applied load level and boundary condition; (iv) use visco analyse type with time periode 365 days, increment 1 and error tolerance 1 x 10^{-6}. The geometry, meshing, apply constant load and boundary condition showed in Fig. 2.

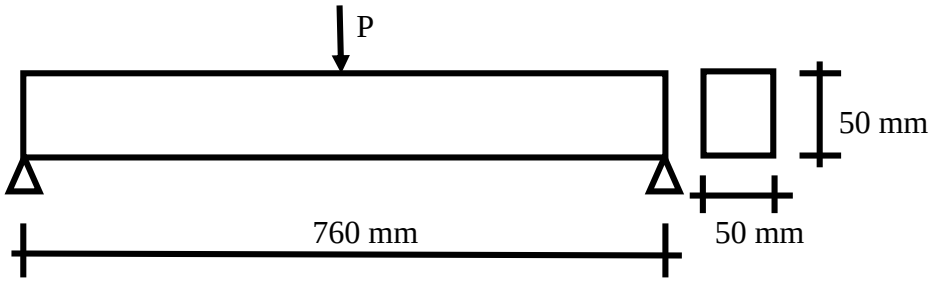

Figure 1. Glued-Laminated Bamboo Beam (Eratodi, 2014)

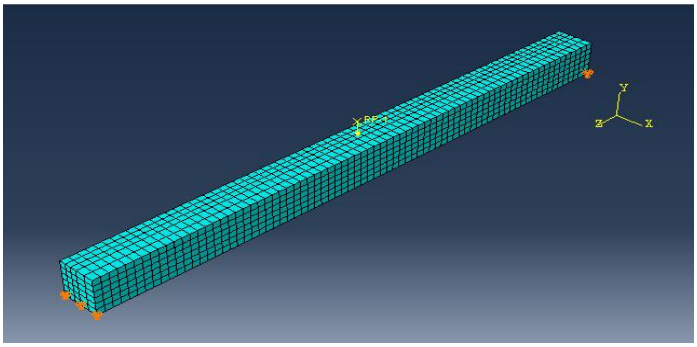

Figure 2. The geometry, meshing, apply constant load and boundary condition glued-laminated bamboo beam

Table 1. Creep properties compression and tension of glued-laminated bamboo (Li and Xiao, 2015)

Parameter	Unit	Compression	Tension
$E_1 = E_M$	MPa	4490	5970
$E_2 = E_K$	MPa	3440	1330
$\eta_1 = \eta_M$	MPa/day	27600000	15100000
$\eta_2 = \eta_K$	MPa/day	651300	102400

Table 2. Creep properties compression and tension of glued-laminated bamboo in prony series

Parameter	Compression	Tension
g_1	0,88	0,18
τ_1	6951,51	13945,73
g_2	0,11	0,81
τ_2	16,74	13,96

4. Result and Discussion

The results numerical simulation creep displacement behavior of glued-laminated bamboo beam under different load level P = 10 kN, 20 kN and 30 kN showed in Fig. 3 and the maximum diplacement in mid span U_2 showed in Fig. 4, 5, 6 repectively.

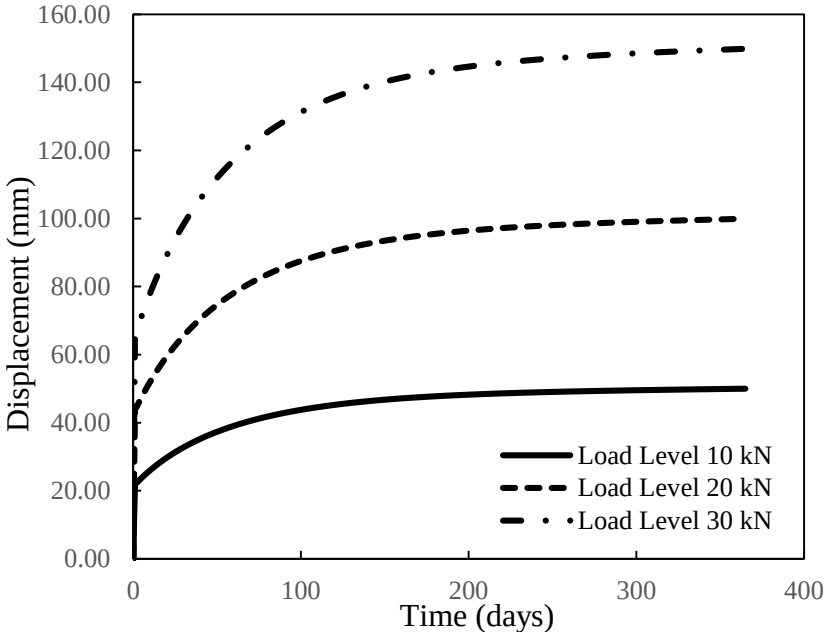

Figure 3. Creep displacement U_2 under constant load

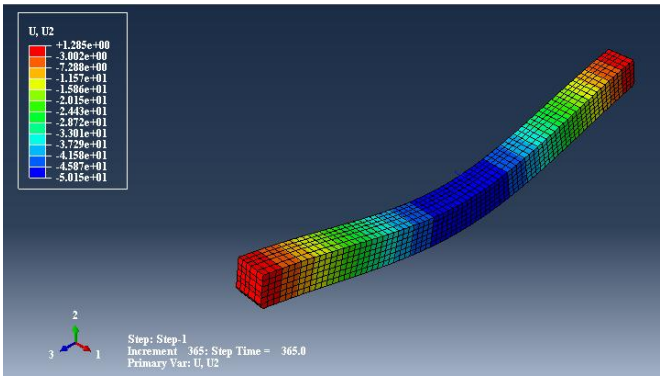

Figure 4. Creep displacement U_2 apply constant load level 10 kN

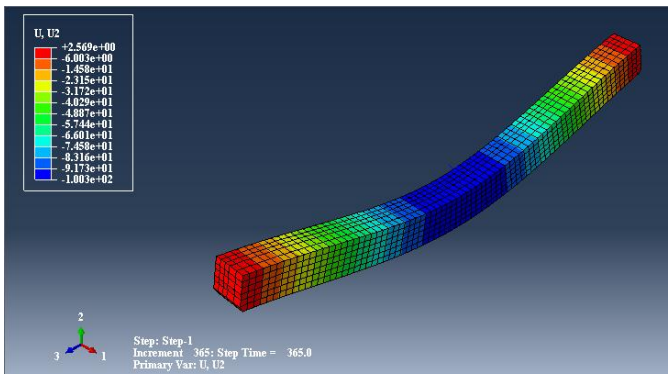

Figure 5. Creep displacement U_2 apply constant load level 20 kN

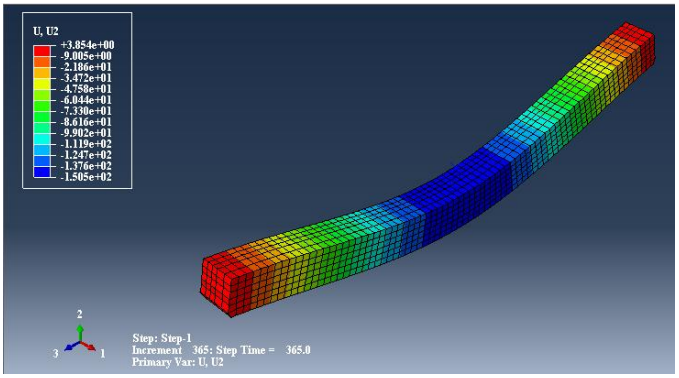

Figure 6. Creep displacement U_2 apply constant load level 30 kN

According to the Fig 3., the initial elastic and creep diplacement of the beam increases in proportion to the load level. The initial elastic diplacement for load level 10 kN, 20 kN, 30 kN are 21.83 mm, 43.65 mm, 65.48 mm respectively. Here the authors also can evaluate quickly initial elastic diplacement based to the elastic theory, displacement of the beam under one unit point load in mid span $\Delta_e = PL^3/48EI$ are 29.41 mm, 58.82 mm, 88.24 mm respectively. In comparison, we can see that the magnitude elastic diplacement theory are more greater than numerical analysis. The graphic also show primary and secondary creep behaviour of the beam.

The Fig. 4- 6 ilustrate distribution of creep diplacement at time 365 days in the span length. The maximum creep diplacement in various load level 10 kN, 20 kN, 30 kN are 50.15 mm, 100.30 mm, 150.50 mm respectively.

4. Conclusion

Some conclusions according numerical analysis above can be drawn as follows: (1) Burger Model can be used as input parameter properties in ABAQUS with conversed in prony series; (2) The finite element analysis is satisfy method for prediction creep diplacement behaviour of viscoelastic material glued laminated bamboo under constant loading.

References

Abaqus Version 6.4 (2003). Abaqus/CAE User's Manual. Pawtucket. Rhode Island. USA.

Eratodi I. G. L. B. (2014). Beam-Column Connection Glued-Laminated Use Steel Plate Dikarter and, Desertasion, Postgraduate Program, Faculty of Engineeering, Gadjah Mada University, Yogyakarta.

Findley M. N., Lai J. S., & Onaran K. (1976). Creep and Relaxation of Nonlinear Viscoelastic Material with Introduction to Linear Viscoelastic, Dover Publication, Inc. New York.

Gottron J., Harries K. A., & Xu Q. (2014). Creep Behavior of Bamboo. *Contruction and Building Material 66*, pp. 79-88.

Holzer S. M., Loferski J. R., & Dillard D. A. (1989). A Review of Creep in Wood : Concepts Relevent to Develop Long-Term Behavior Predictions for Wood Structures. *Wood and Fiber Science, 21(4),* pp. 376-392

Kong J., & Yuan J. (2010). Application of Linear Viscoelastic Differential Constitutive Equation in ABAQUS. *International Conference On Computer Design And Appliations (ICCDA).*

Li L. & Xiao Y. (2015). Creep Behavior of Glubam and CFRP-Enhanced Glubam Beams. *Journal of Compositers for Contruction, June 10*, pp 1-11.

Ni L., Zhang X., Liu H., Sun Z., Song G., Yang L., Jiang Z. (2016). Manufacture and Mechanical Properties of Glued Bamboo Laminates, Glued Bamboo Lumber. *BioResources 11(2),* pp 4459 – 4471.

Sharma B., Gatoo A., Bock M., Ramage M. (2015). Engineered Bamboo for Structural Applications. *Construction and Building Material 81*, pp. 66-73.