Breaking the reconstruction logjam

Haiti urged to recycle concrete rubble

Reginald R. DesRoches, Kimberly E. Kurtis and Joshua J. Gresham

One year following the devastating earthquake in Haiti, reconstruction progresses sluggishly. Vast amounts of debris remain untouched or in huge mounds, creating enormous physical, environmental and engineering obstacles that represent the most significant tangible challenge to Haiti's reconstruction.

After studying the situation, Georgia Institute of Technology's Structural Engineering, Mechanics and Materials School professors Kimberly Kurtis and Reginald DesRoches and graduate student Joshua Gresham argue that unless

the earthquake debris can be used as part of the strategy for reconstruction, the population and the environment remain at risk. Moreover, unless recycling is embraced, Haitian leaders will miss an unprecedented opportunity to rebuild with improved materials to avoid erecting collapse-prone structures.

This isn't an ivory tower exercise. After trips to Haiti to collect sample debris and following countless hours analyzing the aggregates in the Georgia Tech lab, these researchers can demonstrate that recycling of the concrete rubble, as aggregate in new concrete construction, is essential to a successful and sustainable strategy for managing this unprecedented volume of waste.

(Credit: Wikimedia Commons)

The Jan. 12, 2010, earthquake in Haiti damaged about half of all structures in the epicentral area.

The Jan. 12, 2010, 7.0-magnitude earthquake in the Republic of Haiti caused an estimated 300,000 deaths, displaced more than a million people and damaged nearly half of all structures in the epicentral area. More than 300,000 homes and 30,000 businesses collapsed or were critically damaged.[1] The unprecedented damage was caused by, to a large extent, the absence of seismic details, poor-quality materials (concrete and steel) and lack of quality control in construction.

In the wake of the earthquake, the collapsed structures left massive volumes of debris – fragmented concrete, twisted steel, fractured wood and personal items.

One of us, Reginald DesRoches, has visited Haiti eight times since the earthquake and has seen rubble lining the streets, filling the yards and sidewalks, and dumped within the canals of Port-au-Prince. We estimate the volume of the debris to be about 20 million cubic yards, enough to fill the Louisiana Superdome five times.[2]

With a land area of just less than 11,000 square miles (28,000 square kilometers or roughly the size of Maryland) and a population of 10 million, the population density in Haiti is high. As a result, we believe that *landfilling this volume of debris is impossible*. And, our calculations show typical disposal techniques *are simply not practical*.

The debris has created a huge logjam that is blocking reconstruction. Land can't be cleared, streets can't be opened and even foot traffic must be rerouted over long distances.

Nevertheless, the concrete and other debris largely remain where it was when the earthquake struck. Using data from the United States Army Corp of Engineers' debris management plan and reports from the U.S. Agency for International Development, we estimate that debris removal could take 20 years or longer to accomplish at current removal rates.[2]

This may be a mixed blessing because many ideas about what to do with the debris are potentially flawed. For example, use of the debris as fill or to make artificial reefs in the surrounding waters have been proposed, but the environmental concerns could preclude this option, because of the large volume and varying composition of debris to be handled.

Land-based reuse options include using the material as fill to shore up mountainsides, which are susceptible to washout during heavy rains.[3] However, we are wary of this suggestion because

'If we don't clear it'

Rubble is everywhere in this capital city: cracked slabs, busted-up cinder blocks, half-destroyed buildings that still spill bricks and pulverized concrete onto the sidewalks. Some places look as though they have been flipped upside down, or are sinking to the ground, or listing precariously to one side.

So far, only about 2 percent has been cleared, which means the city looks pretty much as it did a month after the Jan. 12 quake.

Government officials and outside aid groups say rubble removal is the priority before Haiti can rebuild. But the reasons why so little has been cleared are complex. And frustrating. Heavy equipment has to be shipped in by sea. Dump trucks have difficulty navigating narrow and mountainous dirt roads. An abysmal records system makes it hard for the government to determine who owns a dilapidated property. And there are few sites on which to dump the rubble, which often contains human remains.

Also, no single person in the Haitian government has been declared in charge of the rubble, prompting foreign nongovernmental organizations to take on the task themselves.

Most Haitians are simply living with the rubble, working and walking around it. After a while, the gray heaps and cockeyed buildings just blend into the tattered background of the city.

"Personally, I don't think Port-au-Prince will ever be cleared," said 47-year-old Yvon Clerisier, an artist working a temporary job clearing rubble with a rusty shovel for a private homeowner. He wore torn jeans, a sweaty T-shirt and sandals, and was covered in a fine dust.

Dan Strode was the rubble-removal operations manager for nonprofit organization CHF International for three months; some dubbed him "the rubble guy" because of his enthusiasm for the job. "Rubble isn't sexy," the Californian said. "And clearing it is not as simple as people think."

Strode's big worry: that debris won't be cleared fast enough and that the piles of rocks and garbage and dirt will be overtaken by tropical growth.

"If we don't clear it, what we will leave behind is something that is worse than before," he said. "If you come back in a year, and the rubble hasn't been cleared, it will be grown over, subject to landslides and unstable."

– Tamara Lush, Associated Press, Sept. 11, 2010

Debris is blocking reconstruction efforts in Haiti. Foot traffic must be rerouted over long distances.

extreme caution must be taken to minimize any secondary effects of debris relocation (e.g., clogging of existing streams and canals, and leaching of particulates or other hazardous materials).

One final consideration is that Haiti, at least as currently developed, does not have natural resources of sufficient quality and quantity to contemplate using all new materials. At best, the supply of construction materials is limited and lacks standardization.

Thus, finding a way to safely reuse the debris can have a huge positive impact on rebuilding efforts, while simultaneously minimizing the impact on the environment and ultimately becoming a key to accelerating reconstruction.

Reuse and recycling

Although some concrete reinforcement is commonly produced from recycled steel, the predominant component of the concrete is the aggregates, which can make up 70 to 80 percent of the concrete by volume. These also can be sourced from recycled materials, thereby conserving natural resources.

Aggregates obtained from crushing concrete (i.e., recycled concrete aggregate, or RCA) are commonly used and found acceptable worldwide in unbound applications, such as in base layers underlying pavements, bulk fill material, drainage materials and landscaping applications.[4] RCA also can be used in new concrete. Use of 20 percent RCA in structural concrete is common practice in much of the European Union.[5] When recycled aggregate is used locally – such as would be the case in Haiti – *recycled aggregate concrete* (RAC) can be produced more sustainably.[6]

There is an added benefit: A recent study[7] demonstrates that carbon capture, via carbonation, can be quite significant in recycled concrete aggregate during its "secondary life."

Today, after recent visits to Haiti,

Amidst the rubble

An interview with Reginald DesRoches by Ann Spence

I understand you were born in Haiti. When did you leave Haiti?

I moved to the United States as a baby, 18 months old. I traveled back to Haiti once as a teenager. That was the last time I had been to Haiti until the earthquake. Interestingly enough, my strongest memory from my teenage trip was the Presidential Palace, which was destroyed in the earthquake. It was a truly beautiful structure.

Did you have any family in Haiti at the time of the earthquake?

The closest family I had in Haiti during the earthquake was an uncle, and my godparents. Unfortunately, my uncle died a few days after the earthquake. My godparents had significant damage to their homes, but fortunately, they were not harmed.

Life in Haiti has certainly changed since the earthquake. Clearly, the most apparent change is the large number of people that are homeless, living in tents on the streets (over 1 million people). Even prior to the earthquake, Haiti was the poorest country in the Western Hemisphere, so the people are used to dealing with tough conditions. I believe this has made it easier for them to deal with the earthquake. The people in Haiti are incredibly resilient.

How many times have you traveled to Haiti since the earthquake?

I have traveled to Haiti eight times since the earthquake. The first trip was just a few days after the earthquake, when I went with a small team of engineers and architects to conduct building assessments. We looked at over 100 buildings to determine whether or not they were safe to reoccupy. During my second trip, I led a team of 28 engineers, architects, planners and social scientists to study the impact of the earthquake with the goal of helping to inform the rebuilding process.

I have been back six additional times to look at various technical aspects of the earthquake, including debris management, and the damage to the main seaport.

What are the implications of the Haitian presidential election in terms of the cleanup and rebuilding process?

It is hard to say. Some think that many projects have been put on hold for the past few months because of the distraction from the elections, and that after the elections, progress will be accelerated. It is really hard to tell.

You estimate that cleanup efforts could take over 20 years. What is the biggest hurdle facing Haitians in the cleanup effort, and what can expedite the process?

we can estimate that 90 percent of the debris resulting from the earthquake remains where it fell. Finding an avenue for high-volume reuse, such as in new concrete construction, could provide a potential solution to the formidable challenge associated with the disposal or removal of the earthquake debris from this island nation. Binding of the debris within concrete also can be advantageous in minimizing the potential for leaching of potentially hazardous components in the debris. Furthermore, reusing the debris in new construction also could facilitate recovery in a region where sufficient natural materials are unavailable

Photo from a May 2010 visit to Port-au-Prince, Haiti, shows earthquake-damaged and collapsed buildings surrounded by piles of concrete rubble and mounds of debris.

Haitian concrete: field work

To determine if this approach is feasible, we recently undertook a preliminary study to assess whether new good-quality concrete construction could be produced using debris as aggregate. Our goal was to obtain Haitian fine aggregates and Haitian-produced concrete, which we would crush and process using simple methods duplicating those typically employed in construction in Haiti. Finally, from these materials, we would produce and test concrete.

To obtain the materials necessary for this study, two of us – Joshua Gresham and Reginald DesRoches – traveled to Port au Prince from May 23 to May 27, 2010. Our purpose was to:

- Obtain samples of concrete rubble and collect samples of the local materials commonly used for concrete construction;
- Observe the local practices for concrete mix proportioning and mixing; and
- Cast samples of recently produced concrete for future testing.

During this visit, construction debris was, as observed in prior and subsequent visits, found surrounding damaged and collapsed structures piled along major roadways and along side-

The estimate of 20 years was based on the early slow rate of debris removal, much of which was being performed by hand. In recent months, there has been an improvement in the rate of debris removal, but still very little of the debris from the earthquake has been removed.

One of the primary challenges is the lack of funding for debris removal. Many donors do not want to fund debris removal. It simply is not "sexy." Donors are much more interested in building schools and hospitals. Fortunately, in recent months, Haitian governmental officials have given debris removal a higher priority, so I think we will see progress in the coming months.

What are the major challenges to recycling the concrete debris?

The first challenge is collecting the debris and securing sites to manage and sort the debris. After this, equipment will be required to crush the debris so that it can be used as aggregate. In addition, quality control measures will need to be put in place to ensure that recycled debris is of adequate quality to be used in producing new concrete.

I think the next steps are to expand the study we presented in the paper to look at a broader range of debris and a broader range of approaches to recycle the debris.

I think the major need is a commitment from the donors and the government of Haiti to make debris removal a priority, followed by a commitment to evaluate the efficacy of recycling the debris. This would require some resources in terms of crushing machines.

What do you think the state of Haiti will be in 5 years or 10 years?

I am hopeful that Haiti will be better off in 5 and 10 years than it is today or was before the earthquake. I hope that we will see people building back safer homes, and will be avoiding living in unsafe parts of Haiti. I also believe the earthquake will be an opportunity to develop infrastructure in less-developed areas outside of Port-au-Prince. I believe depopulating Port-au-Prince will be key to a more resilient and sustainable Haiti.

The Haiti earthquake was one of the largest catastrophes in modern times. It will take many years to rebuild Haiti. It is important for the international community, in collaboration with the government of Haiti, to find sustainable approaches to rebuilding Haiti to be more resilient.

Table 1: Concrete mix proportions

Material	Georgia coarse aggregate mixes		Haitian RCA mixes	
	Dark river sand mix (lb/yard³)	Clayey sand mix (lb/yard³)	Dark river sand mix (lb/yard³)	Clayey sand mix (lb/yard³)
Water	340	340	340	340
Cement (ASTM C 150 Type I)	680	680	680	680
Coarse aggregate*	1720	1588	1539	1421
Fine aggregate*	1196	1280	1169	1256

*Saturated, surface dry condition

Table 2: Specific gravity, absorption capacity and fineness modulus for two commonly used fine aggregates in Haiti

Property	Dark river sand	Clayey sand
Apparent specific gravity	2.84	2.65
Bulk specific gravity (oven dry)	2.60	2.53
Bulk specific gravity*	2.68	2.58
Absorption, percent	3.18	1.67
Fineness modulus	2.51	3.43

*Saturated, surface dry condition

walks and collected into large mounds at the Trutier landfill.

In addition, we observed local construction practices, where concrete was often batched "by eye" volumetrically and mixed by hand. Although larger-scale batch operations exist in Haiti, we saw no concrete-mixing trucks during this visit, but we found numerous crews manually batching smaller volumes of concrete.

Using mixes from several of these construction locations, we cast on-site 13 fresh concrete samples into 3-inch by 6-inch plastic molds that were then capped. We brought these samples back to Georgia Tech for testing, where they were ambiently cured, generally in the laboratory (but also in our luggage, in the belly of the plane, etc.).

Testing was conducted at 56 days of age following ASTM C 39 procedures. Results from these tests showed the Haitian concrete had an average strength of 1,300 pounds per square inch, with a standard deviation of 530 pounds per square inch (Table 1). For comparison, normal strength concrete produced in the United States would be expected to have a minimum compressive strength of 3,000 pounds per square inch. Thus, one major challenge with the recycling of the concrete debris as aggregate is the poor quality of the concrete itself. (Note that these failed concrete cylinders were retained and crushed for use as RCA in concrete mixes presented subsequently.)

Reconstruction offers Haiti an opportunity to rebuild the nation to safer, stronger standards.

Another challenge is the variable quality of the local materials. By speaking with local construction workers in Haiti, we learned that two fine aggregate sources are most commonly used: a dark "river sand" and a lighter-colored "clayey sand." The workers expressed a preference for the darker aggregate, because of its perceived improved workability when used in concrete. Nonetheless, both materials are commonly used.

Samples of each fine aggregate were obtained in Haiti, and powders crushed from these samples were subjected to X-ray diffraction (under Cu-Kα radiation) at Georgia Tech. The diffraction showed the darker material to be a limestone (calcite) and the lighter material to be a mixture of calcite, quartz, feldspars (as albite and anorthite), montmorillonite and the inosilicates diopside and kanoite. We also determined the specific gravity, absorption capacity and fineness modulus of both fine aggregates (Table 2).

Rebuild it better

The silver lining amid the devastation is that reconstruction offers an opportunity to rebuild Port-au-Prince and other affected areas of Haiti to stronger, safer standards. But, to achieve adequate long-term performance in service, including seismic resistance, new construction in Haiti should have significantly higher compressive strength than the strength of the concrete previously commonly produced in Haiti.

To test the feasibility of rebuilding

Haiti better, we first had to determine if the fine aggregates available in Haiti would in some way limit the achievable strength of concrete.

To better understand the influence of the two local fine aggregate sources on the concrete quality, we produced concrete mix designs incorporating, separately, each of the fine aggregates with a Georgian (gneissic granite) coarse aggregate, with maximum size aggregate of 0.75 inch and a dry-rodded unit weight of 98 pounds per cubic foot. We designed the concrete mixes, using the American Concrete Institute absolute volume method, prescribed to achieve moderate strength (4,500 pounds per square inch) with a water-to-cement ratio of 0.5 and a constant cement content of 680 pounds per cubic yard (Table 2). We mixed all concretes by hand, to better replicate conditions in Haiti. As before, we cast samples into 3-inch by 6-inch cylinders that were fog-room cured.

After 28 days we tested the samples in compression. Table 3 shows that both mixes met their design strength, with the dark sand concrete achieving a 5,500 pound per square inch average strength and the clayey sand concrete offering a 5,000 pound per square inch average strength. These results indicate that both sources of fine aggregates are of suitable quality for producing normal strength concrete.

Based upon those results, we next hand-batched two Haitian RCA-containing concretes, using the mix designs in Table 2. To prepare the RCA, we used an ordinary hammer to further crush the fragments from the previously tested Haitian-produced concrete. The resulting aggregates were washed and sieved to 0.187-inch to 0.75-inch. We sieved the coarse aggregate to match the maximum size of the Georgia coarse aggregate used in the companion mixes, for consistency.

Also, the limited amount of materials available to us necessitated the use of smaller sample sizes, which, in turn, required smaller coarse aggregate sizes. However, we also believe that the smaller coarse aggregate size improved the overall strength of the RCA concrete. (The properties of the resulting RCA are shown in Table 4.)

Compressive strengths of the dark sand and clayey sand RCA concretes were measured on five replicates after they were fog-room cured for 28 days. Results in Table 3 and Fig. 2 show that the average strength for each mix exceeded 3,000 pounds per square inch, with a range of 2,990 to 3,660 pounds per square inch.

Although lower than the companion concretes we produced with Georgia virgin aggregate, the strengths of these RCA-concretes greatly exceed those of the concrete from which the aggregate was recycled. Based upon these results, we now believe that Haitian concrete debris, even of inferior quality, can be effectively used as recycled coarse aggregate in new concrete construction.

Table 3: Strength results for Haitian-produced concrete, concretes produced with two Haitian fine aggregates and Georgia coarse aggregate, and concretes produced with two Haitian fine aggregates and Haitian RCA

Mix	Crushed Haitian concrete as RCA		Georgia coarse aggregate	
	Average compressive strength (psi)	Standard deviation (psi)	Average compressive strength (psi)	Standard deviation (psi)
Dark river sand mix	3175	177	5568	561
Clayey sand mix	3335	226	4995	430
Haitian-produced concrete	1312	533		

Table 4: Properties of RCA produced from Haitian concrete

Property	RCA
Apparent specific gravity	2.65
Bulk specific gravity (oven dry)	2.14
Bulk specific gravity*	2.34
Absorption, percent	8.97
Dry-rodded unit weight, pcf	87.7

*Saturated, surface dry condition

More must be learned, but recycling should proceed

Of course, our research is limited in scope, and the successful strength test was based on just one RCA source.

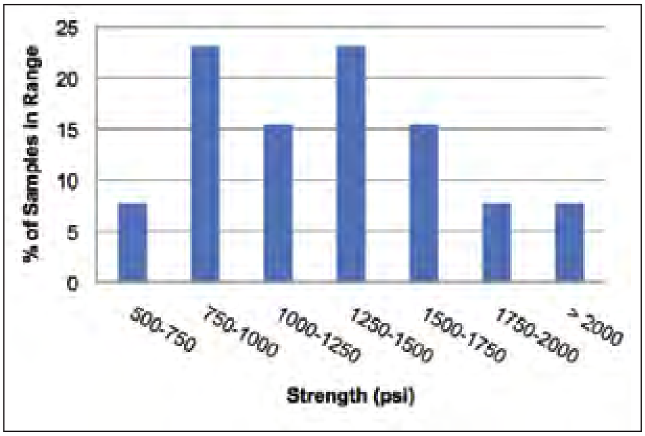


Fig. 1: Distribution in compressive strength results, for strengths measured at 56 days on concrete cylinders hand-mixed and cast in Haiti.

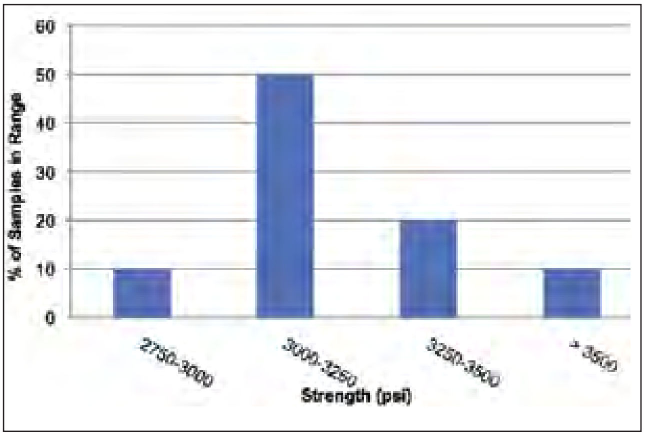


Fig. 2: Distribution in compressive strength results, for strengths measured at 28 days on concrete cylinders hand-mixed and cast from native Haitian fine aggregate and RCA obtained from Haitian concrete.

And, while the compressive strength we have demonstrated is significant enough for us to strongly recommend consideration of the recycling approach, it is ultimately just one measure of concrete performance.

In the context of rebuilding efforts, additional sources of recycled aggregates from debris in Haiti should be characterized and tested in concrete. Additional performance parameters,[8] such as elastic modulus, permeability, creep resistance, dimensional stability and long-term durability, should be assessed.

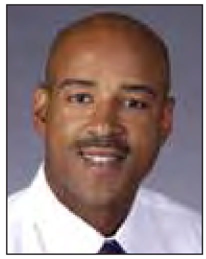
Furthermore, we recommend that a detailed lifecycle inventory and assessment be performed to better quantify the relative impacts of the various debris management strategies proposed, to determine which are most environmentally benign.

These results should be assessed dynamically during reconstruction to determine which strategies could be implemented that would most support efficient recovery, while minimizing environmental impact.

We also recognize that the seismic performance of RCA concrete has been the subject of remarkably few studies.[9] We have located no published research that has considered RCA in Haiti, where our on-the-ground observations and our data suggest that the concrete debris may be of low strength and likely low modulus. We advocate additional research to better anticipate the seismic behavior of Haitian RCA and to improve design codes to consider this material.

It's our recommendation that the Government of Haiti, in cooperation with the various nongovernment organizations working in Haiti, consider the efficacy and long-term benefits of recycling of concrete as part and parcel of accelerating debris removal. Systematic recycling can have a long-term positive impact on Haiti and aid in the recovery and rebuilding of a stronger national infrastructure. ■

About the authors



DesRoches

Reginald R. DesRoches is a professor and associate chair of civil and environmental engineering at the Georgia Institute of Technology. His primary research interests are design of buildings and critical infrastructure under earthquake loads and risk assessment of infrastructure systems. He is a member of the executive committee of the National Academy of Sciences Disasters Roundtable Committee, and he is on the Board for the Earthquake Engineering Research Institute.

Kurtis

ACerS member **Kimberly E. Kurtis** is a professor in the School of Civil and Environmental Engineering at Georgia Institute of Technology. Kurtis has served as Chair of American Concrete Institute's Materials Science of Concrete Committee and Chair of The American Ceramic Society's Cements Division. She served as associate editor of American Society of Civil Engineer's *Journal of Materials in Civil Engineering* and is editorial board member of *Cement and Concrete Composites*. She was named Fellow of the American Concrete Institute in 2010.

Gresham

Joshua J. Gresham is a graduate research assistant in the School of Civil and Environmental Engineering at Georgia Institute of Technology, where he expects to graduate with a M.S. in 2011. He earned a B.S in civil and environmental engineering from Georgia Tech in 2010. Gresham has also been involved in research on stainless steels, cementless, lightweight concrete and fiber reinforced composites.

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A sense of purpose and urgency

Georgia Tech student Joshua Gresham recounts his field research in the aftermath of the Haiti earthquake

By Joshua J. Gresham

During the summer of 2006, while working with a service group in Chiclayu, Peru, I began to realize the importance of infrastructure on the quality of life. I spent three weeks working alongside Peruvians living in a squatter camp to build a retaining wall. The leaders of our service group had made an agreement with the local government: If we would build a retaining wall to protect children from inadvertently chasing a soccer ball off a 20-foot cliff, they would provide the camp with a sewage system.

To my surprise, the local government began work on the sewage system by the end of the second week. Witnessing the responsiveness of the local government to our efforts and realizing its impact on the camp was one of the most rewarding experiences of my life.

My exposure to the infrastructure issues in Peru sparked my interest in the field of civil engineering. After talking with peers about bridge design, infrastructure rehabilitation techniques and team collaboration on projects, I decided to pursue formal CE education at the Georgia Institute of Technology in the spring of 2008.

Since beginning my CE studies, I have enjoyed the practical application of mathematics. I also have become particularly interested in merging structural engineering and material science through experimentally researching the material properties of sustainable and lightweight materials and their applications. My undergraduate investigations included developing a lightweight cementless concrete and studying stainless steel properties.

At Georgia Tech, I was inspired to research sustainable materials in earthquake applications after competing in the Earthquake Engineering Research Institute seismic design competition. I approached professor Reginald DesRoches, to determine if there were research opportunities available.

DesRoches told me about an upcoming project in Haiti involving the reuse of debris as a recycled course aggregate that would be used to aid in the reconstruction efforts. I was intrigued by the opportunity to conduct research that could potentially aid in rebuilding Haiti, and I eagerly looked forward to working on the project.

I decided to continue my education at Georgia Tech as a graduate student member of the Structural Engineering, Mechanics and Materials group, where

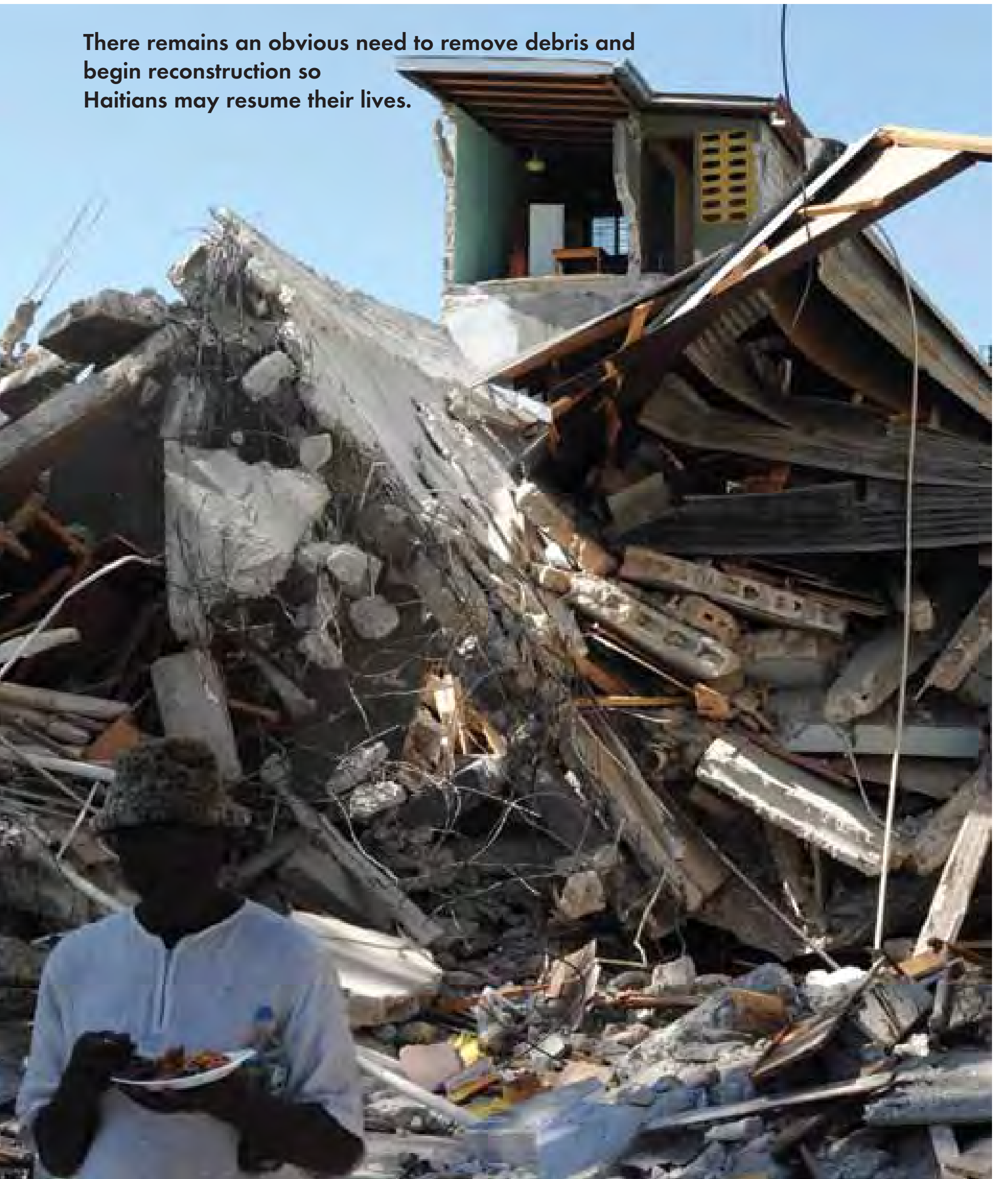
Graduate research in Haitian devastation

I had the opportunity to travel with a research team through downtown Port-au-Prince, Haiti, in late May 2010.

I immediately discovered that the images and footage shown on television of the aftermath resulting from the earthquake did not convey the complete destruction of the area. The streets were filled with debris, and many buildings and homes had either completely collapsed or remained intact only by a few steel reinforcing bars. The obvious need to remove debris and begin reconstruction in order for Haitians to resume their lives and improve living conditions gave our project a heightened sense of purpose and urgency.

As we continued driving through the cluttered streets, I noticed a common image among the collapsed buildings and homes: The floors of the structures had collapsed like a stack of pancakes. It occurred to me that this common failure must have been a design issue. I learned through discussing my observations with DesRoches that this failure results from improper joint detailing and inadequate concrete strength.

The purpose of our research in Haiti deals with the latter of the two issues – concrete strength. Providing adequate concrete strength is an essential component in earthquake-resistant design, but attaining quality concrete in developing countries is often challenging because of the increased cost that is often required. So, our job has been to improve Haitian infrastructure through research to provide a cost-effective structural concrete mix using practical batching techniques. In addition, despite the fact that some previous research about recycling concrete debris had been unsuccessful in achieving adequate structural strengths, we wanted to see if we could provide an avenue for debris removal through incorporating it in reconstruction.



There remains an obvious need to remove debris and begin reconstruction so Haitians may resume their lives.

An alarming detail

Our work in Haiti began by observing everyday mixing techniques and collecting freshly batched concrete samples, native fine aggregates and debris. Taking note of laborers' mixing methods and available equipment was a very important component in the research because we wanted to develop a process Haitians could readily perform without purchasing additional tools.

We learned an alarming detail as we stopped at each construction site. The Haitian laborers were determining the quantities of the concrete mix components by eye. This meant there were inconsistencies between concrete qualities from site to site, but more importantly, there was no guarantee or control of the concrete quality at all. We understood the necessity of having a consistent quality mix and decided we needed to develop a mix procedure whereby the quantities could be easily measured using common construction equipment.

Back at our materials lab we characterized the fine aggregates and debris using the appropriate ASTM methodologies. Subsequently, we were able to develop two promising sets of concrete mix designs. Both the sets were tested in compression at 28 days, and the results turned out just as we had hoped.

Traveling abroad to Haiti and conducting practical research has been a rewarding and meaningful opportunity. Witnessing the resolve of the Haitians as both young and old work together to rebuild their lives has been incredibly motivating. It has allowed me to grow personally and professionally, particularly as a researcher. The chance to conduct research with professor DesRoches – and challenge myself to work on a project with optimism and an open mind, despite what previous research showed – has motivated me to continue to pursue research in my career. ■