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ด้านกิจกรรมวิชาการที่ส่งเสริมงานวิจัย

คณะฯ โดยฝ่ายวิชาการและวิจัย งานวิจัยและเผยแพร่ ได้เล็งเห็นความสำคัญของการพัฒนาศักยภาพนักวิจัย จึงดำเนินการจัดโครงการเพื่อพัฒนาศักยภาพนักวิจัย จำนวน 2 โครงการ ดังนี้

คณะฯ ได้จัดงานประชุมวิชาการในระดับชาติและในระดับนานาชาติ เพื่อส่งเสริมให้อาจารย์ นักวิจัย นักวิชาการ และนักศึกษาในระดับอุดมศึกษา และในสังกัดสำนักงานคณะกรรมการการอาชีวศึกษา ได้มีโอกาสแลกเปลี่ยนความรู้ผลงานวิจัย นวัตกรรม และสิ่งประดิษฐ์ จำนวน 2 โครงการ

1.โครงการประชุมวิชาการระดับนานาชาติ ครั้งที่ 5 ด้านนวัตกรรมทางการศึกษาและเทคโนโลยี ประจำปี 2563

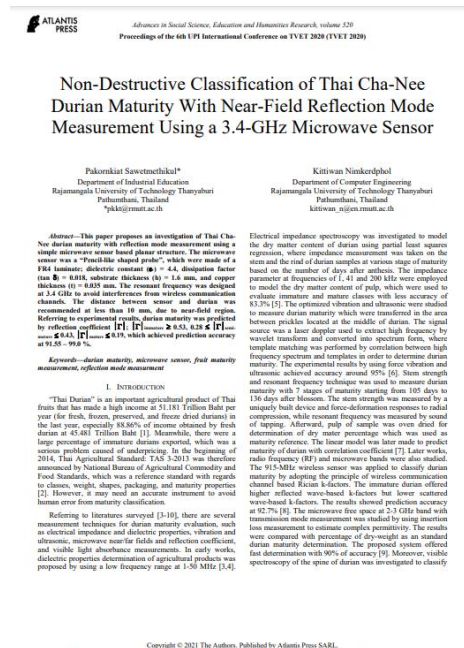
(The 5th International Conference on Innovative Education and Technology 2020: ICIET 2020) จัดเมื่อวันที่ วันที่ 16-17 กันยายน 2563 โดยมีเจ้าภาพร่วม 3 แห่ง 1) Universitas Pendidikan Indonesia (UPI) 2) Universiti Teknologi Malaysia (UTM) 3) National Pingtung University

การจัดงานประชุมเป็นรูปแบบออนไลน์ผ่านแอปพลิเคชัน Zoom Cloud Meeting โดยมีจำนวนบทความทั้งหมดจำนวน 48 เรื่อง ผู้แต่งไทย(Thai) จำนวน 35 เรื่อง ผู้แต่งต่างชาติ (International) จำนวน 13 เรื่อง โดยมีนักวิจัยคณะฯ นำผลงานนำเสนอบทความวิจัย จำนวน 9 บทความ และนำบทความลงในวารสาร Advances in Social Science, Education and Humanities Research ดังนี้

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1	ผศ.ดร.ปกรณ์เกียรติ์ เศรษฐเมธิกุล Kittiwan Nimkerdphol	Non-Destructive Classification of Thai Cha-Nee Durian Maturity With Near-Field Reflection Mode Measurement Using a 3.4-GHz Microwave Sensor
2	ผศ.ดร.เทียมยศ ปะสาวะโน	Effect of Multimedia Lesson with Blended Learning for Grade 4 Students
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8	อาจารย์จตุรวิธ ศิริมหา อาจารย์ปัญญกิจ แก้วเหล็ก	Instructional Media for Construction Drawing by Autodesk Revit Structure
9	ดร.ณัฐวุฒิ ไชยวิโน อาจารย์จตุรวิธ ศิริมหา	Precast Concrete Columns Strengthened With CFRP and GFRP Laminates Under Eccentric Load

1.เรื่อง Non-Destructive Classification of Thai Cha-Nee Durian Maturity With Near-Field Reflection Mode Measurement Using a 3.4-GHz Microwave Sensor



2. Effect of Multimedia Lesson with Blended Learning for Grade 4 Students

Effect of Multimedia Lesson With Blended Learning for Grade 4 Students

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Abstract—The purposes of this research were: 1) created the blended learning lesson plan for Grade 4 students, 2) finding out the efficiency of the multimedia lesson, 3) compare the pretest and posttest of learning achievement result with blended learning and 4) finding out the effective index of the student's learning. The sample did were 20 students in Innovation Demonstration School of Rajamangala University of Technology Thanyaburi (RMUT), Pathum Thani, Thailand who studying in the subject of social study religion and culture in the second term of the 2019 academic year by using the simple random sampling with cast lots method. The instrument used in this research are the Blended learning lesson, learning outcome test. This research is the quasi-experiment research using the pretest-posttest one group design. The data analysis were ETE2, mean, standard deviation and t-test dependent. The result of research showed that: 1) the efficiency of the multimedia lesson by the 80/80 standards had 83.95/85.57, 2) the learning achievement of students by using the blended learning lesson higher than pretest had significantly 8.05 levels and 3) the effective index of this student's learning had 0.59 or 59 percent.

Keywords—blended learning, multimedia lesson, learning innovation

1. INTRODUCTION

The government's policy to accelerate the development of educational technology. By increasing the distribution of educational opportunities to people in urban and rural Thailand to learn throughout life. Access the development of science and technology at all levels, both in quantity and quality. In response to the country's sustainable development, the Ministry of Information and Technology has prepared a Master Plan for Information Technology and Communications of the Year 2004-2008 and the Ministry of education the vision of information technology and communications, the 2004 - 2006 that students, schools and educational bodies everywhere have access to and use of information and communications technology to be learning continuously. Life Management research career development. Quality of life the service has been thoroughly Quality and performance Leading to a society of knowledge and learning. Strategy and operating strategy: 4 is to use ICT to improve the quality of learners using ICT

Management Development. Management and educational services Production and development of personnel in the ICT and spreading ICT infrastructure for education, in addition, the aim of the basic education curriculum 2001 also requires the students to be creative, learning, love of reading, I love learning and research. There is universal knowledge; Knowledge changes and progress of science. And skills and capacity for learning. Communications and technology adaptive ways of thinking how to work with the hardest circumstances. The government has realized the importance of learning through the use of information and communications technology. Also known as E-learning is important and essential for developing countries to improve learning through technology integration, the development of E-learning a new one by the teaching blended with a variety of methods. With multiple media types. This is called the Blended Learning Blended Learning is a learning process [1,2]. The eclectic style of learning, whether it's learning happens in the classroom. Combined with learning outside the classroom to teach students who do not face each other or use a variety of learning resources [3]. Learning processes and activities arising from the strategy. Teaching a variety of forms. The goal is to help the students achieve the learning goals are important [4]. Teaching by means of blended learning that teachers can use to teach. Two or more in the course as instructors offer lessons through technology combined with traditional face to face teaching. But after that, instructor-led content articles hanging on the web. Then follow the activities of teaching using e-Learning LMS systems with a computer lab. After a brief lesson by discussions with teachers in the classroom by blended learning (Blended Learning). Blending how many ways to use in teaching and learning for the students to learn (Teaching and Learning), as taught in the classroom with the teacher over the network (A Combination of Face-to-Face and Online learning) teaching methods should not be used to one way of making student learning. How many lives have to be combined.

Thus, teachers have an important role in choosing the medium of instruction. Creating a provocation and creating a learning environment that encourages students to show their knowledge and skills. And the students will have an interaction

3. Important Characteristics of Buddhist Monk as the Moral Teacher: A Case study in Patumthani Province, Thailand

Important Characteristics of Buddhist Monk as the Moral Teacher:

A Case study in Patumthani Province, Thailand

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Abstract—Thailand declared an educational innovation area as a new act to improve the achievement of the students that every province must drive all provincial educational organizations to support the new act. If Patumthani province has the plan to be a city of innovation area, especially educational innovation plan, how will the Buddhist monks as the moral teacher in Patumthani province to improve the educational quality of the students and support the educational innovation area act? The temples are one of the important factors to support the educational innovation area act because there are many of the moral teachers to teach the students in each school, but they do not have about the important characteristics to support the act. There is no research about the important characteristics as the moral teacher to put the new direction to support the Thailand educational innovation area act. This research consisted of qualitative and quantitative data collection, aim to find out the important characteristics of Buddhist monks as the moral teacher to support Thailand's educational innovation area act. Several data collection methods were used for data collection. The first method is qualitative data collection, divided into 2 steps, 1) Executive in-depth interview technique with the temple administrative committee by Purposive Sampling method, 2) Participatory data collection by the researcher to be ordained as the Buddhist monk for 15 days. The second method is quantitative data collection was used in step 3; the sample is 26 Buddhist monks as the moral teacher in the temple of Patumthani province by the Purposive Sampling method. Content analysis and Exploratory Factor Analysis (EFA) were used for data interpretation. The research findings shows that, Buddhist monk as the moral teacher must have nine important characteristics consist of: 1) The media developer, 2) The learning environment Manager, 3) The researcher, 4) The basic educator, 5) The basic engineer, 6) The temple manager, 7) The social counselor 8) The knowledge integrator and 9) The ICT user.

Keywords—moral teacher, Buddhist monk, moral teacher characteristics, educational innovation, participatory data collection method

1. BACKGROUND OF THE STUDY

Thailand declared an educational innovation area as a new act to improve the achievement of the students that every province must drive all provincial educational organizations to support the new act. This act will make freedom of educational innovation to improve the academic quality of the students by the Government, Sub-district Administrative Organization (S.A.O), Private companies, and social groups [1].

Patumthani province is in the North of Bangkok. There is an area 1,525,856 sq.km. There are 7 districts in Patumthani that included 186 temples [2]. The population is 1,146,092 people, as shown in Figure 1.



Fig. 1. Shows the area of Patumthani province.

There are many provincial education organizations such as local school Moral Teacher, Buddhist Monk, Moral Teacher

4. Learning Management Based on Language Teaching for Communication Combined With Grouping Techniques to Develop Chinese Speaking Skills for Everyday Use of Secondary 4 Students



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Learning Management Based on Language Teaching for Communication Combined With Grouping Techniques to Develop Chinese Speaking Skills for Everyday Use of Secondary 4 Students

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Abstract—Nowadays, language learning focuses on students' ability in real life communication so that students can be in society properly and appropriately. Language learning can be started from the very basic level and gradually increased to the complexity both in depth and width according to the age and level of the learners. Therefore, teachers must understand the curriculum and be able to design learning management focusing on student-centered instruction. This aims to enable learners to use the language in real situations including speaking, listening, reading and writing skills. The main purposes of this research were 1) To compare Chinese communication skills for everyday use of students before and after studying through traditional learning management, 2) To compare Chinese communication skills for everyday use of students before and after studying through language instruction combined with grouping techniques, 3) To compare Chinese speaking communication skills for everyday use of students who studied through traditional learning management and the newly created method. Research sample was 90 students, selected by cluster random sampling, of Pratanadongprapitayaburi School, The Secondary Educational Service Area 8. Research tools were 1) plan for traditional instruction, 2) Learning management plan based on language for communication instruction combined with grouping techniques, and 3) Chinese speaking skill evaluation form for communication. The research result revealed that 1) Chinese communication skills for everyday use, before and after studying, of secondary 4 (grade 10) students who studied through the traditional learning management, 2) Chinese communication skills for everyday use, before and after studying, of students who studied through language for communication instruction combined with grouping techniques were statistically significant difference at the level of 0.05, and 3) the after study Chinese communication skills for everyday use of students who studied through language instruction for communication combined with grouping techniques was higher than those who studied through the traditional learning management.


Keywords—Chinese speaking skills, language instruction for communication, grouping technique

1. INTRODUCTION

In the present society, The People's Republic of China plays an important role in economic development not only in the ASEAN region, but also in various regions of the world. And this is likely to continue to expand its role in the international community. As we may know, Chinese has been spoken by almost 2 billion people around the world. It is the second after the English language and is one of the major languages of the United Nations. Hence, Chinese is a very important and essential foreign language for communication, to build up social and economic cooperation, politics and education. Thailand and China have good diplomatic relations for a very long time. The two countries have agreed with joint investments in businesses and continuing education management. [1]. This also resulted in the widespread of the Chinese instruction and is also considered another foreign language courses offered in public and private educational institutions. In the provision of basic education according to the core curriculum of basic education, 2551 BE, Chinese was also included in the foreign language learning subjects. This aims to develop learners to skills and ability to communicate in basic Chinese effectively and have a good attitude towards the Chinese language [2]. In Chinese language learning management, teachers should be aware and understand how to outline Chinese instruction correctly so that students learn how to acquire and use it effectively for real communication in daily life [3].

Comparing all four language skills: listening, speaking, reading and writing, it was found that speaking is basically a very important and essential skill of all. This is because speaking is used to communicate in everyday life and is an important process for exchanging information, conveying thoughts and understanding including feelings for the audience to know and understand the purpose of the speaker [4]. In maximum benefit of communication, the speaker must have a

5. Learning Management Through the Combination of STEAM Education and Phenomenon-Based Learning to Develop Creative Thinking of Secondary 6 (Grade 12) Students



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Learning Management Through the Combination of STEAM Education and Phenomenon-Based Learning to Develop Creative Thinking of Secondary 6 (Grade 12) Students

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Abstract—Learning management based on STEAM Education is the integration which combined the knowledge to the real phenomena. In this research, the purposes were to 1) develop learning management of STEAM education combined with phenomenon-based learning, 2) compare creative thinking in Physics before and after traditional learning management, 3) compare creative thinking in Physics before and after learning management through the combination of STEAM Education and Phenomenon-based learning, and 4) compare creative thinking in Physics after studying through STEAM education combined with phenomenon-based and traditional learning management. Research sample was two classes, selected by cluster random sampling, of secondary 6 (grade 12) students in the first semester of the academic year 2020. The research instruments consisted of learning management plan, creative thinking tests in science and creative work evaluation form. The results revealed that The results revealed that 1) STEAM Education and Phenomenon-based learning consisted of 6 steps - 3PA, 2) creative thinking in Physics for students studying through traditional learning management showed that the after study was higher than the before study, 3) creative thinking in Physics for student studying learning management through the combination of STEAM Education and Phenomenon-based learning showed that the after study was higher than the before study, and 4) creative thinking in Physics for student studying of the after learning management through the combination of STEAM Education and Phenomenon-based learning showed higher than the traditional learning management.

Keywords—STEAM education, phenomenon based learning, creative thinking

1. INTRODUCTION

In the 21st century, the world changes rapidly because of new technologies and knowledge. It makes changes in the living context and education. In retrospect, teachers teach through the transmission of knowledge. Nowadays, teachers are responsible for facilitating students, students use technology and tools to quest for knowledge rather than textbooks. The advancement of communication technology, learners are able to research their own knowledge from various learning sources and learn at any time they want. Society of learning has changed, the classroom is no longer just a book. Students have laptops, tablets, iPads, and smartphones to get in touch with Technology in the 21st century, leading the world to revolutionize the old industry to the digital world. The demand of the labor market has changed, learning in the classroom isn't enough.

Thailand is facing with new economic, social, political, technological, energy and environmental changes. We have to keep up with the industry 4.0. This turning point is another important step towards for Thailand and neighboring ASEAN countries to prepare for the trend of education of production bases and adapting robot technology and automatic mechanical systems to replace the dependence on cheap labor. It is estimated that by 2020 more than 375 million workers worldwide may have to change professions or disappear especially workers who are unable to adapt in time [1]. At the same time, in the 21st century, there will be new and more highly skilled jobs. Producing and developing workforce skills to meet rapidly changing market demands is essential in today's world.

Preparing the young generation with 21st century skills, including critical thinking, communication, collaboration, and creativity. Life and professional skills are always changing [2]. These are important and also one of the most important skills in the 21st century that must be developed and promoted to meet towards the modern world that focuses on business and innovation. It is transformative and highly compatible with the creative skills necessary to cultivate citizens of the country.

6. Development of Sound Insulation Panel From Oil Palm Fiber



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Development of Sound Insulation Panel From Oil Palm Fiber

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Abstract—The purpose of this research is to develop sound insulation panel from oil palm fiber (OPF). The study compared panels made from OPF with other acoustic panels in the market. This raw material is a byproduct from agricultural harvest. Hot press technique with the pressure of 400 kg/cm² was used to create the panel with the thickness of 20 mm. The temperature during the compression was 150°C, and the force used for pressing the panels for 8 minutes ranged between 25-30 kg/cm². The amount of pHMDI applied as a binding agent was 5% by weight of the panels. Sound absorption tests were carried out in a test box with sound level meters. The results of the tests showed that the sound-absorbing property of the developed OPF panels with holed surface is greater than that of the traditional OPF panels and acoustic boards. It was found that different sizes and patterns of holes have an effect on sound-absorbing capacity. The developed OPF panels showed a good sound-absorbing capability in medium-to-high frequency (500 Hz – 2000 Hz). The best sound insulation panel made from OPF is the panel with a 5% by weight of pHMDI and has a density of 400 kg/m³. The physical and mechanical properties of the panels comply with the standard of strength and mechanical properties of soft boards (Library of Congress Cataloging – In a Publication Data).

Keywords—oil palm fiber, sound insulation, hot pressing process

1. INTRODUCTION

The noise pollution is a serious problem and tends to increase due to rapid urbanization. The competition in business area and housing development has significantly affected the environment and created pollution. One of the most obvious examples in Thailand is the residential community or educational institutions located around Suvarnabhumi airport which experiences severe noise pollution leading to health and wellness issues.

The architectural design to reduce the noise pollution using sound-absorbing insulation such as acoustic foam sheets and glass fiber insulation has been widespread to control and prevent noise caused by the source inside the building. However, these sound-absorbing insulation is made from synthetic materials which is often concerned with health safety of users. In addition, many materials used in a production process must be imported from abroad [1]. Therefore, many natural materials have been used instead. Such natural materials also reduce energy

consumption, chemicals, and toxins created in the production process of synthetic materials [2].

Oil palm is one of the cash crops in Thailand with a yield of 3.256 million tons per year, and the amount of oil palm fiber (OPF) remaining from agriculture is about 64,000 tons per year [1]. The remaining OPF have been processed into the agricultural industry but some are still not utilized [1]. OPF can also be used as an extra component to create an insulation sheet to absorb sound in the building [3]. The use of OPF insulation panel is considered as another way to reduce the volume and increase the value of agricultural waste. Therefore, this study aims to improve the efficiency of sound absorption and develop the insulation panel made from OPF into a commercial product.

II. LITERATURE REVIEW

Hearing is one of the most important communications for humans. It may be inferior to seeing with eyes. However, eyes can be closed when facing an excessive amount of light or unpleasant images. Ears must be listen to both satisfying and unsatisfying sound. To prevent noise, therefore, it is necessary to start preventing from an environment before noise reaches the ears. Sound control in the building [4] is used to improve the hearing condition and control unnecessary noise. Sound in the building consists of 2 types: direct noise and reverberant noise.

While direct Noise can be reduced by a barrier between the sound source and the listener, reverberant noise can be reduced by sound absorbing materials on the walls, especially the side of walls that causes a lot of resonance.

Undesirable sounds may be decreased by reducing the resonance with materials which has a better capable of sound absorption than does glass, plaster, or concrete. Each type of materials has different qualities of sound absorption according to the frequency of sound. Sound absorbing materials can be categorized into 4 types as follows:

- Porous type is transparent, light, sponge-like, and suitable for high frequency sounds.
- Membrane type is suitable for low frequency sounds.
- Resonance-absorbing type can adjust the size to suit the frequency range of the sound, and can absorb the narrow wave sound.

7. Instructional Media for Using the Program Autodesk Robot Structural Analysis Professional



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Instructional Media for Using the Program Autodesk Robot Structural Analysis Professional

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Abstract—Nowadays, programs used in construction work are important in drawing and design. Several options are available. Design programs are two- and three-dimensional structural analysis and design programs which can analyze large and complex structures accurately and rapidly. Moreover, a design software can design various types of building structures and constructions. A video media of software tutorial was created to make teaching and learning more efficient and to easily understand how to use the program for accurate calculation, analysis and design by using the Autodesk Robot Structural Analysis Professional program. A steel structure warehouse with a dimension of 30 x 60 meters was chosen as an example in this study. The instructional media was produced to demonstrate the use of Robot Structural Analysis Professional software in analysis and design of the selected warehouse step by step. The instructional media was evaluated the effectiveness of the content by five experts. The revised instructional media according to the comments of the experts was tested by 34 students via pretest and posttest. The result was found that analysis for efficiency in production technical is in a very good level. Analysis for content performance is in a good level. Production technical satisfaction analysis is in a good level. The average score of content satisfaction analysis, test results, users, and media usage before studying was 8.17%, and after studying was 14.29%. The score after studying was statistically significant more than before studying at 0.05.

Keywords—structural analysis, building structures, instructional media

1. INTRODUCTION

Currently, the program can be considered as a necessity for everyday work. Several programs are available to be used and each program has its own advantages. If the user does not have sufficient knowledge of the program, it may cause problems and errors.

Autodesk Robot Structural Analysis Professional is a 2D and 3D structural analysis and design program capable of analyzing large and complex structures accurately and quickly [1,2]. Able to design various types of building structures and constructions. The structural steel structure. Reinforced concrete, wood and aluminum as well.

Instructional media is necessary for teaching process [3]. To illustrate and explain the use of the program in each step for the learners to be able to understand more easily and efficiently, the researcher has prepared the video media. The media also gives an example and explain how to use the program step by step for the learners to gain more knowledge and understanding of how to use the Autodesk Robot Structural Analysis Professional program.

II. EXPERIMENTAL PROGRAM

The instructional media of warehouse design with the size of 30 x 60 meters was produced using the Autodesk Robot Structural Analysis Professional software as follows [4]:

- Study information and procedures for using Robot Structural Analysis program.
- Determine the steps for using the Robot Structural Analysis program, divided into 10 steps as follows:

1) Set project type



Fig. 1. Set project type

8. Instructional Media for Construction Drawing by Autodesk Revit Structure

Instructional Media for Construction Drawing by Autodesk Revit Structure

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Abstract—The purpose of this research is to create a teaching tool using Autodesk Revit program. The production of instructional media for drawing construction with the Autodesk Revit Structure consists of the study of data and usage of program procedures. The teaching material of Autodesk Revit Structure was produced in the form of video media. The instructional media was assessed by the experts. The students also evaluate the satisfaction and then bring evaluation results are evaluated by dividing the assessment into two types is content and technical production of the media. After that, the results from the validation of the content of the teaching media was used to improve the media of Autodesk Revit Structure according to the recommendations of the experts. The instructional media was used to test with a sample of students via pretest and posttest. The test result is in a good level. From the results of the assessment and achievement tests effective teaching of drawing materials, with the Autodesk Revit Structure program can be used in teaching and learning.

Keywords—construction drawings, instructional media, Autodesk Revit Structure

I. INTRODUCTION

Drawing is a way of transferring the ideas of designers on paper for people to understand. Drawing also is one of the languages used in industrial work and a language that conveys the ideas or needs of the designer to others to know and understand correctly. However, in order to get a consistent understanding, drawing must be in a universal language. The symbols and various forms must be easy to understand, even those who do not study drawing are able to understand reasonably.

Autodesk Revit is an architectural design program with BIM (Building Information Modeling) [1]. Building modeling technologist, architects, engineers, contractors or other relevant parties can use the detailed building information continuously to reduce duplication of work, conflicts, and cost of operating the whole system. At the same time, the quality of design works is improved. In building Information Modeling (BIM) for architecture, the architect is the creator of information to those involved in the design. The construction can be used smoothly [2]. Time was saved for creating new information over and over again. It can reduce construction

costs and a chance of mistake. Revit Structure program designed for engineers. Building structure and especially engineering drawing can also be transferred to the analysis program and composed in different structural design programs.

Therefore, in order to learn drawing of a 3D construction model effectively, instructional media should be used [3]. The researcher has chosen the Autodesk Revit Structural Analysis Professional program which is a highly efficient software to draw the building construction.

II. EXPERIMENTAL PROGRAM

The process of the use of Autodesk Revit Structure software was determined by dividing into six chapters as follows: Chapter 1 Format and Functionality of Autodesk Revit Structure; Chapter 2 Constructing the Building; Chapter 3 Roof Structure Drawing; Chapter 4 Inserting reinforcing bars in structures; Chapter 5 Structural Materials Estimation; Chapter 6 Printing.



Fig. 1. 3D structure model.

Instructional materials for Autodesk Revit Structure program in the form of video media was produced. Subsequently, the effectiveness of the instructional media, content was evaluated by experts and then applied to the sample to assess media performance [4].

9. Precast Concrete Columns Strengthened With CFRP and GFRP Laminates Under Eccentric Load

Precast Concrete Columns Strengthened With CFRP and GFRP Laminates Under Eccentric Load

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Abstract—This paper presents the experimental results of precast concrete columns strengthened and repaired with externally bonded carbon fiber reinforced polymer (CFRP) and glass fiber reinforced polymer (GFRP) laminates. The aim of the study was to investigate the structural behavior of a precast concrete column with a notch and the efficiency of CFRP and GFRP laminates in strengthening and repairing the columns subjected to eccentric load. A total of 15 precast concrete columns with notches were tested up to failure. Load was applied on a column notch causing eccentric load on a column. The specimens were equally divided into five groups based on the types of fiber reinforced polymers and damage conditions of columns (undamaged or partially damaged): columns with non-strengthening/repairing; columns with CFRP strengthening; columns with GFRP strengthening; columns with CFRP repair; columns with GFRP repair. The results were compared and discussed in terms of load carrying capacity, lateral deflection, and mode of failure. It was concluded that the application of CFRP and GFRP laminates in strengthening and repairing precast concrete columns improved the load carrying capacities up to 27.6%.

Keywords—precast column, eccentric load, CFRP laminate, GFRP laminate

I. INTRODUCTION

Concrete columns are considered to be one of the most essential structural members in residential homes due to their failure causing collapse of a whole structure. Several experimental and numerical studies, therefore, have focused on the issue of strengthening and repairing of concrete columns [1-4]. Among other applications, the use of fiber reinforced polymer (FRP) to retrofit and repair concrete columns has widespread due to the advantages of high strength and stiffness to weight ratio, high corrosion resistance, and application flexibility [4-7]. Commercial FRP materials typically used for structural strengthening and rehabilitation are carbon fiber reinforced polymer (CFRP) and glass reinforced polymer (GFRP). In comparison of both types of FRPs, GFRP is less expensive, however, CFRP exhibits greater tensile strength and stiffness. In general, CFRP laminates would be three times thinner than GFRP laminates in order to achieve the same tensile stiffness [8]. Besides cast-in-place concrete column, precast concrete column is used in order to save construction time and to control the quality of the construction more efficiently. Since

precast columns are fabricated from manufacturing plants before transporting to the site, it is convenient to form them into the particular shape suitable for some structures such as concrete-wooden homes as shown in Fig. 1. Such columns have notches at the top end in order to place wooden beams which are generally bolted to the side of columns. The beam-column connection is illustrated in Fig. 1. Based on the notch and connection, a column is subjected to eccentric concentrated load transferred from beams.

The previous studies [4-7] have evaluated several types of columns retrofitted with various FRP and configurations. However, research on the precast column with a notch and a specific connection to beams is limited. The purpose of the current paper is to investigate the ultimate load and mode of failure of the columns to deliver a guideline for development of precast concrete columns. In addition, the effectiveness of CFRP and GFRP laminates in strengthening and repairing the precast columns were examined to provide safety to home occupants.

II. EXPERIMENTAL PROGRAM

A. Test setup

In the experimental program, 15 full-scale destructive tests were conducted on precast concrete columns repaired and strengthened with both CFRP and GFRP laminates. The load was applied using a hydraulic jack on a rectangular solid steel block placed on the column notch. The block was bolted to the lateral side of the top part of the column representing a wooden beam and beam-column connection in a realistic construction practice. Pinned end restraints were applied at the bottom end and at the notch location of the column. Lateral deflections at mid height of the column where maximum deflections occurred were measured in both directions using dial gauges. While the hydraulic pressure was increased gradually during testing, crack initiation and crack propagation were continuously observed. The test setup and connection between a steel block and column are depicted in Fig. 2.

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