

Research Experience for Teachers 2017

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AP Physics

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Richmond, Texas



Research Experience for Teachers



❖ Outline:

- **Material Science Research Group**
- **RET Summer 2017**
- **“Vibratory Motion of Skyscrapers”**
- **“Shake and Rattle”**
- **Conclusion**



Material Science Research



❖ “Sustainable Infrastructure” Research Group

- **Dr. Nicholas Brake** (Principal Investigator)
- **Saeid Hosseini** (Ph. D. candidate)
- **Soheil Oruji** (Ph. D. candidate)
- **Saeed Rabbanifar** (Ph. D. candidate)
- **Kyle Edwards** (Ph. D. candidate)



Sustainable Infrastructure



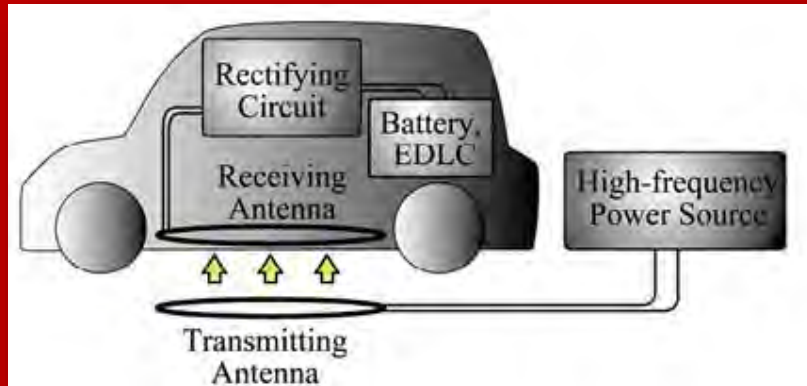
- Infrastructure that facilitates a place or region's progress towards the goal of sustainable living
- Sustainable living is a lifestyle that attempts to reduce an individual's or society's use of earth natural resources and personal resources





Sustainable Infrastructure

Efficient wireless power charging of electric vehicles by means of conductive concrete medium



Cost-effectively increase concrete conductivity to decrease the required vehicle charging time





Research Experience for Teachers Lamar University 2017



Sage Automation



Forterra Precast Concrete





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Concrete Samples





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Mini-Slump Test

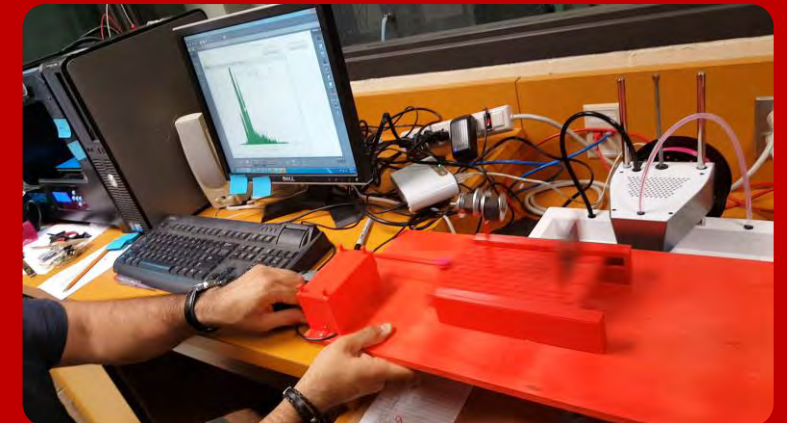




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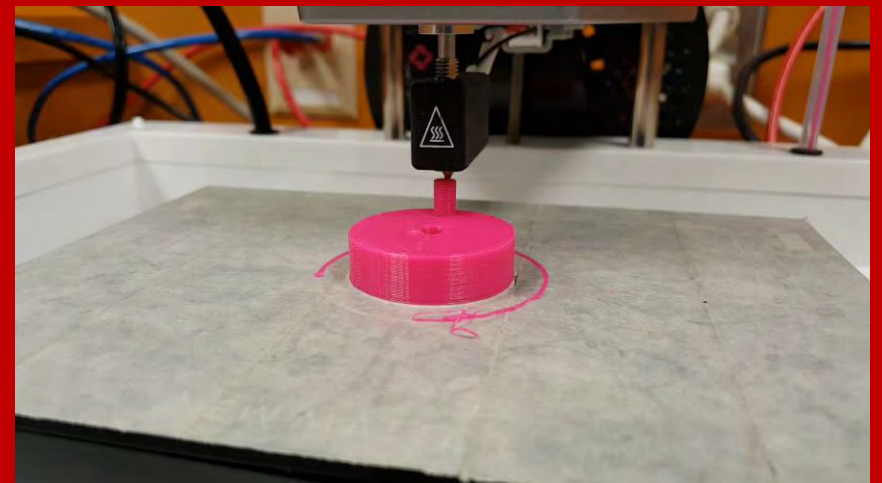
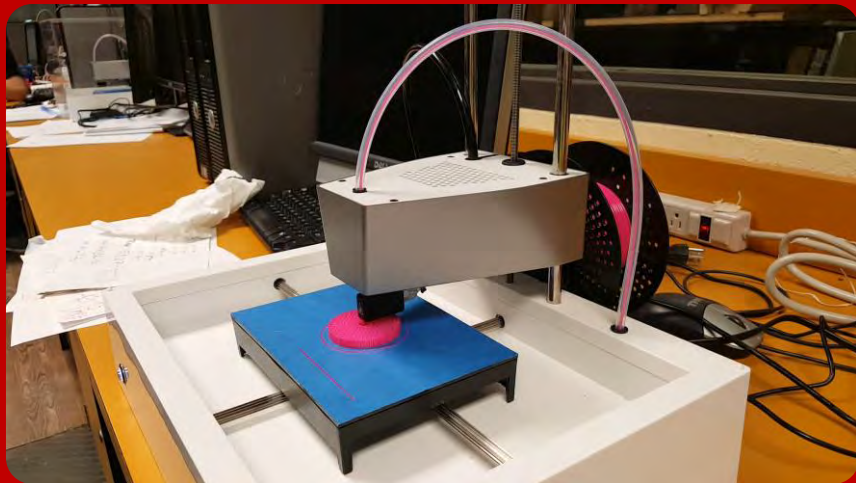
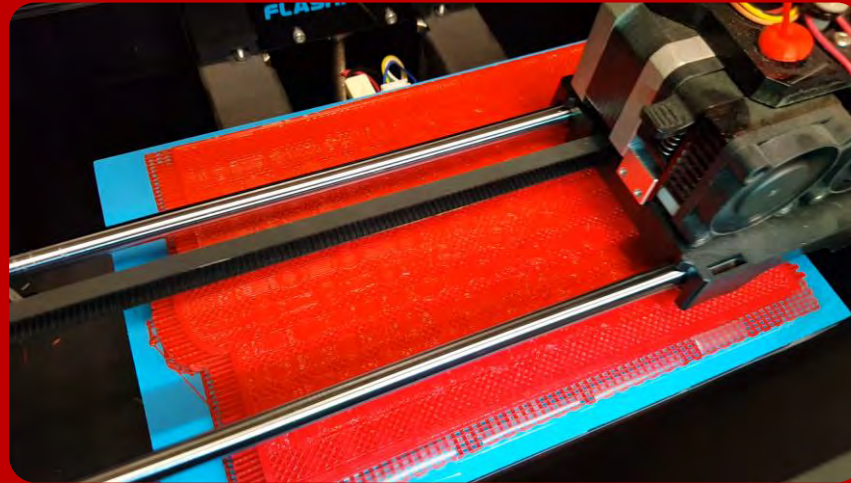


**3D Printed
Shake Table**





Research Experience for Teachers





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“Vibratory Motion of Skyscrapers”





“Vibratory Motion of Skyscrapers”



❖ PROCEDURE:

➤ Day 1

- *"A Day Made of Glass"*
- *Present 2017 RET*
- *Conduct Pre-Test*

➤ Day 2

- *Pre-Lab Activity*
- *Introduce “Simple Harmonic Motion”*





“Vibratory Motion of Skyscrapers”



➤ Day 3

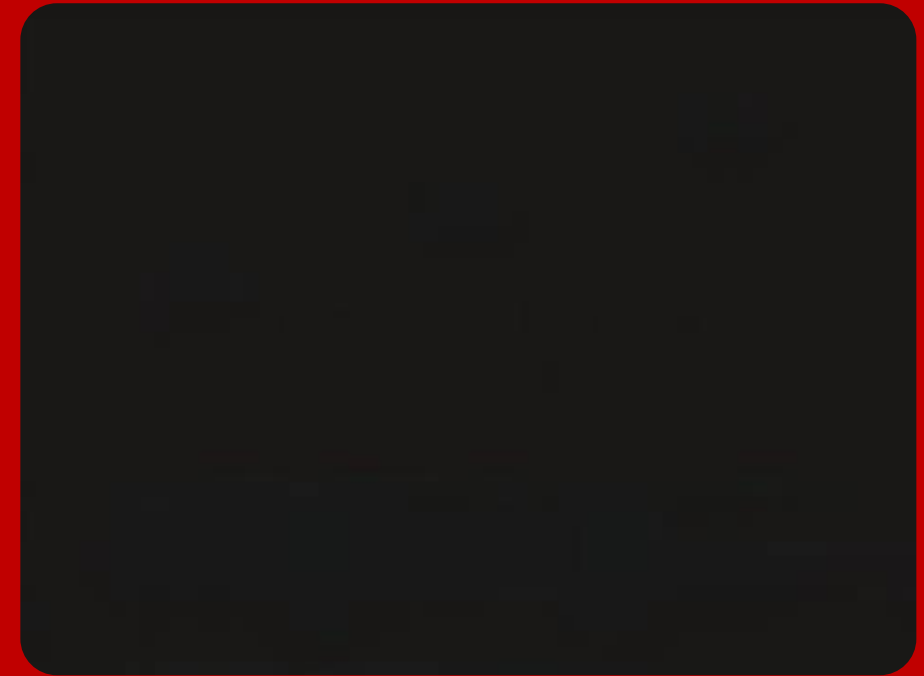
- *“Shake and Rattle”*

➤ Day 4

- *Post-Lab Discussion*
- *Lecture “Simple Harmonic Motion”*

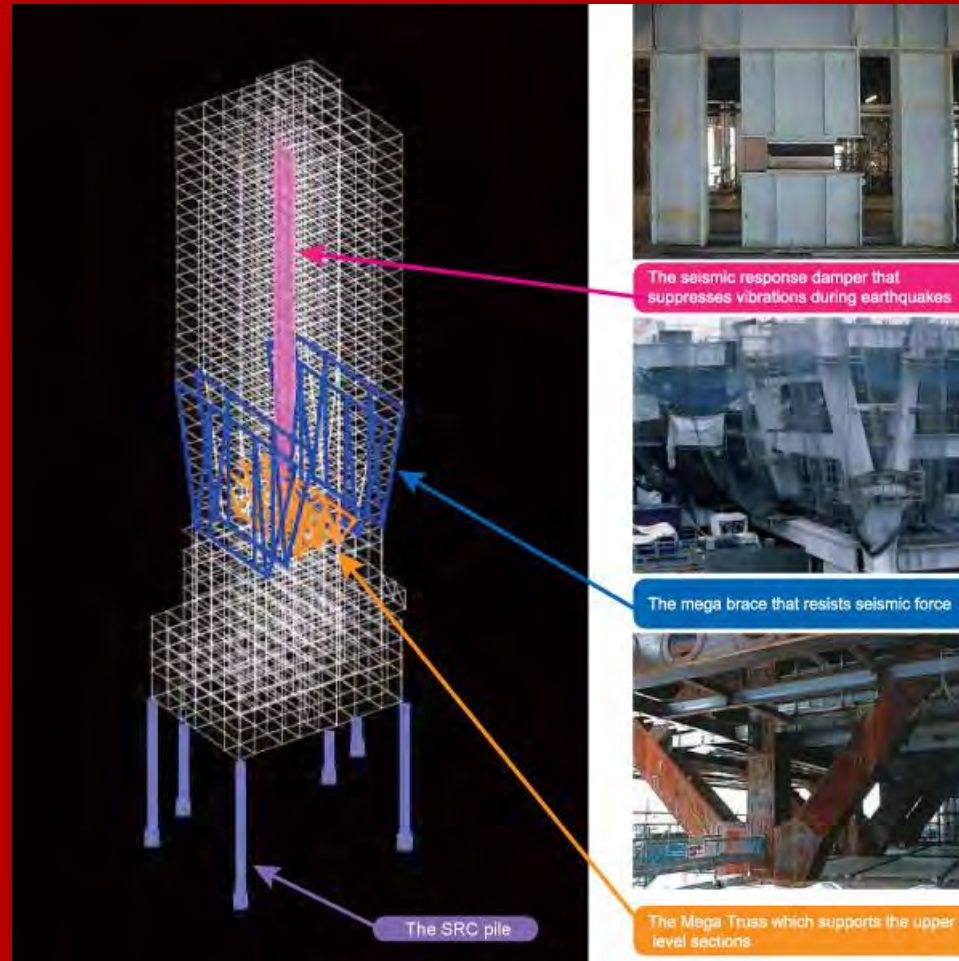
➤ Day 5

- *Conduct Post-Test*
- *Closure*





“Shake and Rattle”





“Shake and Rattle”

❖ **Grade Level**

Grade 12

❖ **Time Required**

55 minutes

❖ **Group Size**

20 to 25 students in triads

❖ **Assessment**

Pre- and Pose-Tests, Short Answer Questions, Word Problems, Lab Report



“Shake and Rattle”



❖ Summary

In this activity, students will simulate the effect of an earthquake to a vertical structure. A 3D printed shake table will represent ground movement. The vertical structure representing a skyscraper will be constructed using balsa wood connected by Styrofoam balls. Students will design and construct this structure with minimum oscillation from a varying simulated earthquake intensity. Furthermore, the aforementioned vertical structure must not fail at maximum shake table movement.



“Shake and Rattle”

❖ Engineering Connection

Teamwork plays another vital part in the work of an engineer in order to complete an assigned task. Everyone needs to actively participate in the solution to a problem. During the entire engineering design process, each one should be able to effectively express himself or herself. Trial and error is also an integral part in the success of an engineering feat. In this regard, students mimic the vibratory motion of a skyscraper by constructing a vertical structure made of balsa wood and place it on a 3D printed shake table. Finally, making some actual measurements as well as mathematical calculations completes this student activity.



“Shake and Rattle”



❖ Educational Standards

➤ State STEM Standard:

- *Texas: Science(2017), Subchapter C. High School (9-12). Physics. Scientific Processes. The student uses a systematic approach to answer scientific laboratory and field investigative questions. The students is expected to express and manipulate relationships among physical variables quantitatively, including the use of graphs, charts, and equations.*
- *Texas: Science(2017), Subchapter C. High School (9-12). Physics. Science Concepts. The student knows the characteristics and behavior of waves. The students is expected to examine and describe oscillatory motion and wave propagation in various types of media.*



“Shake and Rattle”



❖ Educational Standards

➤ ITEEA Standards:

- ITEEA (2017), The Nature of Technology (K-12).

Standard 1. Students will develop an understanding of the characteristics and scope of technology. In order to comprehend the scope of technology, students should

learn that:

F. New products and systems can be developed to solve problems or to help do things that

could not be done without the help of technology.

- ITEEA (2017), The Nature of Technology (K-12).

Standard 2. Students will develop an understanding of the core concepts of technology. In

order to comprehend the core concepts of technology, students should learn that:

M. Technological systems can be connected to one another.



“Shake and Rattle”

❖ AP Physics C Scope and Sequence

- I. First Six Weeks (Aug. 28 – Oct. 6)
 - a) SI Units, Dimensional Analysis, and Vectors (18 Days)
 - b) Vector Multiplication (10 Days)
- II. Second Six Weeks (Oct. 9 – Nov. 10)
 - a) Rectilinear Motion (15 Days)
 - b) Planar Motion (10 Days)
- III. Third Six Weeks (Nov. 13 – Dec. 22)
 - a) Introduction to Newton’s Laws of Motion (11 Days)
 - b) Applications of Newton’s Laws of Motion (11 Days)
- IV. Fourth Six Weeks (Jan. 8 – Feb. 23)
 - a) Work, Energy, and Power (11 Days)
 - b) Conservation of Energy (10 Days)
 - c) Impulse, Momentum, and Collisions (11 Days)
- V. Fifth Six Weeks (Feb. 26 – Apr. 20)
 - a) Rotational Kinematics (11 Days)
 - b) Rotational Dynamics (11 Days)
 - c) Translational and Rotational Equilibrium (11 Days)
- VI. Sixth Six Weeks (Apr. 23 – Jun. 7)
 - a) Gravitation (10 Days)
 - b) Simple Harmonic Motion (10 Days)





“Shake and Rattle”



❖ **Physics Unit TEKS**

➤ **Physics 2E**

- *Design and implement investigative procedures, including making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness.*



“Shake and Rattle”

❖ Learning Objectives

After this lesson, students should be able to:

- *calculate the period and frequency of an oscillatory motion,*
- *design and construct a vertical structure under vibratory motion,*
- *predict and identify the proper location of a damper for an object undergoing vibration.*



“Shake and Rattle”



❖ **Material List**

- *shake table*
- *scissors*
- *washers*
- *paper clips*
- *balsa wood*
- *styroform balls*
- *triple beam balance*
- *laptop computer with Internet access*



“Shake and Rattle”

❖ Vocabulary

mass, pendulum, period, frequency, hertz, oscillation, vibration, cantilever



“Shake and Rattle”

❖ **Assessment**

➤ **Pre-Activity Assessment**

- *Descriptive Title:* “Period versus Frequency” Students should be able to differentiate these two concepts based on what they have learned from the previous year during their Pre-AP Physics class.

➤ **Activity Embedded Assessment**

- *Descriptive Title:* “Simple Harmonic Motion” Probing questions will be asked while students are designing and constructing their vertical structure prior to testing on the shake table.

➤ **Post-Activity Assessment**

- *Descriptive Title:* “Damper” Students should be able to figure out the proper design or proper placement of dampers on their structure in order to prevent it from collapsing.



“Shake and Rattle”

❖ Activity Extension

The optional extra credit assignment will be the extension activity. Interested students can either simulate and analyze their structure design using Fusion 360 or present a trifold poster on "Smart Materials"



“Swinging Column”

❖ Activity Scaling

No activity scaling is planned for this AP Physics class.



“Shake and Rattle”



❖ Classroom Testing Information

A major test is going to be conducted for approximately 50 AP Physics students sometime on the week of November 13, 2017 at Foster High School in Richmond, Texas.



RET Summer 2017



❖ Acknowledgements

- *Dr. Weihang Zhu, Lamar University RET Program Director*
- *Dr. Nicholas Brake, Material Science Lab, Lamar University*
- *Saeed Rabbanifar, Soheil Oruji, Saeid Hosseini, and Kyle Richards, Lamar University Department of Civil Engineering*
- *2017 RET Cohort*



RET Summer 2017



Thank you very much!!!

