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Home > About the Journal > **Editorial Team**


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- Focus and Scope
- Section Policies
- Peer Review Process
- Publication Frequency
- Open Access Policy
- Publication Ethics
- Plagiarism Policy
- Author Fees

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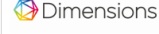
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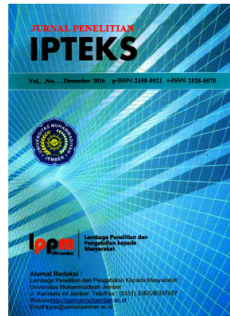




Home > Vol 6, No 1 (2021)

## Jurnal Penelitian IPTEKS

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### Announcements

No announcements have been published.

[More Announcements...](#)

### Vol 6, No 1 (2021): JURNAL PENELITIAN IPTEKS

#### Table of Contents

<b>Analisis Daya Dukung Tanah Pada Pondasi Dangkal Dengan Metode L Heminier Dan Meyerhof</b>	PDF (BAHASA INDONESIA)	1-5
DOI : 10.32528/ipteks.v6i1.4171    Abstract views : 24 times		
Hilfi Harisan Ahmad		
<b>Pendugaan Kebutuhan Air Tanaman Terhadap Tiga Rotasi Penanaman Padi, Jagung dan kedelai Dengan Istirahat Satu Minggu di Antara Tanam Dengan Aplikasi Cropwat</b>	PDF	6-15
DOI : 10.32528/ipteks.v6i1.5110    Abstract views : 40 times		
Abdul Jali		
<b>Pengaruh Pendidikan Kesehatan Hipertensi Dan Senam Hipertensi Terhadap Tekanan Darah Pada Lansia di Desa Jenggawah dan Ajung Kabupaten Jember</b>	PDF	16-21
DOI : 10.32528/ipteks.v6i1.5111    Abstract views : 32 times		
Cahya Tribagus Hidayat		
<b>Analisis Pendapatan Usahatani Dan Efisiensi Pemasaran Jamur Merang (Volvariella volvaceae) Di Kecamatan Ajung Kabupaten Jember</b>	PDF	22-32
DOI : 10.32528/ipteks.v6i1.5112    Abstract views : 17 times		
Annisa Istiforin Qorina, Henik Prayuginingsih, Syamsul Hadi		
<b>Analisis Kemampuan Guru Pendidikan Agama Islam Dalam Penyusunan Rencana Pelaksanaan Pembelajaran (RPP) Kurikulum 2013</b>	PDF	33-43
DOI : 10.32528/ipteks.v6i1.5113    Abstract views : 7 times		
Siti Nursyamisyah, Abdurachman Habibullah, Achmad Aminullah		
<b>Kebijakan Pemerintah Indonesia Untuk Membebaskan Narapidana Sebagai Upaya Pencegahan Penyebaran Covid-19 Di Lapas</b>	PDF	44-51
DOI : 10.32528/ipteks.v6i1.5115    Abstract views : 17 times		
Fauziah Fauziah, Vidya Ayu Herawati		
<b>Konsep Pendidikan Akhlak Luqmanul Hakim ( Kajian Tafsir Al-Misbah Dan Al-Maraghi )</b>	PDF (BAHASA INDONESIA)	52-61
DOI : 10.32528/ipteks.v6i1.5251    Abstract views : 24 times		
Fauziah Mujayyannah, Benny Prasetya, Nur Khasiah		
<b>Kerja Sama Orang Tua Dan Guru Dalam Membangun Kreativitas Siswa Madrasah Ibtidaiyah Melalui Pembelajaran Online</b>	PDF (BAHASA INDONESIA)	62-71
DOI : 10.32528/ipteks.v6i1.5252    Abstract views : 14 times		
Nur Khasiah, Ari Susandi, Agustarini Eka Dheessari		
<b>Nilai-Nilai Pendidikan Akhlak Dalam Kitab Risalatul Mu'awanah Dan Relevansinya</b>	PDF (BAHASA INDONESIA)	72-89
DOI : 10.32528/ipteks.v6i1.5253    Abstract views : 29 times		
Muhammad Syamsi Harimulya, Benny Prasetya, Devi Habibi Muhammad		
<b>Pengaruh Jarak Klem Selang Pada Kuat Tarik Tulangan Bambu</b>	PDF (BAHASA INDONESIA)	90-96
DOI : 10.32528/ipteks.v6i1.5282    Abstract views : 29 times		
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Page 1 of 11 Total Records : 1

No	Journal Name	Impact ↑	H5-Index	Citations (5 Years)	H-Index	Citations
1	Jurnal Penelitian IPTEKS Universitas Muhammadiyah Jember   ISSN : 25280570   P-ISSN : S4 	0	6	100	6	100

Page 1 of 11 Total Records : 1



## Pengaruh Jarak Klem Selang Pada Kuat Tarik Tulangan Bambu

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Diterima: Desember 2020 ; Dipublikasikan Januari 2021

### ABSTRAK

Tulangan bambu yang sudah dibentuk biasanya mempunyai permukaan licin hampir 50%. Namun, pada permukaan licin tulangan bambu adalah letak kekuatan serat yang paling tinggi. Tujuan penelitian ini adalah untuk meningkatkan kuat tarik tulangan bambu dengan memasang klem selang pada tulangan bambu. Metode yang digunakan adalah uji *pull-out* tulangan bambu dengan dimensi 15x15 mm<sup>2</sup> yang ditanam pada silinder beton berukuran diameter 150 mm dan tinggi 300 mm. Pengujian dilakukan dengan mesin UTM kapasitas 500 kN. Hasil pengujian menunjukkan bahwa kuat tarik cenderung linier positif seiring dengan meningkatnya jarak pemasangan klem selang. Tulangan bambu dengan *treatment* lapis perekat dan klem selang jarak 5 cm mempunyai kuat tarik tertinggi sampai 400,35% dari tulangan bambu normal. Penggunaan perekat pada tulangan bambu harus dilakukan sebagai lapis kedap air dan mengurangi permukaan licin.

**Kata kunci:** Tulangan bambu; Kuat tarik; Klem selang

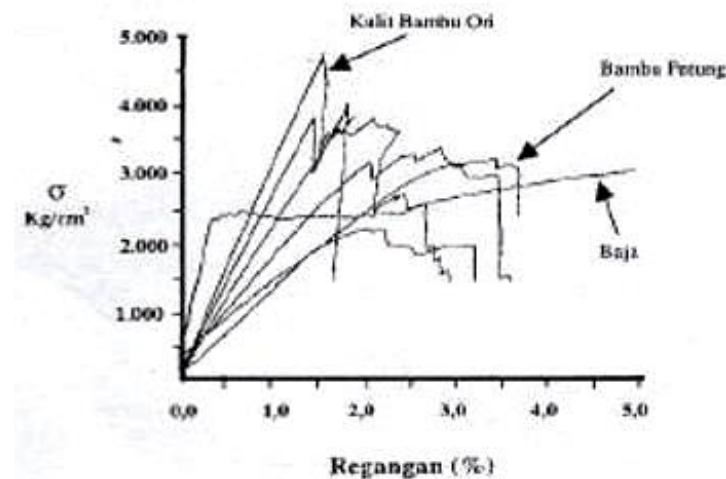
### ABSTRACT

*Bamboo reinforcement that has been formed usually has a smooth surface of almost 50%. However, on the slippery surface of bamboo reinforcement is the location of the highest-fiber strength. This study aimed to increase the tensile strength of bamboo reinforcement by installing hose clamps on bamboo reinforcement. The method used is a pull-out test of bamboo reinforcement with dimensions of 15x15 mm<sup>2</sup> which is planted in a concrete cylinder size 150 mm in diameter and 300 mm in height. The test was carried out with a UTM machine with a capacity of 500 kN. The test results show that the tensile strength tends to be positive linear as the distance between the hose clamps is increased. Bamboo reinforcement with adhesive layer treatment and hose clamps at a distance of 5 cm has the highest tensile strength of up to 400.35% of normal bamboo reinforcement. The use of adhesive on bamboo reinforcement must be done as a waterproof layer and reduce slippery surfaces.*

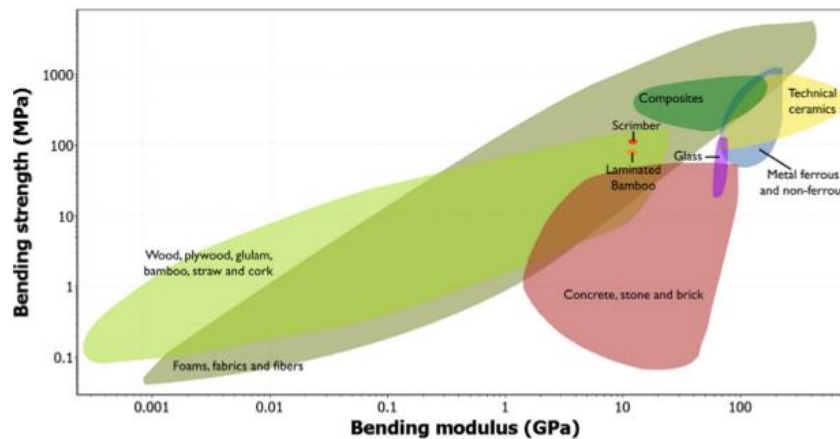
**Keywords:** Bamboo reinforcement; tensile strength; Hose Clamp

### PENDAHULUAN

Penggunaan bambu sebagai bahan bangunan konstruksi telah banyak digunakan oleh masyarakat pedesaan, seperti konstruksi rumah tinggal sederhana, rangka jembatan semi permanen, konstruksi rangka gudang, konstruksi turap pada saluran irigasi, dan sebagainya. Bahkan penggunaan bambu sebagai material alternatif pengganti tulangan baja dalam konstruksi beton telah banyak dilakukan oleh peneliti, diantaranya Ghavami (2005), Dewi & Nuralinah (2017), Mali & Datta (2020), Kathiravan et al. (2020), Muhtar et al. (2019), dan lain-lain. Alasan bambu digunakan sebagai material alternatif tulangan baja karena kuat tariknya yang cukup tinggi. Beberapa hasil penelitian menyatakan bahwa bambu memiliki kekuatan tarik yang tinggi mendekati tulangan baja sebagaimana Gambar 1 (Morisco, 1999), sehingga dapat digunakan sebagai tulangan beton. Ghavami (2005) menyebutkan kekuatan tarik bambu yang relatif tinggi dapat mencapai 370 MPa. Keuntungan lain dari bambu adalah kekuatan lentur dengan rasio kepadatannya. Gambar 2 memperlihatkan bahwa kuat lentur bambu laminasi lebih tinggi dari beton maupun bahan komposit alami lainnya (Sharma et al., 2015). Selain itu, kebutuhan energi yang digunakan untuk menghasilkan baja 50 kali lebih besar daripada bambu, sehingga bambu merupakan salah satu material yang ekonomis dan lebih ramah terhadap lingkungan.



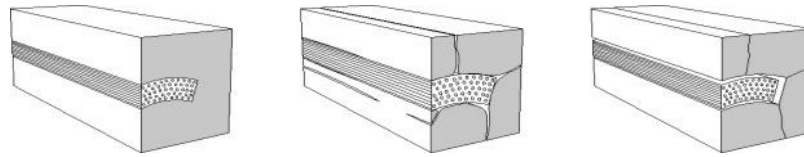
Gambar 1. Diagram Tegangan Regangan Tulangan Baja dan Bambu (Morisco, 1999)



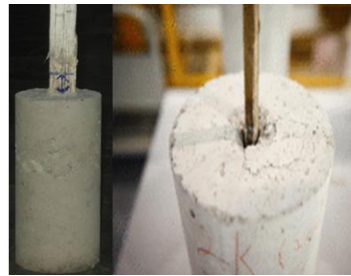
Gambar 2. Modulus lentur vs kuat lentur untuk macam-macam bahan konstruksi (Sharma et al., 2015)

Bambu untuk dapat digunakan sebagai tulangan beton, harus direndam, dikeringkan, dan dilapisi dengan lapisan kedap air (*waterproof*) seperti cat kayu, epoksi, melamin, vernis, dan lain-lain. Hal ini dimaksudkan untuk menghalangi terjadinya saling menyerap air antara bambu dan beton. Penyerapan air terjadi dua tahap. Tahap pertama waktu beton basah. Air beton basah diserap oleh bambu yang bersifat hygroskopis dan menyebabkan bambu mengembang (*swelling*). Gambar 3 menunjukkan masalah mengembangnya tulangan bambu tanpa *treatment* dalam beton. Pada tahap kedua sesudah beton mengeras, air yang ada di bambu diikat oleh molekul semen di dalam beton. Proses ini disebut proses hidrolisis yang berlangsung sampai waktu tak terhingga. Dengan demikian jika bambu tidak dilapisi dengan lapisan kedap air maka bambu yang semula banyak mengandung air lama kelamaan akan mengecil karena air bambu diikat oleh beton. Javadian et al., (2016) melakukan penelitian uji *pull-out* tulangan bambu yang diberi beberapa jenis lapisan epoxy dan pasir untuk menentukan perilaku ikatan antara beton dan tulangan bambu-komposit. Hasil penelitiannya menunjukkan bahwa tulangan bambu-komposit tanpa lapisan ikatan cukup memadai dengan matriks beton, namun dengan lapisan dasar epoxy dan partikel pasir bisa memberikan perlindungan ekstra tanpa kehilangan kekuatan ikatan. Oleh karena itu pemberian lapisan kedap air dan pelaburan pasir mutlak diperlukan.





**Gambar 3.** Pembengkakan tulangan bambu dalam beton, retak mikro, dan ekspansi tulangan bambu (Javadian et al., (2016)



**Gambar 4.** Pola keruntuhan slip pada silinder beton (Agarwal et al., 2014 dan Javadian et al., (2016)

Beberapa penelitian tentang kuat tarik dan kuat lekat tulangan bambu yang telah ditreatment dengan metode uji *pull-out* diantaranya Ghavami (2005), Agarwal et al. (2014), Nindyawati et al. (2013), Dey & Chetia (2016), dan Sakaray et al. (2012). Dari hasil penelitian yang telah dilakukan oleh beberapa peneliti menunjukkan bahwa kuat tarik dan kuat lekat meningkat, namun masih menunjukkan pola keruntuhan slip sebagaimana diperlihatkan pada Gambar 4. Hal ini menunjukkan kuat tarik dan kuat lekat tulangan bambu dan beton belum maksimal. Oleh karena itu, penelitian ini bertujuan meningkatkan kuat tarik dan kuat lekat tulangan bambu dan beton. Hipotesis penelitian ini adalah diduga pelaburan lapis kedap air, pelaburan pasir, dan pemasangan klem selang dapat meningkatkan kuat tarik maupun kuat lekat antara tulangan bambu dan beton.

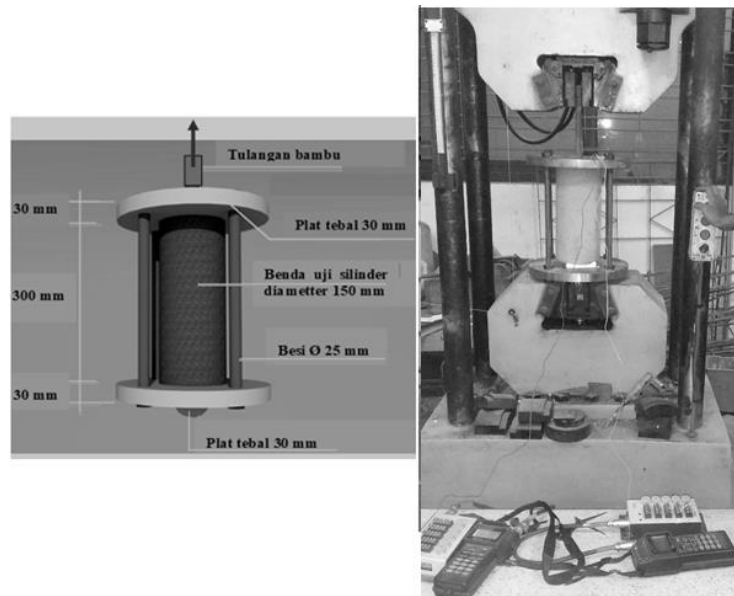
## METODE PENELITIAN

Uji cabut dilakukan pada tulangan bambu dengan dimensi 15 mm x 15 mm x 400 mm yang ditanam pada silinder beton sedalam 200 mm. Silinder beton berukuran diameter 150 mm dan tinggi 300 mm. Tulangan bambu ditanam pada titik pusat silinder. Proporsi campuran beton normal yang digunakan adalah semen portland pozzoland, pasir, agregat kasar, dan air dengan proporsi 1 PPC : 2 Ps : 3 Kr. Pengujian dilakukan dengan mesin UTM kapasitas 500 kN setelah silinder beton berumur 28 hari dari pengecoran. Pengujian uji cabut tulangan bambu mengikuti Ghavami (2005) dan Muhtar et al. (2019) yaitu menggunakan metode *Conventional pull-out test*.

Rancangan eksperimen uji cabut terdiri dari 6 perlakuan yang terdiri dari: (1) tulangan normal, (1) tulangan dengan klem-selang jarak 100 mm, (3) tulangan dengan Sikadur<sup>®</sup>-752, (4) tulangan dengan klem-selang jarak 5 mm + Sikadur<sup>®</sup>-752, (5) tulangan dengan klem-selang jarak 15 mm + Sikadur<sup>®</sup>-752, dan (6) tulangan dengan klem-selang jarak 20 mm + Sikadur<sup>®</sup>-752. Bentuk benda uji tulangan bambu ditunjukkan pada Gambar 5. Detail dan pengaturan uji *pull-out* dapat dilihat pada Gambar 6.



Gambar 5. Tulangan bambu dengan *treatment* pelaburan perekat, pelaburan pasir, dan klem selang



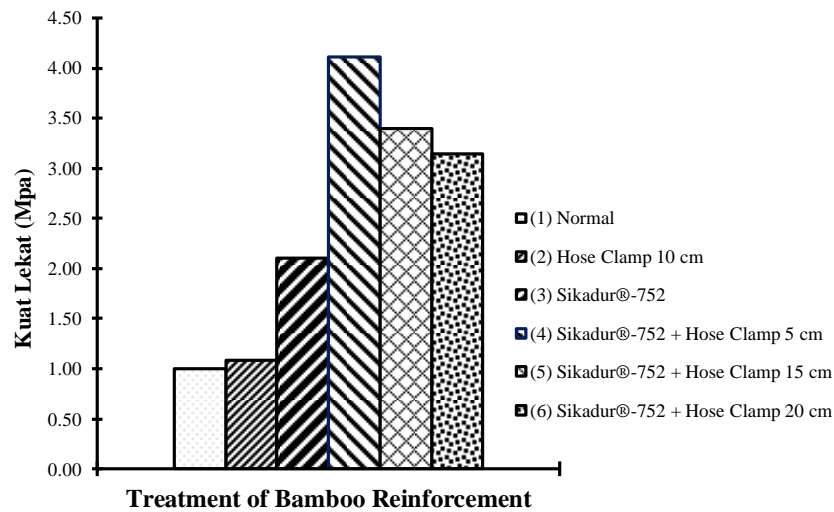
Gambar 6. Pengaturan uji *pull-out* tulangan bambu

## HASIL DAN PEMBAHASAN

Uji kuat lekat tulangan bambu yang tertanam pada silinder beton menggunakan mesin *Universal Testing Machine* (UTM) berkapasitas 1000 kN. Dari data hasil uji *pull-out* tulangan bambu dengan perlakuan pelaburan perekat sikadur<sup>®</sup>-752, pasir, dan bercincin klem-selang yang tertanam pada silinder beton menunjukkan peningkatan tegangan lekat sebesar 400,35%, 240%, dan 214% dari bambu tanpa perlakuan dengan jarak klem-selang berturut-turut 5 cm, 15 cm, dan 20 cm. Untuk tulangan bambu tanpa pelaburan perekat sikadur<sup>®</sup>-752 dan pasir, dengan klem-selang dengan jarak 10 cm meningkat sebesar 8%. Sedangkan tulangan bambu dengan pelaburan perekat Sikadur<sup>®</sup>-752 dan pasir tanpa menggunakan klem-selang meningkat sebesar 150% seperti yang diperlihatkan pada Tabel 1 dan Gambar 7.

Benda uji dengan tulangan bambu yang diberi perekat sikadur<sup>®</sup>-752, pelaburan pasir, dan klem-selang menunjukkan pola keruntuhan lekatan dan prisma beton (*bond and concrete cone failure*) dan keruntuhan batang bambu (*Bamboo failure of node*) sebagaimana ditunjukkan pada Gambar 8(b) dan Gambar 8(c). Hal ini menunjukkan adanya efek perekat Sikadur<sup>®</sup>-752 dan klem-selang pada tulangan bambu telah bekerja dengan baik, yang ditunjukkan dengan melekatnya beton pada tulangan bambu. Benda uji dengan perekat Sikadur<sup>®</sup>-752 dan pasir menunjukkan keruntuhan geser-lekat (*bond-slip failure*), namun mempunyai kuat lekat yang cukup tinggi seperti yang ditunjukkan

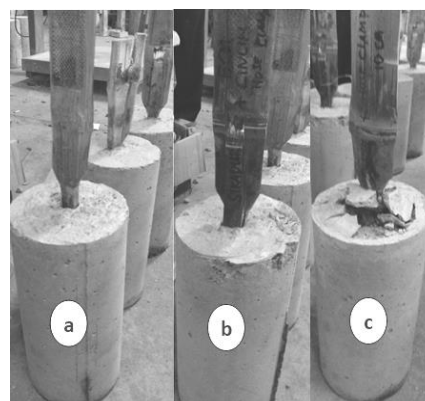
pada Gambar 8(a). Sedangkan benda uji dengan klem-selang tanpa perekat mengalami keruntuhan geser-lekat (*bond-slip failure*) dengan kuat lekat hampir sama dengan tulangan bambu tanpa perlakuan, pola keruntuhan ditunjukkan pada Gambar 8(a).



Gambar 7. Kuat lekat tulangan bambu uji *pull-out*

Tabel 1. Kuat tarik dan kuat lekat tulangan bambu

No benda uji	Perlakuan	Lebar b (mm)	Tebal t (mm)	Jarak tertanam tulangan bambu (mm)	Kuat tarik (kN)	Kuat lekat (MPa)	Kuat lekat rata-rata (MPa)	Pola keruntuhan
1	(1) Normal	15	15	200	12	1.00	1.00	Gagal lekatan dan slip
2			15		12	1.00		
3			10		10	1.00		
4	(2) Klem-selang jarak 10 cm	15	15	200	13	1.08	1.08	Gagal lekatan dan slip
5			15		13	1.08		
6			10		11	1.10		
7	(3) Sikadur®-752	15	15	200	31	2.58	2.50	Gagal lekatan dan slip
8			15		30	2.50		
9			15		29	2.42		
10	(4) Sikadur®-752 + Klem-selang jarak 5 cm	15	15	200	49	4.08	4.11	Gagal pada batang bambu
11			15		49	4.08		
12			15		50	4.17		
13	(5) Sikadur®-752 + Klem-selang jarak 15 cm	15	15	200	42	3.50	3.40	Gagal pada batang bambu
14			15		39.5	3.29		
15			15		41	3.42		
16	(6) Sikadur®-752 + Klem-selang jarak 20 cm	15	15	200	38	3.17	3.14	Gagal pada batang bambu
17			15		38	3.17		
18			15		37	3.08		



**Gambar 8.** Pola keruntuhan silinder beton uji *pull-out* tulangan bambu

Dari analisa hasil uji dan pola keruntuhan, menunjukkan penggunaan perekat atau lapis kedap air mutlak harus dilakukan, sedangkan pemasangan klem-selang pada tulangan bambu tanpa perekat atau lapis kedap air tidak mempunyai pengaruh yang nyata.

### KESIMPULAN

*Treatment* tulangan bambu dengan perekat sikadur<sup>®</sup>-752, pasir, dan klem-selang menunjukkan peningkatan kuat lekat dan kuat tarik tulangan bambu. Pemasangan klem selang tanpa perekat tidak mempunyai pengaruh yang nyata. Pelaburan perekat dan pasir pada tulangan bambu mutlak harus dilakukan. Tulangan bambu dengan perlakuan pelaburan perekat sikadur<sup>®</sup>-752, pasir, dan bercincin klem-selang yang tertanam pada silinder beton menunjukkan peningkatan tegangan lekat sebesar 400,35%, 240%, dan 214% dari bambu tanpa perlakuan dengan jarak klem-selang berturut-turut 5 cm, 15 cm, dan 20 cm. *Treatment* perekat sikadur<sup>®</sup>-752, pelaburan pasir, dan klem-selang menunjukkan pola keruntuhan “*bond and concrete cone failure*” dan “*Bamboo failure of node*”. Benda uji dengan perekat Sikadur<sup>®</sup>-752 dan pasir maupun tanpa *treatment* menunjukkan keruntuhan “*bond-slip failure*”.

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