IME 400

Independent Study Project

Self Draining Downspout Project

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Executive Summary

For this project, we developed a self-draining drinking water downspout for use in South East Asia. The system was designed to divert the first 60 L of rainfall from a roof and then divert the remaining water from the storm into pre-existing drinking water tanks. The 60 L tank holds the first rain water in order to minimize debris entering the drinking water tank. This design allows the drinking water supply to be accessed at any time thus eliminating the need to wait after a storm for debris to settle. The system was implemented on 16th of May, 2009 at the Center for Vocational Building Technology (CVBT), Nong Khai, Thailand. We tested the system with a simulated average rainfall of 20 L/minute and were successful in diverting the first 60 L.

We designed and constructed the project with the help of Geoffrey Wheeler from the Center for Vocational Building Technology in Nong Khai, Thailand.

Purpose

In Thailand, all or most of the drinking water required for a year can be collected during the four month rainy season. This water is free and requires minimal setup to implement a collection system. Most people construct a collection system utilizing the roof and gutter system. Unfortunately, the first water collected after a storm off the roof contains hazardous amounts of debris, including animal feces. The roof often collects dirt, dust, tree particles, and feces which contaminates the drinking water. Some systems have water diversion pipes that detach from the storage tank. This allows the initial water to wash through the pipe and after a certain amount of time a operator can go out to change the pipe position to start collecting clean rain water. However, the villager's typical solution consists of collecting all the water then waiting for the debris to settle to the bottom of the tank in hopes the water tank spout lies above the layer of hazardous sediment at the bottom. Unfortunately, this waiting period is often ignored or cut short. Many villagers drink contaminated water and some become sick. Our system intends to eliminate the necessary settling period and reduce the possibility of roof debris entering the drinking water tanks. In addition, the debris that enters the system would also be easier to remove from our system instead of the drinking water tanks.

Design Goals from Geoffrey Wheeler:

- Low Cost (250 Baht, or about $7.50 USD)
- Easy to install
- Easy to use (self flushing in preferable, but manual flushing is acceptable)
- Easy to clean
- Easy to fabricate
- Durable design and construction material
- Easy to repair with common village tools

Project Summary

Our goal was to use appropriate technology to improve on the collection of drinking water from a rain and gutter system. This system was to be researched, designed, and implemented under the supervision of Geoffrey Wheeler for the Center for Vocational Building Technology (CVBT) located in Nong Khai, Thailand. He provided us with the project specifications and goals.

Figure 1: View of installed downspout system

Some research was done prior to design over the internet to investigate potential initial designs and for to better understand what was expected of the design. However, most research took place on site in Nong Khai using the books Mr. Wheeler has collected on appropriate technology and sheet metal designs. Two designs were sketched up by hand and in AutoCAD, along with a pro-cons list paralleling the design goals. After briefing the alternatives to Mr. Wheeler, we concluded that a vertical tube system would provide the best solution. Please see the attached design pages for the fabrication specifics of our design.

Galvanized steel was selected because of its familiarity, price, and durability within the villages. The tube design allows the villagers to fabricate the tank with minimal difficulty. We designed this system with no moving parts, while keeping the system self draining, with intentions of keeping fabrication simple. Many villagers currently use sheet metal for their roof and gutter systems, which means the materials used in fabrication are also familiar. Most sheet metal shops can fabricate the design.

Our initial system located at CVBT we call the CP Syphtin Drinking Water Safety System. The system collects the first 60 L of water off the existing roof and gutter after each rain in the vertical cylinder tank. This vertical cylinder also acts as the primary support. To allow for flexibility in roof height, the design calls for a variable height of blocks to support the weight of the system. At the bottom of the diversion tank the design includes a drain hole that slowly releases the water which makes the system self draining. A removable conical cap on the bottom allows access to the diversion tank for cleaning out debris and other maintenance. This cap is press fitted into place.

Figure 2: Bottom of cylinder tank

One of the aspects of our design is little needed set-up or maintenance of the drain hole. The overall design, shown in Figure 1, consists of a vertical tube that collects the initial rainwater coming off the roof. When the initial rainwater fills up the 60 L tank, the continuing water overflows into the drinking water storage tank. The water now overflows into the storage tank and has less debris thus safer to drink. The collected water is now less likely to be contaminated and can be accessed nearly immediately after a storm. The design succeeded in meeting most of the goals of the project, but improvements are necessary to achieve all the goals specified.

Figure 3: Connection between gutter down drain and inlet point for CP Syphtin

Analysis of Goal Success

The following section discusses the goals that were aspired to, and what we can do to improve our design to achieve more.

Low Cost:

The final cost for the downspout was much higher than the design goal of about 250 THB. The sheet metal shop where we fabricated our design charged 2500 THB. There were a few factors that contributed to this high price. First, we had a rushed fabrication schedule; the metal worker fabricated the product in 6 hours. Second, the metal worker only had No. 27 galvanized metal, which is much more expensive than the No. 18 or 19 galvanized metal we planned to use in the design. One sheet of No. 27 galvanized metal cost 800 Baht; No. 18 or 19 usually costs about 2/3 as much. However, even 2/3 of that price would not lower the price to our goal of 250 THB.

The cost could be less if the metal worker had more time to fabricate the design and if a cheap grade of galvanized metal such as No. 18 could have been used. A cheap type of metal could be used to bring down cost. Finally the design could be optimized by researching the minimum amount of water to be diverted. Our 60 L design was a conservative estimate and the majority of the material used went into fulfilling this 60 L requirement. Researching for other abundant materials, such as PVC or Bamboo piping could also provide a solution.

Easy to Install:

The system does not need to be 100% efficient, making the installation more flexible. The system was easy to install for one person. The exact height of the gutter to the ground is irrelevant due to the flexibility of our design. The higher the building the higher a villager needs to build a base using available materials. By adjusting the height of the block supports, the design accommodates for differing roof heights thereby eliminating the need to customize the product to each roof. The exact diameter of the gutter drain pipe merely needs to be smaller than the conical top of the system to allow for proper flow into the system. The extra materials required for an install are blocks and/wood to provide a strong, flat base for the base. A few more blocks are needed to support the removable cap. There are no tools or assembly required.

Ways to make installation easier include making the top inlet of the system larger in order to accommodate larger gutter drain pipes. The base could be sturdier thus requiring less blocks to make it level.

Easy to Use:

After installation, the system required minimal effort in order to operate. Cleaning the sediment out of the system requires the user to pull out the handled press fitted bottom and wipe off the debris from the inside of the tank and the handled press fitted bottom. This needs to be done after each rain. The villagers no longer have to risk going into the storm to put the pipe in the right position to collect water. The flow of the rain coming into the system automatically diverts into the existing water storage tank once the rain fills the pipe to a certain level. The clean drinking water is put into the existing drinking

water tanks as before.

Usage may present difficulty when cleaning out the debris if it is not done following each storm.

Easy to Clean:

The bottom of the vertical cylinder tank has a removable handled press fitted cap to allow for removing the sediment that collects at the bottom. The user can completely drain the water out as well as clear the debris without any tools. Most of the debris collected at the bottom will fall out due to gravity or a hand or stick can reach it.

The cap is press fitted to the bottom, which creates a metal-on-metal contact area. When dirt or water is present between the metal pieces it may become difficult to remove and may also become more apt to rust. A redesign of the cap would be useful. A simple fix may include having longer handles for a more stable gripping point. A redesign of the bottom may be necessary due to the likelihood of the leak at the bottom becoming larger with wear. At this time a cap not using press fit would be beneficial to allow for easier removal and rust prevention.

Easy to Fabricate:

The owner of the sheet metal shop we visited to fabricate our design possessed the standard tools found throughout the area including a roller, and a tinner, among others. The shop fabricated the design in one day. Hardware stores and sheet metal shops could sell the pattern for this design and customize it for each user if desired. The system requires minimal special parts or processes in the fabrication of the design.

Most of the pieces of the system have to be fabricated from sheet metal and some are not commonly pre-fabricated parts. Each piece must be made from a flat sheet of metal. This demands more time to construct, but will allow for production cost to stay lower. Utilizing commonly found pre-fabricated pieces in conjunction with custom parts would reduce the need for fabrication by a third-party metal shop. Using pre-sized sheet metal cylinders and other prefabricated valve systems may also aid in easing the fabrication process and cost.

Durable Design and Construction Materials:

Constructing the product out of sheet metal, the villagers may be more likely to know how to take care of the system.

Conclusion

Our project, the CP Syptin Drinking Water Safety System, has already proved itself to be helpful. The rainy season has allowed for CVBT to already get use from the diversion tank. Geoffrey Wheeler has reported rains filling the tank in about 15 minutes and then seeing the water flowing into the drinking water storage tank. This project forced us to shift our mindsets from our normal lifestyle to the lifestyle of the Thai people. In doing so, we were able to achieve an understanding and a design that is appropriate to the lifestyles of another culture. By working with a client in industry, we were able to get a better exposure to the future work we will be doing, and the process we need to follow.