

CLUSTER 4: WHEN DISASTER STRIKES: EARTHQUAKE ENGINEERING

Cluster 4 spent the first week learning the lay of the land on the UCSD campus. We hit the ground running (or more realistically walking) to the Structural and Materials Engineering building each day.

Day one the Faculty Instructor Jacqui Le introduced students to qualities that make good engineers and loaded us with information about how gravity and lateral movements from earthquakes impose forces on a structure. Our K'nex buildings were not a complete failure. Many of the K'nex structures withstood the earthquake simulating shake table, because we learned about and



implemented techniques

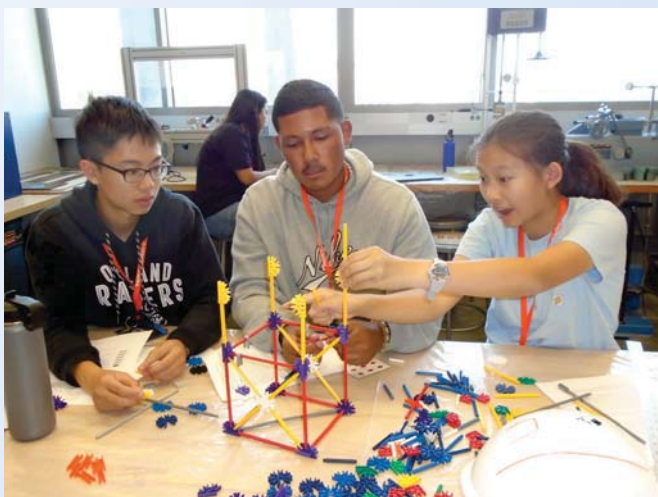
such as moment frames, cross-bracing and shear walls that provide lateral resistance. Students learned about various important historical earthquakes and the lessons engineers have learned from their “stories”.



The rest of the week required students in Cluster 4 to get their hands dirty. Quite literally in the case of the liquefaction project group. Students teamed up into eight different projects groups that focus on processes, devices and materials related to engineering for earthquakes. This week students started phase 1 testing for projects, which included learning some new skills and repurposing other skills. Who knew that soldering and using piping bags used for cake decorating would come in handy when learning about reinforced concrete columns and masonry? Tuned mass dampers and base isolation groups needed a little extra research, while other groups working with wooden structures were yelling

“Timber!”. Although we do have at least one “soft story”, there is more to learn and do in the upcoming weeks of COSMOS.

At times engineering can have a demanding workload. We do force ourselves to use our brains and that can result in some stress to develop. Cluster 4 was lucky that we had our Teaching Assistants Alan and Maria to help out with the tensile testing that took place. Fortunately, we also had our COSMOS Olympics to reduce some strain at the end of the week.



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Week two started out as lovely as a day on the beach, and it was! Cluster 4 traveled to Torrey Pines State Reserve to observe the unique geology of the area. Learning about types and rates of rock formations, uplift, erosion made us ready for a little fun in the sun. We traveled from the rocky cliffs to the sandy shore for a little liquefaction in action demonstration. After a stop at the Visitor Center it was time to head back to UCSD campus.



Our instructor Rad taught the cluster about the structure of Earth and the types of waves caused by earthquakes. This background will prove useful in understanding the way the ground beneath the engineering projects might react to seismic activity. We received real seismogram data and analyzed the various peaks and different ways and time it takes for energy to be transmitted. Then we were able to calculate and determine the epicenter of the earthquake on inflatable globes.

Soil samples had to be collected in order to characterize properties. This is important to know when building on top of ground that may be unstable or prone to issues. It was easy enough to find sand, but seemingly difficult to find clay. After drying and further

analysis, we discussed the building challenges for engineers that each sample presented.

Oh lollipop, lollipop! Learning about natural frequency is sweet! Jacqui helped us calculate the natural frequency and oscillations of various weighted rods. While the math calculations were challenging, it taught the importance of unit consistency and dimensional analysis.

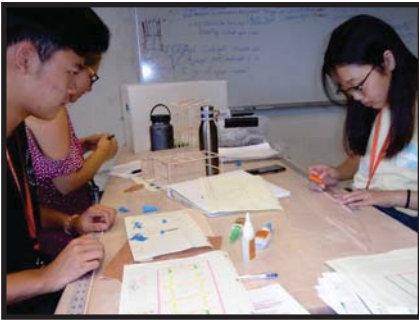
Phase 1 testing groups presented their findings and handed over their lessons learned and projects to the newly formed phase 2 groups. With the information and discoveries from phase 1 hopefully the phase 2 testing will go smoothly. Regardless, we know it will be an exciting week ahead!



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After learning about various seismic retrofit strategies and soil improvements for mitigating hazards in week three we continued on our Phase 2 testing; some of which needed careful calculations. The Slope Stability group found out how slippery sand could be as forces were applied to replicate seismic activity. Reinforced Concrete group made some hot progress with their newly found soldering and cementing skills. The Timber group members found themselves constantly cutting away at their work load. Some groups like the Soft Story team was stuck in a holding pattern as they waited for their glued joints to dry. Other groups like Liquefaction were pillars of the classroom when they successfully tested their first re-design.

This week Cluster 4 was lucky enough to have field trips where we saw similarities in the COSMOS tests we have been doing at the research and professional levels. Jacqui gave us a quick lesson about the sites and Personal Protective Equipment (PPE)



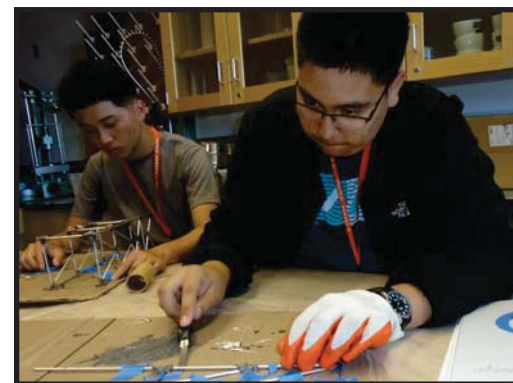
prior to the tour of Powell Lab facilities and shake table on the UCSD campus. Here we were able to see large scale testing of engineering solutions similar to our own COSMOS projects. At the Seismic Response Modification Device

(SMRD) test facility we were given insight regarding retrofit strategies for earthquake design. Later at Englekirk Structural Engineering Center we viewed the largest outdoor shake table that allows researchers to perform earthquake safety tests at full scale. Lelli is even one of the Principal Investigators helping to get the shake table updated to allow for six degrees of freedom.

Once we had learned about schematics, design development and construction drawings Cluster 4 did a site analysis using construction documents. The lesson was that design is only good if someone else can use it to correctly build the structure; and that



requires lots of detail. Although we only navigated a small section of the documents required for the building, the volume of information was overwhelming. This reinforced the takeaway that as engineers the final product for the client are always the drawings that are created and instilled the idea of the various stakeholders in the project team. By Thursday we were a shoe in, with our hard soles and leather uppers, for the construction site visit. When we saw it the building was far from done, but with the concrete poured and the designs we analyzed in our mind, we could envision the completed project.



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By the last week Cluster 4 had loaded us with enough knowledge to evaluate structural systems through a truss challenge. Although the work was demanding at times, by the end of the four weeks we had the capacity for greatness. What we have learned here will at COSMOS will help to bridge the gap between high school and college. We were even fortunate enough to have a chance to ask questions to a three person panel this week made of an undergraduate student in Structural Engineering at UCSD, an Architectural Engineer who has turned to Construction, and a UCSD Ph.D student in Geotechnical Engineering.

After learning about earthquake hazards, soil and engineering solutions we felt confident in our projects. Throughout our time in cluster 4 we have gained an understanding that failure in testing provides an opportunity for learning in life. After a few cycles of research, design, test, fail, redesign and repeat, we were proud of our final products. In our groups we enhanced our collaboration, communication and presentation skills until we felt more confident. Our knowledge and communication skills were further tested during our Jeopardy "Final Exam". It may have been stressful, but it was loads of fun. We practiced to refine our presentation skills within our fellow earthquake engineers before sharing the information with Cluster 5 COSMOS students who had been focusing their time on lasers.

The four weeks of summer flew by in Cluster 4. Visiting the largest outdoor shake table or an active construction site are special opportunities that most people never get. It was interesting to hear all of the perspectives of the people we met on the field trip and that participated in our panel. Plus, what is more fun than going on a field trip to a construction site where you get to wear a hard hat? Trisha Torres admitted "My three favorite things from my COSMOS experience are the interesting lectures and activities, the new friends I have made, and the onion rings at lunch." Reflecting back on our time at COSMOS, the consensus was that we will remember the people the most. We appreciate the mentors that helped us grow and the new friendships that will last into the future. "We have come a long way in four weeks, at first the students were all strangers at COSMOS, then it got cliquey, but now we are all bonded in Cluster 4" said Aarushi Wadhwa. The new skills and friendships that were gained over the past month will follow us home and serve us well into the future.

