Development of Eco-Guide Post for Road Traffic Safety in Rural Areas by Using Vetiver Clay Composites

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The Fifth International Conference on Vetiver (ICV-5)
"Vetiver and Climate Change"
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CONTENT

State of The World Today

CROWED

THE 20TH CENTURY POPULATION EXPLOSION: FROM ONE TO SIX BILLION PEOPLE. TODAY'S POPULATION IS ABOUT 7 BILLION, AND IS PROJECTED TO GROW TO 10 BILLION DURING THIS CENTURY

FLAT WORLD

Even before the end of the 20th century, it was realized that economic growth supported by wasteful technologies, and a life-style of wasteful consumption by affluent sections of society, is NOT SUSTAINABLE

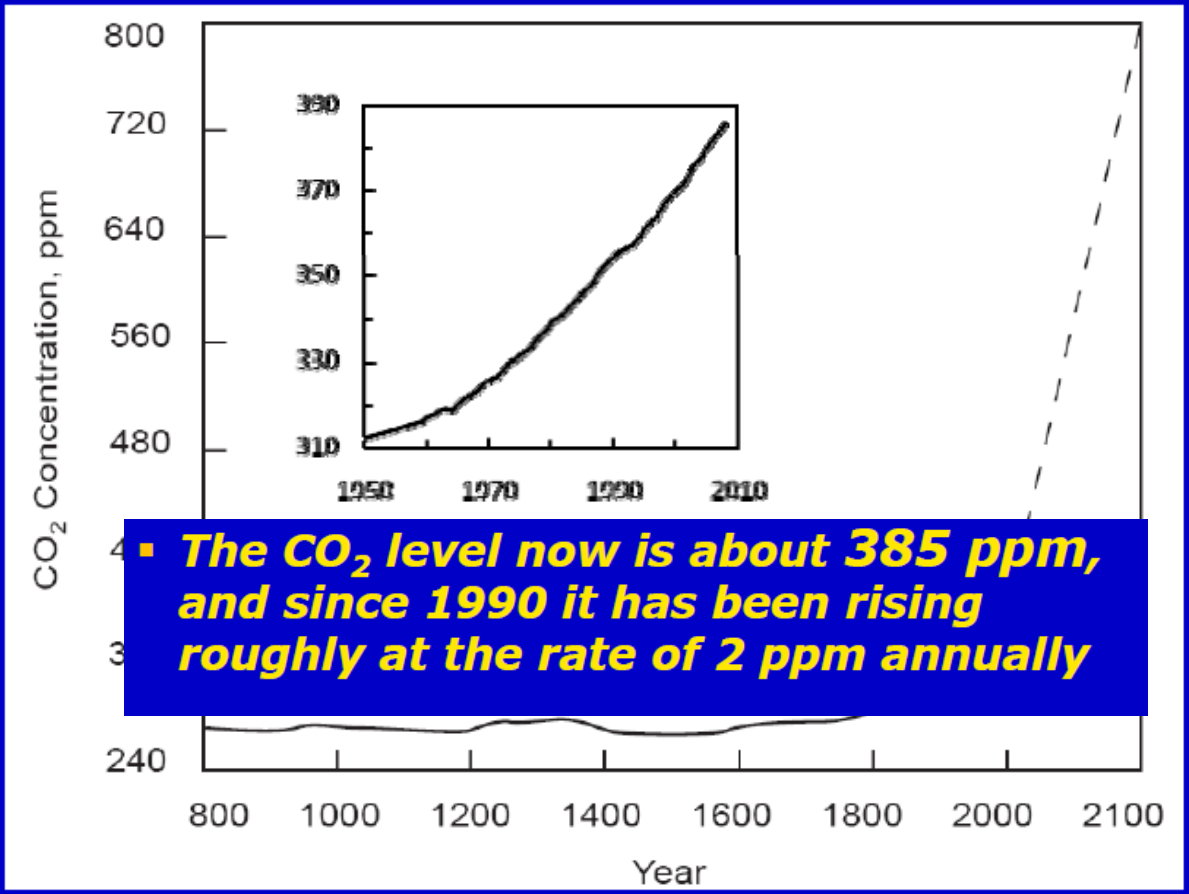
HOT

Crowed and flat world → Global warming

Source :Thomas L. Friedman, 2008

State of The World Today

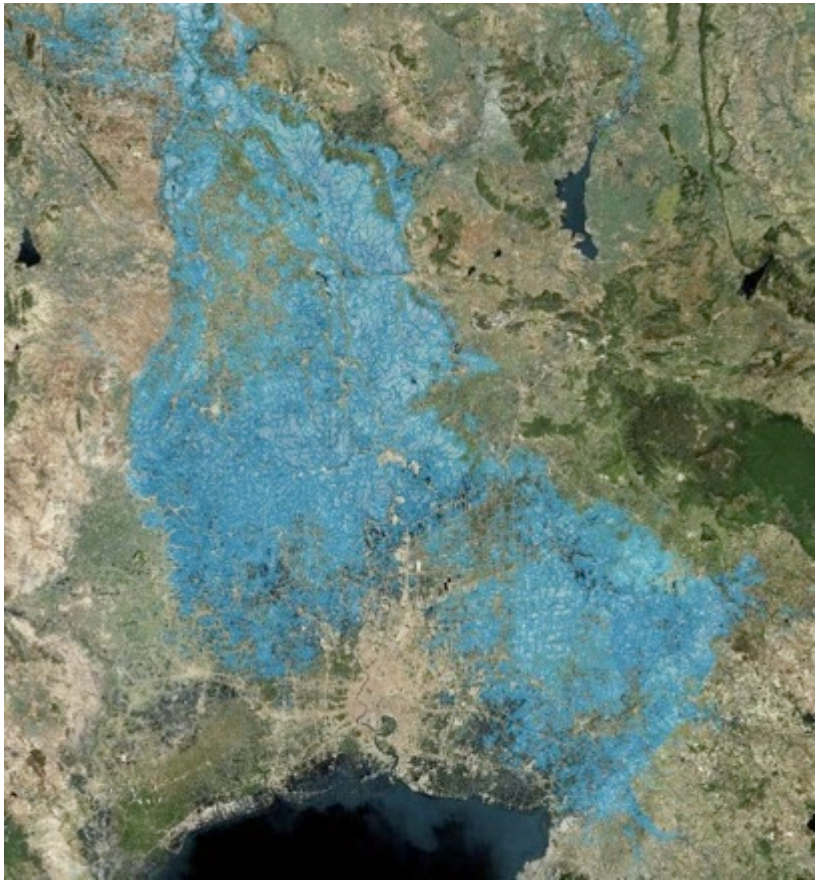
Historical and Projected Atmospheric CO_2, ppm



- ***The CO_2 level now is about 385 ppm, and since 1990 it has been rising roughly at the rate of 2 ppm annually***

(U.N. Intergov. Panel on Climate Change, Cambridge University Press, 2007)

Effects From The Global Warming in Thailand



Source: GISTDA, 2011

- In 2011 More than 12 Storms Attacked
- In October 2011 Worst Flood About 17,000 Million Cubic Meters Overwhelm from Northern to Bangkok
- More than 20 Provinces were swamped Including Bangkok
- Approximately 6.5-7.0 Billion US$ Damaged

How do we fight against big flood?

Very strong dykes of 4.5 meter height were constructed along the river side at Nakornsawan province

Finally Human Loose

Nature Win ☹

10 October 2011 9.00 a.m., 50 meter of dykes collapsed

3 hours later the city was submerged under water

Can we escape from the effects of the hot world?

AIT, 22 October 2011

Highway → Canal

How can we reduce environmental impact?

The answer is : NO, but its not too late to start thinking

Environmental Impact from cement and concrete

- The most widely used construction materials is concrete
- The world's yearly cement production of 3.3 billion ton's accounts for about 10 % of the
- Producing a ton of Portland cement requires about 4GJ energy, and Portland cement clinker manufactures releases approximately1 ton of carbon dioxide into atmosphere
- ***The lower the cement consumption the lower the CO_2 emission***

" The trend of construction materials now is to replace conventional materials by green or eco-friendly materials"

Properties of Eco-Friendly Materials

Definition: A product that has been designed to do the least possible damage to the environment

Source: Zigisha Mhaskar, 2007

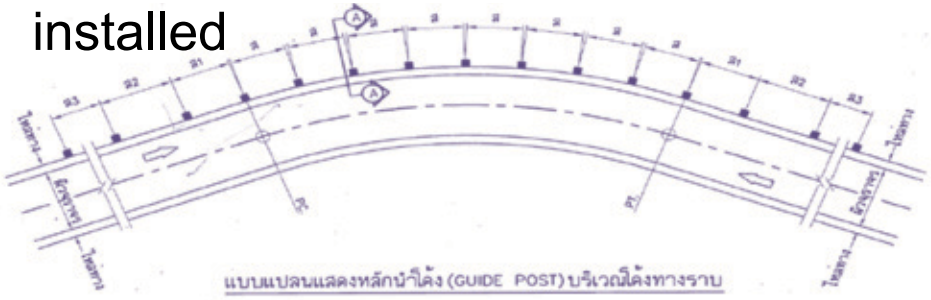
Guide post

- The posts used to mark the edge of the road carriageway

- It assists the road users by indicating the alignment of the road ahead

- Almost all of guide posts in Thailand's highway are made from very stiff materials such as reinforced concrete

- Approximately one million are required along the roads side in Thailand, however only 30% were installed



Problems of Using Concrete Guide Post

- Made from very stiff materials which cannot protect vehicle occupants from injures upon impact

- Caused environmental pollution such as green house gas from materials used as well as manufacturing process

- Cost per unit is very expensive, and cannot apply on the road side in rural areas

- No cooperation between related community and government organization

Proposed Concepts in Design of Eco-Guide Post

Eco-Guide Post Developed Should be

- Forgivable Product
- Eco-Friendly Materials
- Low Cost and Local Availability
- Cooperation between Communities and Related Organization

Utilization of Vetiver in Thailand

Soil and water conservation

Can we apply as

Natural Fibers For Reinforcing Clay Composites?

Applications of Vetiver Leaf in Construction Materials

Prefabricated structural members for housing system By Nimityongskul et.al. 2006

Vetiver clay bundles paddy storage by Nimityongskul and Hengsadeegul et.al. 2004

Vetiver clay brick for production of low cost housing By Parichatprecha et.al 2008

Why Vetiver Leaves?

"It reveals that the vetiver leaves can also be efficiently used for stabilizing and reinforcing of clay bricks and building materials. The use of vetiver-clay composites and natural materials is a possible hybrid material for developing the eco-guide post."

CONTENT

Objectives and Scope

The main objective of this research is to develop the eco-guide post by using a hybrid vetiver-clay composites and natural materials. The concepts of appropriate and uncomplicated technology, conserving environmental friendliness and ecology are applied to produce the eco-guide post in accordance with Thai's DOH standard.

Sub-Objectives

•To investigate the most suitable molding technique and optimum proportions of ingredients by comparing the results in terms of physical, mechanical, and durability properties from various experimental programs.

•To investigate the durability and apply the prototype of the eco-guide post developed for the real use by installation on the road side of rural area.

•To transfer the technology developed to the related communities and organizations and establishing cooperation between government organizations such as Department of Highway (DOH) and agriculturists in rural areas.

CONTENT

METHODOLOGY

1) Development of Eco-Guide Post

Investigate 8 molding techniques with various mixture proportions

- Materials preparation
- Testing of raw materials
- Testing of physical properties
- Testing of mechanical properties

⇩

Prototype of eco-guide post with optimum proportion and molding technique

⇩

2

METHODOLOGY

Prototype of eco-guide post with optimum proportion and molding technique

2) Durability test and Application

Testing of durability in accordance with AWPA E7-09

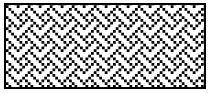
Application to the real use on road number 104 in Wangchao-Tak region, Tak Province

3) Contribution to the Related Organizations and Communities

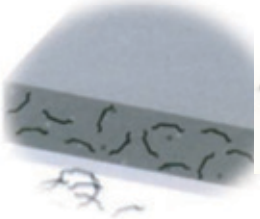
METHODOLOGY

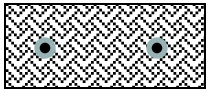
4 Approaches for application of Vetiver and Bamboo Sticks as Fibers and Reinforcing Bars

Use bamboo sticks as reinforcing bar

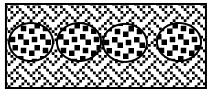


Use vetiver fibers as fibers reinforcement



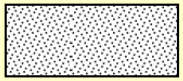
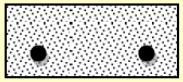
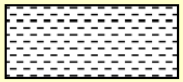
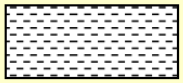
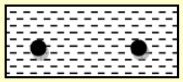
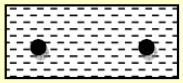
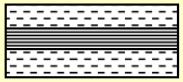
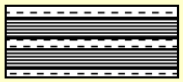


Hybrid vetiver fibers and bamboo sticks



Hybrid vetiver fibers and vetiver clay bundle

Details of 8 molding techniques and various mixture proportions

Number	Details of Molding Technique	Structural Model	Mixture Proportions clay:sand:3-5cm vetiver fibers (by volume)
1	Control mixture without fibers.		1:0.15:0, 1:0.3:0
2	Bamboo reinforcement without fibers.		1:0.15:0, 1:0.3:0
3	Clay with 3-5 cm vetiver fibers reinforced and stabilized with 15% fine sand.		1:0.15:0.4, 1:0.15:0.6, 1:0.15:0.8, 1:0.15:1.0
4	Clay with 3-5 cm vetiver fibers reinforced and stabilized with 30% fine sand		1:0.3:0.4, 1:0.3:0.6, 1:0.3:0.8, 1:0.3:1.0
5	Hybrid bamboo and vetiver fibers reinforcement and stabilized with 15% fine sand.		1:0.15:0.4, 1:0.15:0.6, 1:0.15:0.8, 1:0.15:1.0
6	Hybrid bamboo and vetiver fibers reinforcement and stabilized with 30% fine sand.		1:0.3:0.4, 1:0.3:0.6, 1:0.3:0.8, 1:0.3:1.0
7	Hybrid 1 layer of vetiver clay bundle and 2 layers of vetiver fibers and stabilized with 30% fine sand.		1:0.3:0.4, 1:0.3:0.6, 1:0.3:0.8, 1:0.3:1.0
8	Hybrid 2 layers of vetiver clay bundle and 3 layers of vetiver fibers and stabilized with 30% fine sand.		1:0.3:0.4, 1:0.3:0.6, 1:0.3:0.8, 1:0.3:1.0

MATERIALS PREPARATION

Harvest

Vetiver Bundles

Cutting

Sun Drying

Fabrication Processes

Kneading

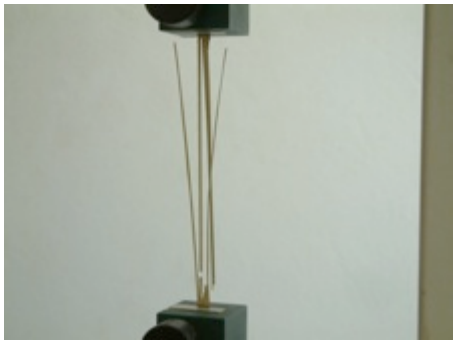
Blending

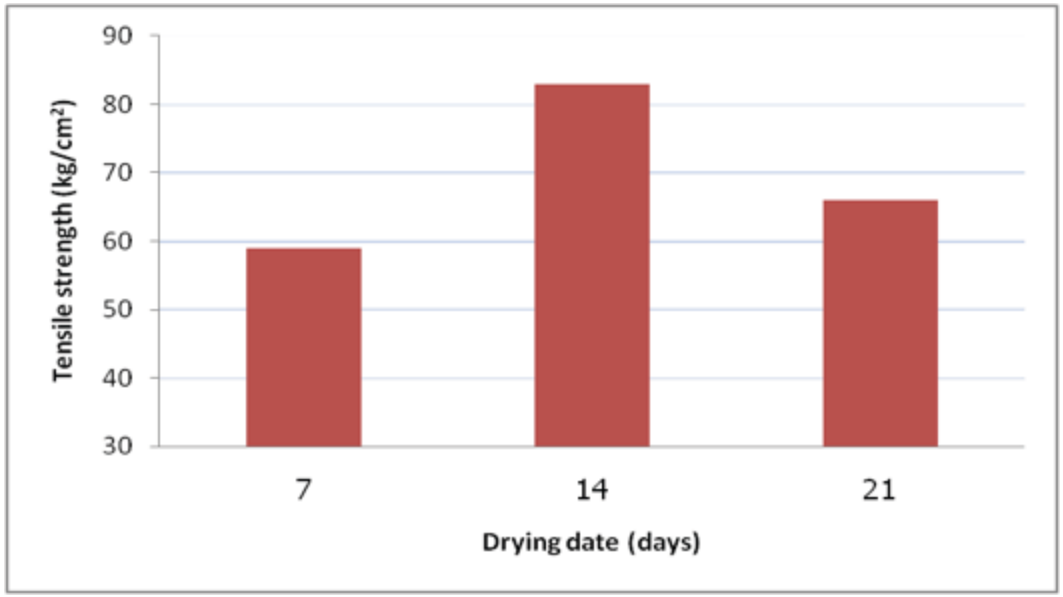
Vetiver clay bundle

Molding

CONTENT

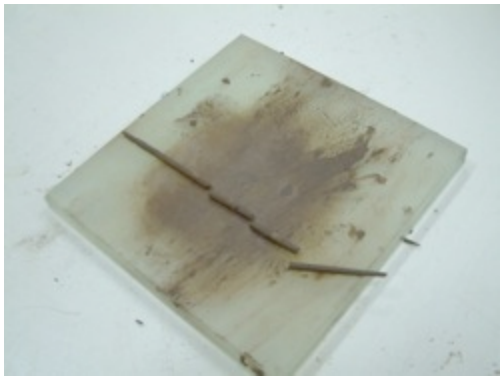
Materials Properties





The relationships between drying date and average tensile strength of vetiver grass

Materials Properties



Properties of Clay

Liquid limit (LL) = 60%

Plastic limit (PL) = 23%

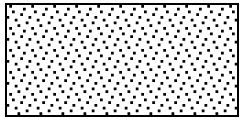
Plastic index (PI) = 37%

Moisture Content = 4.8%

Specific Gravity = 2.8

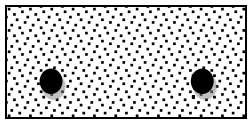
Visual Inspection

Model 1



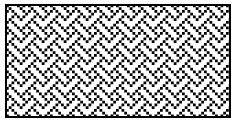
Shrinkage, warping, and cracks was found.

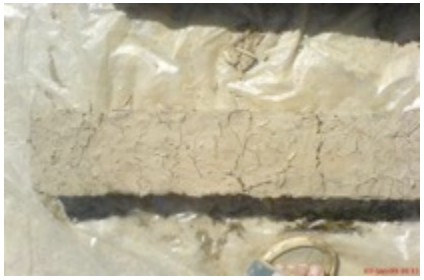
Model 2



Shrinkage, warping, and cracks was found.

Model 3

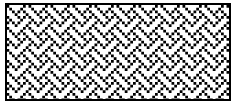




Shrinkage, warping, and cracks was found.

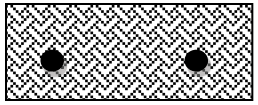
Visual Inspection

Model 4



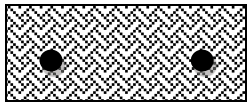
Highly shrinkage was found

Model 5



Highly Shrinkage and cracks was found

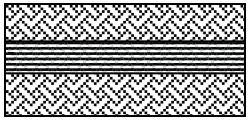
Model 6



Highly Shrinkage and cracks was found

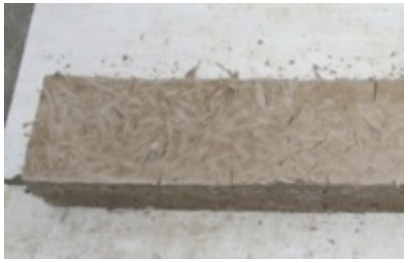
Visual Inspection

Model 7



Only hair line cracks was found

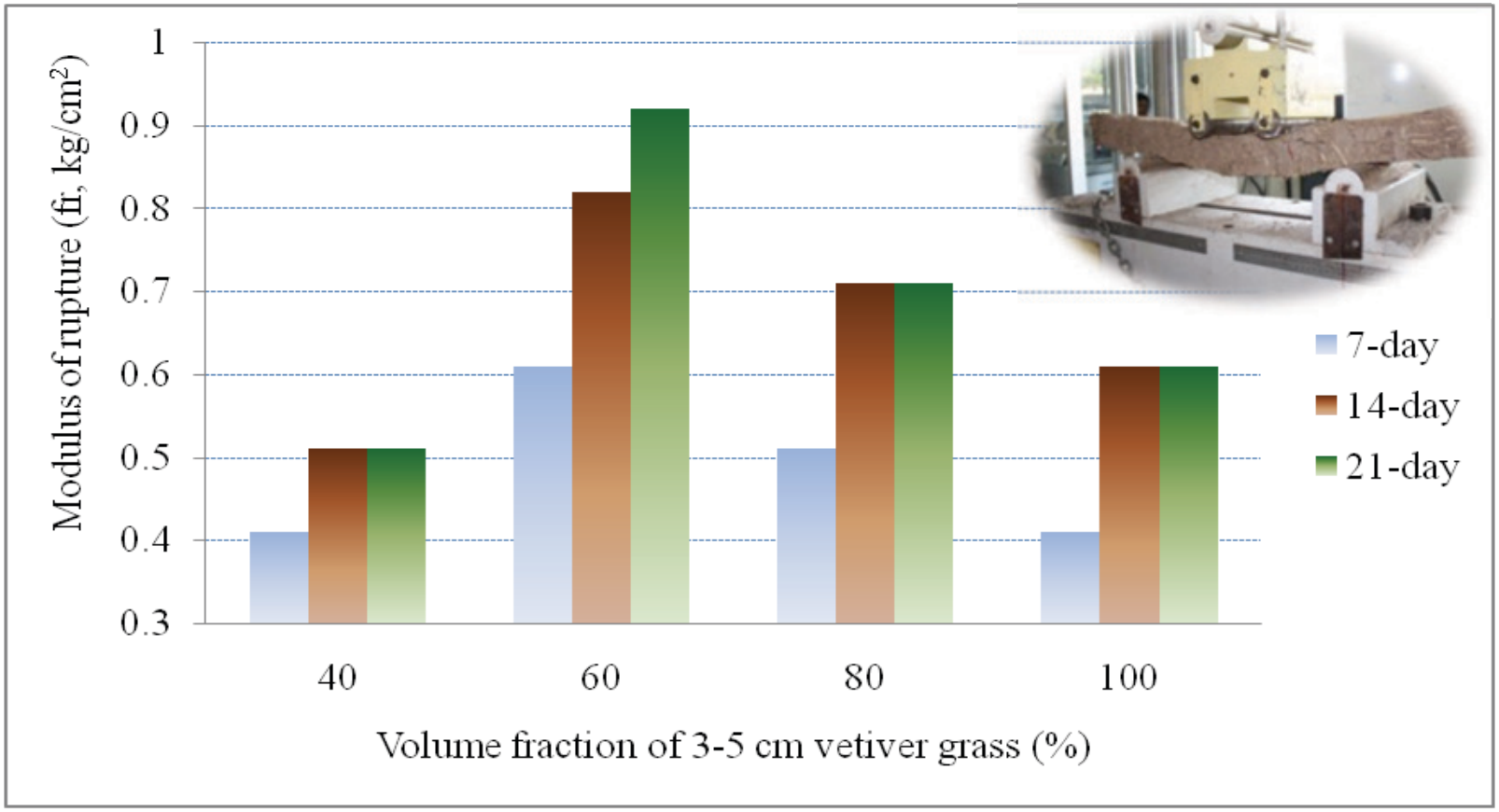
Model 8



Cracks, warping, and shrinkage disappear

The short fibers of vetiver play an important role in stabilizing the matrix in the guide post developed. Whereas, the long fibers in terms of vetiver clay bundles were used as fiber reinforcement to enhance its mechanical property.

Mechanical Property



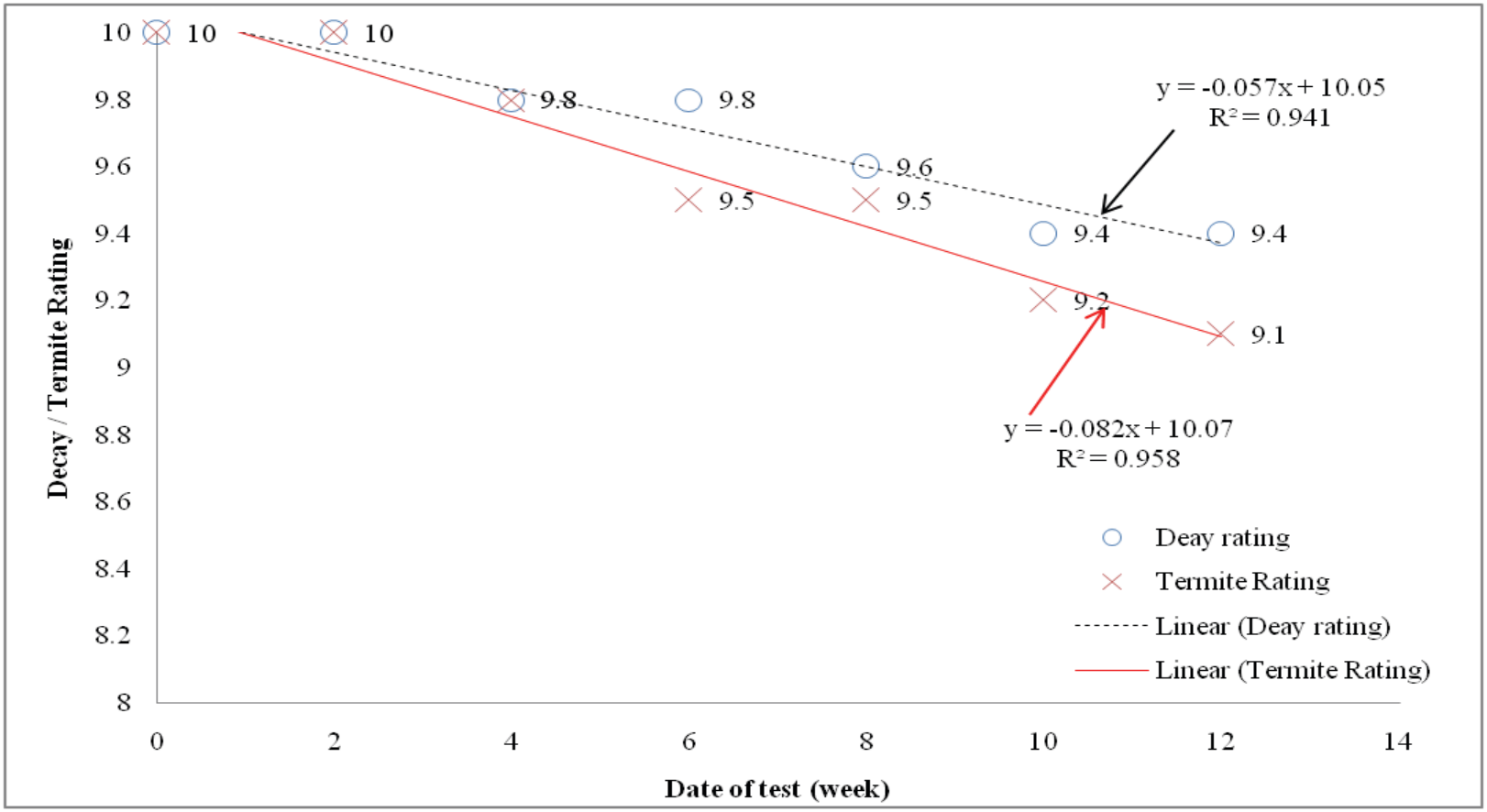
- *The 60% vetiver grass at 21-day drying gave a highest modulus of rupture of 0.91 kg/cm².*
- *The suitable volume fraction of 3-5 cm. vetiver grass with more than 14-day drying period can be improved the flexural strength of eco-guide post.*

Durability

American Wood Protection Association (AWPA E7-09) standard was applied to investigate the durability of 20 samples (Model 8 with 60% of short fibers) in terms of decay and termite rating .

AWPA
PROTECTING WOOD
SINCE 1904

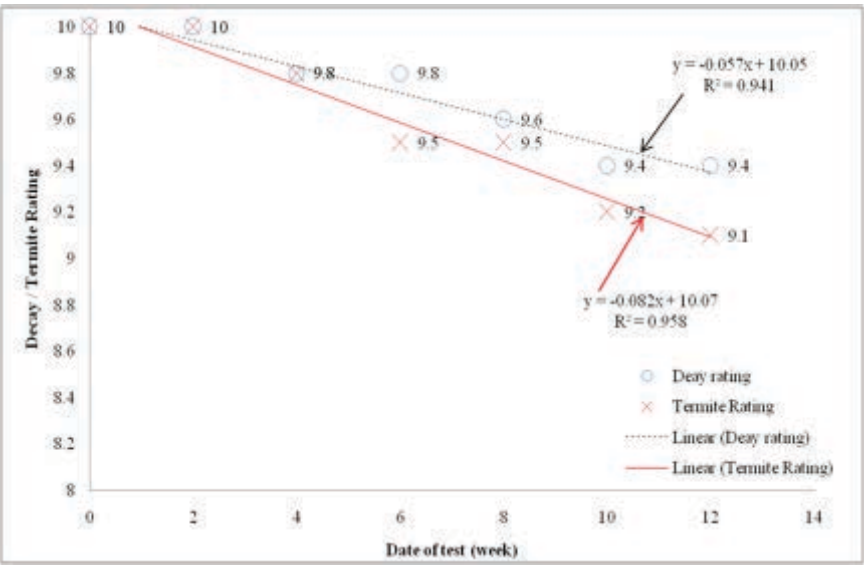
Durability



It can be summarized that the durability of eco-guide post in terms of decay and termite rating index along 3 months period was found to be sound condition

Durability

Prediction of Service Life of Eco-Guide Post



Linear Regression

Decay Index = -0.057(Date of test, weeks) + 10.05 ; R^2 = 0.94

Termite Index = -0.082(Date of test, weeks) + 10.07 ; R^2 = 0.96

The limited condition for serviceability of guide post was setting at 30-50% cross sectional area affected and the index for both rating was 6. By using this condition and best fit equations, the service life of eco-guide post in this study was approximately found to be 12 months.

Cost Analysis

Unit price of reinforce concrete guide post

No.	Materials	Unit price per piece of guide post* (Thai baht)
1	Concrete	25.0-29.0

It can be found that the unit cost of eco-guide post was approximately 9.15-10.50 Thai baht which was approximately 8 times cheaper than reinforced concrete guide post.

Unit price of eco-guide post

No.	Materials	Unit price per piece of guide post (Thai baht)
1	Clay	2.2-2.5
2	Vetiver grass included manufacturing processes	0.05-0.07
3	Sand	0.9-1.1
4	Labor*	6.0-7.0
	Total	9.15-10.5

Applications

Application of eco-guide post on road number 104 in Wangchao-Tak region and road number 1090 in Maesord-Umphang region, Tak Province, Thailand

2nd version of eco-guide post with replace reflectors with used CD

Dissemination to Related Communities and Organizations

To transfer the technology developed to the related communities and organizations includes establishing cooperation between them, the training programs were conducted and contributed to related communities and organizations as follows:

- Bureau of High Way Tak and Bureau of Highway Sakonnakorn, Department of Highway
- Department of Rural Roads at Sakonnakorn branch
- Sub district organizations at Sakonnakorn Province
- Faculty of Engineering and Faculty of Agricultural, Kasetsart Chalerm Phrakiat Sakonnakorn Campus, Kasetsart University
- Land Development Department at Tak Provinces
- Communities of vetiver growers in Phitsanuloke, Tak, and Sakonnakorn Provinces

“Strong Cooperated Between Related Organizations and Communities is the Key for the Success.”

CONTENT

Conclusions

- The hybrid between 2 layers of vetiver clay bundle and 3 layers of 60% vetiver clay composite (Model 8) was the most suitable in molding of eco-guide post.

- The unit cost of eco-guide post developed was approximately 9.15-10.50 Thai baht which was approximately 8 times cheaper than reinforced concrete guide post.

- The use of eco-guide post was found to be much more economical than the use of reinforced concrete guide post in terms of cost and environmental impact. The use of eco-guide post can reduce pollution and enhance the traffic safety in local roads.

Conclusions

- The guide posts developed have now been installed at roadside on road number 104 in Wangchao-Tak region and road number 1090 in Maesord-Umphang region, Tak Province, Thailand.

- The transferring technology of this research to the related communities has launched by conducting the training programs and distributed to the several areas on the northern and the northeast regions of Thailand.

Acknowledgement

The author gratefully acknowledges partial financial support of this research by Industrial and Research Projects for Undergraduate Students (IRPUS). The author would like to give the special thanks to his students at Naresuan University for their help in providing materials. The author is also thankful to Bureau of Highway Tak and Sakonnakorn under the Department of Highway for the support on the application and contribution of this research, and to Faculty of Engineering, Naresuan University and Srinakharinwirot University for the laboratory testing.

The author also would like to extend his appreciations to the Chaipattana Foundation for the financial assistance to attend and present at ICV-5.

THANK YOU

What is the Suitable Eco-Friendly Materials?

- Forgivable Product
- Eco-Friendly Materials
- Low Cost and Local Availability
- Cooperation between Communities and Related Organization

Apply 100% Natural Materials

Clay + Natural Stabilizing Agent + Natural Fibers Reinforcement

Durability

Decay Rating

Rating	Condition	Description
10	Sound	No sign or evidence of decay, wood softening or discoloration caused by microorganism attack.
9.5	Trace suspect	Some areas of discoloration and/or softening associated with superficial microorganism attack.
9	Slight Attack	Decay and wood softening is present. Up to 3% of the cross sectional area is affected.
8	Moderate	Similar to "9", but more extensive attack with 3-10% of cross sectional area affected.
7	Moderate/Severe Attack	Sample has between 10-30% of cross sectional area decayed.
6	Severe Attack	Sample has between 30-50% of cross sectional area decayed.
4	Very Severe Attack	Sample has between 50-75% of cross sectional area decayed.
0	Failure	Sample has functionally failed. It can either be broken by hand due to decay, or the evaluation probe can penetrate through the sample.

Termite Rating

Rating	Description Condition
10	Sound
9.5	Trace, surface nibbles permitted.
9	Slight Attack, up to 3% of cross sectional area affected.
8	Moderate attack, 3-10% of cross sectional area affected.
7	Moderate/severe attack and penetration, 10-30% of cross sectional area affected.
6	Severe attack, 30-50% of cross sectional area affected.
4	Very severe attack, 50-75% of cross sectional area affected.
0	Failure