

# Design, Funding, and Construction of the August Pine Ridge School/Hurricane Shelter in Belize

*"He who opens a school door, closes a prison."  
- Victor Hugo*

*"This building stands as a monument to the collective efforts and hard work of dozens of people, that although from different countries and backgrounds, are united with the common purpose to improve the human condition."  
- June 1<sup>st</sup>, 2012*

## BACKGROUND

The rural village of August Pine Ridge, located in the Central American country of Belize, was faced with overcrowding classrooms in its school. Despite intense efforts by the school's principal and members of the PTA, no assistance was forthcoming. Our university's chapter of Engineers Without Borders took on the task of helping this village realize its dream.

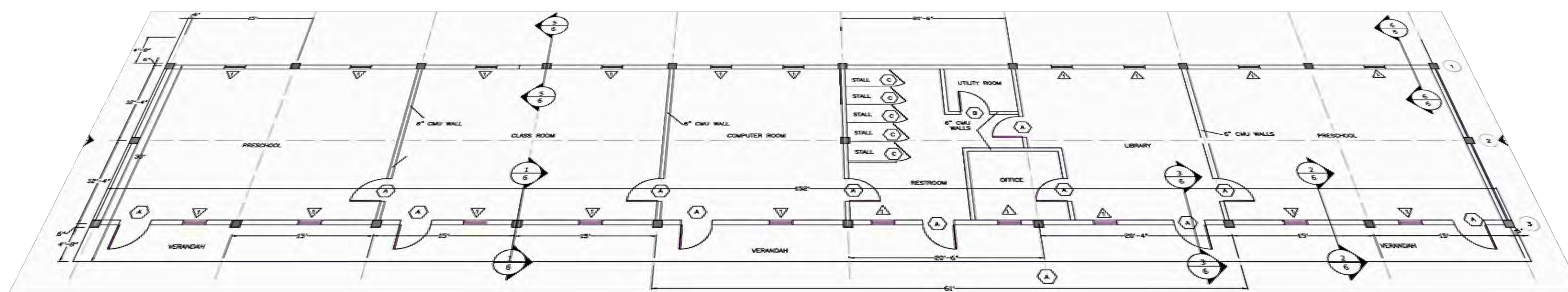
The goal of this project was for the chapter's student volunteers to not only expand the number of classrooms, but to provide a building encompassing many facets of education. The design would also address the community's inadequate hurricane shelter stock by incorporating design elements that would allow the completed structure to shelter members of the village from the force of a category III hurricane.



## COLLABORATION

To ensure the success of such an undertaking, the chapter sought assistance from the university's licensed professional engineers (P.E. & Ph.D.) who made up the Civil Engineering Department faculty as well as local members of the engineering community (P.E. & S.E.). These local professional mentors volunteered their time to introduce the students to the real world profession of engineering.

Along with these local professionals the students also established relationships with several licensed professional engineers (P.E., M.I.C.E., E.I., and P. Engr. Belize) and architects located in Belize. These professionals, many of whom were educated in the United Kingdom and the United States, provided invaluable insights as to how and what could be done in Belize. Such collaboration provided QA/QC and oversight of the final design and construction drawings.



To bring their design to life, One graduate student remained in Belize during construction while groups of volunteers accompanied by professional mentors traveled to Belize at various intervals. These groups worked along side more than a hundred volunteers from the village to complete the project. For some it was their first experience actually constructing a structure such as this. The village opened their hearts and homes to the students.



## BENEFIT TO PUBLIC HEALTH, SAFETY, AND WELFARE

Working closely with the community of August Pine Ridge the final layout of the building was decided on and ground was broken for the 3,700 square foot building on April 6<sup>th</sup>, 2011. The new building would contain three large classrooms, a library, computer room and an office for the principal. The main loading members are comprised of steel reinforced cast-in-place concrete columns and beams. The infill walls are load bearing and are made up of 8-inch CMUs that are fully grouted and contain steel reinforcement both vertically and horizontally. The floor is a 6-inch slab on grade and the roof is a steel reinforced 6-inch slab. To benefit public health, the building also has a restroom with toilets and sinks that are tied into a new on-site waste treatment system to allow the existing outhouses and 25 year-old cesspools to be decommissioned.

Working with over one hundred volunteers from the village and with the support of various organizations which include, but not limited to, the Belize Government, university alumni, and the professional chapter of the American Society of Civil Engineers, the students completed the \$500,000.00 (US) structure. The building was inaugurated on June 1<sup>st</sup>, 2012 and now serves not only the children but also serves as a community center when school is not in session.

To ensure the success of this project, the students made every effort to include not only licensed professional engineers from both the United States and Belize, but to also include many from allied professions such as concrete contractors and finishers, heavy equipment operators, electricians masons, plumbers, and contractors.

## KNOWLEDGE GAINED

The knowledge that was gained during this worthwhile humanitarian project would fill volumes. Everyone involved took away something from this unique experience. For many of the student volunteers it was a chance to design a large building, produce all the drawings and documentation required to build it, estimate material costs, and establish a construction schedule. Then raise funds through donations and grants to purchase the materials and travel to Belize to work side by side with the village to actually built it. A few examples of what was learned are:

- How something that looks nice and neat in AutoCAD back in the States may not be easily constructed with volunteer labor in a village 2,000 miles away in another country.
  - The knowledge in knowing the success of this building will continue to serve this community for decades to come.
- This is the greatest knowledge of all, for this project clearly demonstrated the power of our chosen profession's ability to elevate and improve the human condition. It is a profession in which we take great pride.





## DESIGN, FUNDING, AND CONSTRUCTION OF THE AUGUST PINE RIDGE SCHOOL/HURRICANE SHELTER IN BELIZE

### *Abstract*

This project, located in the rural village of August Pine Ridge, Belize, was the first undertaken by student members of our university's chapter of Engineers Without Borders. The goal was to address the insufficient classroom space for more than 400 children attending school. Our student volunteers also sought a solution to the community's lack of hurricane shelter capacity for its population of about 3,000.

Visiting Belize twice during the design phase allowed our volunteers to establish a relationship with the villagers and acquire a feel for what could and could not be accomplished in Belize. Collaborating with **licensed professional engineers** (*P.E., S.E.*) from the University's Civil Engineering Department and local structural engineering community at home, the students began the process of designing a structure that would **benefit public safety and welfare** by providing shelter from winds of a category III hurricane and provide new learning space for the children. After many alternatives were examined, the final design, which was agreed upon by all stakeholders, would total 3,700 square feet and provide three large classrooms, a computer room, library, and an office for the principal. To **benefit public health**, the design would also include indoor toilets and sinks integrated into a new on-site waste treatment system that would allow the existing outhouses and 25 year old cesspools to be decommissioned.

To ensure the project's success, the student volunteers established important relationships with **licensed professional engineers** (*M.I.C.E., P.Engr Belize, E.I.*) within Belize. These professionals, many educated and licensed in Great Britain and the United States, provided valuable knowledge as to local conditions. Two in particular, a Belize structural engineer and an **allied professional** (*licensed architect*) reviewed the final design documents and stamped the construction drawings. The use of their professional seal indicated their satisfaction that the students had utilized proper engineering methods and followed the requisite codes.

With great fanfare, ground was broken on April 6, 2011. One graduate student volunteered to remain in Belize during construction while several groups of students, accompanied by professional mentors, arrived from the States to participate in the construction process. Working alongside the students were over a hundred volunteers from the community. Also, contributing to the success of the project were **allied professional participants** that included concrete contractors, licensed electricians, heavy equipment operators, masons and plumbers. Those villagers who were unable to participate directly donated materials and provided meals to the students during their stay. After much hard work, the \$500,000 (US) project was completed and inaugurated on June 1, followed by completion of the septic system on August 22, 2012.

The **knowledge gained** from this experience can easily fill volumes. It was engineering on the frontier and back to basics. Students and professionals alike dealt with circumstances one does not find in the United States. Such opportunities would arise and allow everyone involved to gain a new perspective on the profession of engineering. Thus, **students, faculty, and licensed professional engineers** alike took away something from this experience. For this student volunteer of Engineers Without Borders, it was the pride in witnessing the awesome power of our chosen profession's ability to elevate and improve the human condition.



## **DESIGN, FUNDING, AND CONSTRUCTION OF THE AUGUST PINE RIDGE SCHOOL/HURRICANE SHELTER IN BELIZE**

### **1. PROJECT DESCRIPTION**

This was the first project undertaken by our University's student chapter of Engineers Without Borders - USA. The Chapter was started in the late fall of 2008 and was awarded the opportunity to work with the community of August Pine Ridge in the Central American country of Belize. The goal of this project was to address the insufficient classroom space for more than 400 children attending the August Pine Ridge RC School. Our student volunteers also sought a solution to the community's lack of hurricane shelter capacity for its population of about 3,000.

The project team, made up of both undergraduate and graduate civil engineering students, was in constant consultation with the school expansion committee set up in August Pine Ridge. Accessing the needs of the community, the project team settled on a building that would have three large classrooms, a computer room, a library, and a principal's office. The design would also include indoor toilets and sinks connected to a new on-site treatment system that would allow the decommissioning of the existing outhouses that sat over 25 year old cesspools. The student project team also sought to address the community's lack of hurricane shelters by ensuring that the completed school building would be designed to withstand a category III hurricane. Visiting Belize twice during the design phase allowed our volunteers to acquire a feel for what could and could not be accomplished in Belize.

Collaborating with licensed professional engineers (*P.E., S.E.*) from the University's Civil Engineering Department and local structural engineering community, the student design team developed a structure that was comprised of steel reinforced concrete columns and beams complemented with infill walls of fully grouted eight inch wide concrete masonry units that contained both horizontal and vertical reinforcing steel. The roof of the structure was a six inch thick slab that measured 32 feet by 153 feet with a veranda to the front of the building and sloped 3% to the rear. A six inch slab on grade was used for the floor. Working with other licensed professional engineers a separate student team designed an onsite waste treatment system.

The total design package, including documentation and construction drawings was completed in December of 2010. During this process students, faculty, and licensed professional engineers volunteered their time and resources to prepare the project documents for review by the EWB-USA Technical Advisory Committee. This committee is comprised of up to four licensed professional engineers and is responsible for approving those designs that fulfill the EWB requirements for safety, public health and welfare. A presentation was made to this committee and various questions that were raised were answered by the students. Approval to begin construction was granted after the first review.

Raising the funds necessary to build the project was split between the chapter's volunteers and the villagers of August Pine Ridge. The estimated cost of building material for the structure totaled around \$350,000 (U.S.). Money was raised with the cooperation of many licensed professional engineers primarily from the civil engineering organizations. Organizations, such as the American Society of Civil Engineers, along with local contracting and engineering design firms are active in our region. Along with bake sales, grant writing, and the support of the Engineering College many local professionals provided donations to the student chapter to allow some 40 student volunteers with several professional mentors to not only travel to Belize but also to purchase the materials required to construct the building. In Belize deals were struck with various socially conscience contractors and suppliers to provide goods and services at a price that would stretch the project budget to its maximum. Proper strength CMUs and reinforcing steel were major components of the structure and as such were tested by engineers in Belize. All concrete pours were also sampled by a professional engineering firm in Belize and the results documented. The Central Building Authority in Belize examined our drawings and concluded that a building such as this would have cost a little over \$1 million (Belize dollars, \$500,000 U.S.)

Ground was broken for the new school building on April 6, 2011 to much fan-fare. Students and community volunteers with the aid of the Belize Ministry of Works backhoe went to work immediately. Foundations were excavated and steel reinforcing bars were cut to length and the foundation mats fabricated. Construction continued at the brisk pace of six days a week through the summer months. The structure was finally completed by the end of August 2011. Finishing the project was a daunting task that was finally seen completed in August of 2012. Today the building is fully functional and serves the community and the children well. As an added benefit to the community, the building is open in the evenings to allow members of the community the opportunity to utilize the computer room and the library.



## **2. COLLABORATION OF FACULTY, STUDENTS, AND LICENSED PROFESSIONAL ENGINEERS**

The design team was fortunate to have a local licensed professional structural engineer volunteer his time to help guide the students. His contributions to the design team went beyond merely checking calculations and drawings to really teaching the group about the profession of being an engineer. The group learned how to assemble all the calculations in an orderly fashion and proper ways to check each other's work. He demonstrated the importance of establishing a proper QA/QC review of all documents and drawings related to the project.

When working on complex issues of design, the students made use of advice and guidance provided by the faculty of the Civil and Environmental Engineering Department at the University. Areas where their expertise and experience played a large role were in the design of both the steel reinforced concrete roof slab and the masonry walls. When the students had completed the design all the documentation, including calculations, material estimates, and construction schedules, were reviewed by the licensed professional engineers making up EWB-USA's Technical Advisory Board. Approval was granted in December of 2010.

To ensure the project's success, the student volunteers established important relationships with licensed professional engineers (*M.I.C.E., P.Engr Belize, E.I.*) within Belize. These professionals, many educated and licensed in Great Britain and the United States, provided valuable knowledge as to local conditions. Two in particular, a Belize structural engineer and an allied professional (*licensed architect*) reviewed the final design documents and stamped the construction drawings. The use of their professional seal indicated their satisfaction that the students had utilized proper engineering methods and followed the requisite codes. Such approval is required by the Belize Government's Central Building Authority (CBA) for a structure of this size.

Construction of the new school building was begun with great fanfare on April 6, 2011 and was completed on August 22, 2012. During this time one graduate student volunteered to remain in Belize during construction as the Project Manager while several groups of students, accompanied by professional mentors, arrived periodically for week long stays to participate in the construction process. The licensed professional engineers from Belize made themselves available to the Project Manager should any issues arise during construction. Foremost in the minds of all involved were the concerns of safety and the responsibility that goes with such a project. Such a collaboration with all of these licensed professionals truly demonstrated what it is to be a licensed professional engineer and what the practice of being an engineer entails.



### 3. BENEFIT TO PUBLIC HEALTH, SAFETY, AND WELFARE

The design that was settled upon after input from the August Pine Ridge School Projects Committee, August Pine Ridge PTA, and other community stakeholders was one that provided three large classrooms, a computer room, library, and an office for the principal. To benefit public health, the design would also include indoor toilets and sinks integrated into a new on-site waste treatment system that would allow the existing outhouses and 25 year old cesspools to be decommissioned.

The safety and welfare of the community was always on the minds of the students and welfare of the school children was always first in the minds of the Project Manager and everyone involved in the project. From the volunteers to the contractors, care was taken to ensure that the building was properly built and would serve the community as a shelter during a category III hurricane.



***Above: Two of the three new classrooms now in use by the students of August Pine Ridge. Below: (left) Existing outhouses and 25-year old cesspools, (right) New computer room with ten computers, a projector, and printer.***



#### 4. ALLIED PROFESSION PARTICIPATION

Licensed professional engineers and volunteers alone would not have been able to complete a project of this magnitude. Working alongside the students were over a hundred volunteers from the community who donated half their pay to the project and those who were unable to participate directly still donated materials and kept the students feed. Also, contributing to the success of the project were the dozens of allied professional participants that included concrete contractors, licensed electricians, heavy equipment operators, masons and plumbers. The level of experience and expertise they brought to the project was indispensable in constructing what was designed in the United States into a reality in Belize.



***Above: Students, faculty, masons, volunteers and contractors all worked together to see the project brought to a successful conclusion.***

#### 5. KNOWLEDGE GAINED

The knowledge gained from this experience can easily fill volumes. From design through documentation to funding and construction, every student volunteer and faculty member alike learned something new. For those students who worked on the design and went on to construct the school learned the valuable lesson that what looks well and good in AutoCAD drawings doesn't always translate well in the field. This project was engineering on the frontier and back to basics. Even the everyday things one takes for granted in the U.S., such as a ready supply of lumber and nails, were only procured after exerting great effort. Working with the community afforded the students and professionals alike a chance to teach new techniques and learn new ones themselves. For example, when the total station malfunctioned and no builder's level was available, the contractor on the job got a length of clear plastic hose, filled it with water and taught the students how to use a water level. When faced with similar circumstances everyone involved was able to gain a new perspective on the profession of engineering.

For the Project Manager the chance to see what was designed in the United States brought to life in Belize was a unique experience. During the course of this project many challenges were dealt with on a daily basis. Only through close collaboration with everyone from the Prime Minister of Belize to the volunteers from August Pine Ridge was this task completed. Witnessing first hand the awesome power of our chosen profession's ability to



elevate and improve the human condition is something that will remain with many of the projects participants throughout our engineering careers



***Above:*** Site of the new school building in August Pine Ridge, Belize



***Above: (left)*** Students and faculty work together to fabricate the 700 stirrups required for the roof beams using ingenuity and a portable rebar bender and cutter.  
***(right)*** Students, faculty, and village volunteers working together to prepare materials for the concrete roof.