Getting Curious with Jonathan Van Ness & Ashly Cabas

JVN [00:00:00] Welcome to Getting Curious. I'm Jonathan Van Ness and every week I sit down for a gorgeous conversation with a brilliant expert to learn all about something that makes me curious. On today's episode, I'm joined by Ashly Cabas, where I ask her: What's it like to survive an earthquake? Welcome to Getting Curious, this is Jonathan Van Ness. I am so excited for this episode, I have been wanting to do this for such a long time. We have the most amazing guest. We are going to learn today how to survive an earthquake! And who better to be here than Ashly Cobus, who is a professor in the Department of Civil Construction and Environmental Engineering at North Carolina State University, and she specializes in seismic hazards. Ashly, welcome to the show.

ASHLY CABAS [00:00:44] Hi Jonathan! Thanks for having me. I'm so excited.

JVN [00:00:47] So I'm going to tell you, like, where all of this came from, In this one salon where I was an assistant, it wasn't my first, but this, this man was a professor of, like, civil engineering and, like, he researched, like, impacts of earthquakes, like, specifically in Southern California. And he was telling me that he would never let his daughter buy a house in downtown L.A. because if there was ever any earthquake of, like, over eight point zero, it's going to be totally, like, isolated and totally fucked. And he would never let her go there. And then I was like, "Oh, my God. Like, what happens after earthquakes?"

So then my boss at that conversation said that, like, they wrote up this thing in Japan about, like, how they survived earthquakes and the whole, like, you shouldn't really get under the desk and like, really, you're supposed to get on the side of the desk for, like, the little, like, triangle or whatever. And so then, that, then I was actually in an earthquake and it went for, like, forty five seconds and I didn't know what the fuck to do. I was running all around the house. I might as well have just taken a glass bowl and shattered over my head because I was running around, didn't know what to do. And so, and then we found you and I was like, "Ashly can tell us what to do!" So, thank you!

ASHLY CABAS [00:01:53] Yeah. Yeah. What you describe is very, I think, meaningful because people are scared of earthquakes. It's a natural hazard and an extreme natural event. So observations after past earthquakes can be definitely scary. We see a lot of buildings collapsing and, and life lost. So, yeah, I can sympathize with that. And I study earthquake engineering. I study earthquakes. And I think it's, it's important for, for people to feel comfortable with information about how earthquakes happen, why they happen, and how engineers work very diligently to create earthquake resistant civil infrastructure so that you don't have to necessarily avoid earthquake-prone regions, but understand your hazard and the risk imposed to your life and to your assets.

JVN [00:02:47] So tell me if I'm wrong. One thing that I think, and I want to get into more basics about, like, earthquakes, what they are, how they're caused, the fallout of them. But in researching you, you have such a unique job. And again, just tell me if I'm wrong, but I think the way I understood it is: is there’s, like, architects who, you know, build buildings and they need to, like, build, like, earthquake resistant buildings and, like, buildings safely. So there's the architects. Then there's, like, the scientists who study, like, earthquakes and, like, you know, the seismic plates and the tectonic shifts. And then there's the scientists who have to liaise, go between the architects and, like, the seismologists or, like, earthquake scientists to, like, tell them about everything. And isn’t that you? Aren't you the one who has to know about everything, like the earthquakes, the different types, the dirt, the soil and the buildings? You know, you do all that because you got to know a little bit of this and that. That's right. Right.

ASHLY CABAS [00:03:38] This is a highly multidisciplinary field. And to do good science, sound science, you definitely need to understand all the different dimensions. So if you can think of this in the different components you just described, there is the scientific part related to the phenomenon, the natural phenomenon. And that's where you can find geologists and seismologists looking at the characteristics of the earthquake source. But then as the earthquake happens, you will have seismic waves propagate in all directions and they propagate throughout the crust. So you've got people understanding how that traveling can affect the intensity of the ground shaking you ultimately feel at the ground surface. Now we are at the ground surface, and we know that our civil infrastructure, it's not just floating. Right.

You need geotechnical engineers, those that study soils, mechanics of soils and, and how to design foundations for our buildings and other structures. You need us to understand that bridge, that translates the hazard from the ground shaking into how the soil, how those Earth materials will impact the ground shaking. And then we communicate with the structural engineers who are in charge of that design for the earthquake-resistant structure. That superstructure, above the ground surface, and yeah, the architect also plays the role there in the design, along with the structural engineer. But yeah, in my case, I am in that transition or that area between seismologists and structural engineers trying to communicate with the scientific portion of it and the engineering, more applied-based science part of it.

JVN [00:05:23] Wow, wow, wow, wow, wow. That is such a major job. OK, so now we're going to wind all the way back to, like, you know, junior, or freshman year in high school level because we all got to get it together. I think I, I think Earth science for me was in, like, seventh grade. So, like, we really got to roll it back. So please bear with me. What is an earthquake? And what causes them?

ASHLY CABAS [00:05:51] Mm hmm. That's an excellent starting point, Jonathan. And to understand earthquakes is to understand the story of the interior of the Earth, and also the story of stresses, basically forces acting on an area: deformation and energy. So for many years, scientists have used data from earthquakes to understand what's going on beneath the ground surface, all the way to the interior of our Earth. And the way we do that is by understanding how these waves travel, the time it takes them to get from that source to different stations that report these earthquakes. Because we’ve, yes, because we've had a steady beat of earthquakes throughout history, then we've got very good at understanding what's happening beneath that surface.

So we basically have three layers. We have the crust, the mantle and the core. And if you can think of an egg for an analogy for scale, the outer part would be the crust. It’s very thin and brittle. It can break, not necessarily easily, but abruptly. And then you have the mantle, that would be the white. And then the yolk would be the core. The main difference with his egg analogy would be that in the case of Earth, our core has two parts, one liquid, the outer part; and then the solid part in the middle. So with these layers, if we had no changes in temperature, pressure, composition within the earth, then seismic waves will just travel past through. No changes, nothing.

However, that's not what happens. We know that there are changes in the path of that seismic wave, different times of arrival. So by understanding these travels of the seismic waves we understood boundaries between these different materials inside the Earth, and we understand what they represent. So in a way, earthquakes have helped us take a deep, deep look into Earth's interior. And more recently, the same principle has been used in Mars as well to help scientists in NASA understand the interior structure of Mars. Same principle, using Marsquakes in this case.

JVN [00:08:01] Oh, my God, a Marsquake. OK, wait, so. So I love that analogy. So then what really? What's causing the earthquake?

ASHLY CABAS [00:08:11] Yeah. So back to the egg analogy. We have our beautiful layers, and we will look at the outer part, that crust and the mantle that's right below it, because those are brittle and they react or behave similarly. For many years, they've been cooled, and now they have been broken down in different plates, different masses. And these masses move around. They continuously move around slowly. So that doesn't really match with our picture of an earthquake happening really suddenly and very abruptly. A lot of movement, a lot of shaking.

So what's causing this movement? Why does it feel so strongly at certain sites? And the reason is that that mantle has different temperatures at the top. It's closer to a cooler area. It's close to the atmosphere. And then at the bottom, it's closer to a very hot area. Right. So, yes, the difference in temperature causes that the more dense cooler plates will start sinking as they sink, they start warming up, and then they continue. They will start rising and you get the cyclic movement as they, as they rise, they cool off; as they cool, they get denser, they start sinking. And this movement is called convection. And then that is what causes the plates to move.

JVN [00:09:35] Holy shit, that's the convection. OK, then. OK, so then, 'cause aren't there, like, multiple types of feeling, there's, like, 'cause that motion, you're-, that's giving me, like, the wave one where it's, like, [NOISE], I've felt that one. But then I've also felt one that was, like, it sounded like horses hooves and there's, like, [NOISES]. Then, there was when there was more like, like, more like undulating waves. Why? Why does that happen? And so is there, like, three types of earthquakes or something or like five or two.

ASHLY CABAS [00:10:07] This is a great question, Jonathan, because we need to differentiate earthquakes from earthquake ground motions. So what I would describe then is the natural phenomena of the earthquake, the fault rupturing, a very weak spot in the rock where it slips and seismic waves are generated. What you are describing is what you experienced in terms of the earthquake ground shaking or ground motion. And yes, the seismic waves are different types. There are two main types: body waves and surface waves. What you most likely felt at first was a compressional wave, you're going up and down, up and down. But then comes the secondary wave.

Those are shear waves and those move horizontally. So that's when the building goes side by side and everybody in a swell. And the last one is the slowest ones are surface waves. And that's when you feel that rolling. It's a very cyclic type of movement, but those are corresponding to the earthquake ground motion. And then, yes, there are different types of earthquakes, but those refer to the main event, to the rupture, what I'm talking about here in terms of the Earth's structure. So those are those plates interacting with each other and creating a slip in a weak portion of the rock.

JVN [00:11:22] So let me see if I'm getting this straight. So the earthquake itself is just, like, the plates, like, the initial, like the, "bah!" But then the results of the waves, that the earthquake related movements.

ASHLY CABAS [00:11:34] Yes. Yes, you got it.

JVN [00:11:35] And, and so, and that, and so does that mean that there's so all three of those different types of waves can exist in one as a result of, like, one earthquake event?

ASHLY CABAS [00:11:46] Yeah, yeah! And the interesting part and why seismologists need to look into this and engineers as well is the seismic energy is distributed differently for every event and all the different types of waves. And this matters because buildings will react differently to different types of frequencies. Soils can also play a role in how that seismic energy is distributed. So we need to understand earthquake ground motions. And that's why you see earthquake, earthquake engineers like me focusing on that. What characteristics of the medium of the soil can affect the characteristics of the shaking?

JVN [00:12:26] Oh, my God, I can't wait to go there, because the way back to our analogy, another difference between, like an egg and our Earth would be, like, like, because there aren't the tectonic plates, like, because this is, they're, like, different types of movements that cause the earthquake? Like, can't there be, like, one going underneath, and then one going, like, side to side or something?

ASHLY CABAS [00:12:46] And you're bringing me back to the stress story. So we talked about the interior of the Earth and the stresses. And you're exactly right. When we have these plates moving relative to each other, there can be three types of boundaries. Plates can be actually pushing towards each other and that creates compression that can cost different uplift mountains, like the Himalayas. And, and that creates one type of fault mechanism or different weaknesses, weak spots in the rock. But then plates can also diverge from each other, and they're pulling from each other. And then that can also create other types of plate boundaries. And the last one would be plates passing each other. And those create what are called strike slip faults. And for example, in California, we have a great example, the San Andreas Fault.

JVN [00:13:41] I was just going to ask you about that, I was gonna ask you what the San Andreas was! So it's the slip kind! It's the back and forth! Is there one that's the most dangerous?

ASHLY CABAS [00:13:52] So so there are ways to understand your hazard. And in the US, the, the most seismically active state is actually Alaska. But then California, Oregon and Washington and all the Pacific Northwest also are seismically active. And in the case of California, you can see that multiple earthquakes have happened in the past and will continue to happen. It's the fault sound that is well studied by seismologists. So we have a, well, good understanding how, how fast those plates move and we can assess the seismic hazard from there.

JVN [00:14:32] My ADD is kicking in so hard right now. I have so many questions. It's, like, really killing me. OK, so OK. So I think I'm understanding. There's, but, but is there a type of, though-, though-, is that San Andreas one the most dangerous kind of one, or is it, like, no, they all kind of equally have their own risks?

ASHLY CABAS [00:14:50] So they're different. And the largest earthquakes actually happen when you have that convergence of two plates and one starts going below the other, because very high pressures can build up. And then once those are released, that's when very large magnitude earthquakes happen. And those are called subduction zone earthquakes, Japan has subduction zone. We have in the Pacific Northwest the subduction zone as well, that possibly can create nine point zero magnitude earthquakes. Chile is another example. The largest earthquake that we've seen is a nine point five, nine point six earthquake in Valdivia, Chile.

JVN [00:15:29] When was that?

ASHLY CABAS [00:15:30] When? 1960.

JVN [00:15:32] It was? Did everything just get, like, totally demolished? Because it's like the biggest earthquake?

ASHLY CABAS [00:15:39] Chileans have a great code, seismic, seismic design. And we've seen more recent earthquakes like the Maule earthquake in 2010, a very large magnitude earthquake. And their structures seem to withstand these loads, because the main idea for US earthquake engineers is to make sure we understand the hazards so that our civil infrastructure can be built in accordance so that we can, they can withstand those forces. And I think Chileans have done a good job. In the 60s, yes, there was a lot of damage, but I think they have grown and learned a lot from the earthquakes since then.

JVN [00:16:15] I feel like we need to do a separate podcast about, like, that specific earthquake because, like, nine point six, I've never heard about that. That's, like, so gigantic. That's so huge. I can't even imagine. OK, wait, so OK, I'm so obsessed. I think I've learned so much already. I know the different types of earthquakes, I know the different types of waves. I know the difference between an earthquake and then an earthquake related, like, ground movement. So and then Ring Of Fire, honey, that's like that whole tectonic plates of like Japan to China, like the eastern side of Russia, Korea, and then like to Alaska in the western side of the U.S., like all the way down to Chile and, like-. Major! OK, so that's, like, is that the place where they're most common, the Ring of Fire, or do they have in other places, too?

ASHLY CABAS [00:16:54] That's where 90 percent of the earthquakes happen, actually, in the Ring of Fire. That Circum-Pacific Belt, and all the coast of those countries that you mentioned have seen, have seen very large amounts of earthquakes annually, from that system. In the US, as I said, the Western Coast is the most seismically active and Alaska. But yeah, 90 percent is from there.

JVN [00:17:19] OK, so this is like a hard right question. Like, I didn't know I was going to ask it, but now it's just, like, on my mind, I can't help but wonder. Could North America along the Mississippi River like those, just split down the middle and become like two like bodies of tectonic plates and not be one? Could the Mississippi, because they just are pulling apart and then become like that one kind of zone? And does that like how long would that take? Or is that probably not going to happen because they're moving together? Like, what do you think?

ASHLY CABAS [00:17:46] OK, a lot of questions and I'm sorry, I'm not. That's great. I think you're asking a good question because the, what's underlying that question is our understanding that earthquakes happen in the boundaries between those plates. Right. But then what you're talking about in Mississippi, it's right in the middle of the North American plate. So what I've explained so far about the interaction between plate boundaries doesn't quite explain an earthquake there or what's the situation in terms of those weak spots within the rock. So seismologists have studied this for a while and there's still room to understand the mechanisms. They are not fully understood so far.

We do have, when you look at the hazard for-, the seismic hazard for the US, we have seismic sources from historic earthquakes, basically earthquakes that were not recorded because we didn't have any instrumentation then. But there are features in the ground that allow scientists, geoscientists to understand that there was an earthquake and they can back calculate the magnitude, the size that, that earthquake and try to use that to characterize the hazard there. So there have been earthquakes there in that zone as well as in South Carolina. But we don't quite understand what's going on. And we think that plate, why is that-, those zones of weakness, those fault system activating, they are just more infrequent. So they don't happen as frequently as the earthquakes from the San Andreas Fault. But we know that they can happen.

JVN [00:19:15] Does does that mean that, like, a river, like, the Mississippi River, like, could that create like a weak spot in the tectonic plate that eventually could make them feel, like, lava could come up from beneath from the mantle and they could maybe start to move away? I don't know why I want my hometown to be a coastal town so bad. Like, I don't want it to be on the ocean, but I'm just getting, like, is it possible it could happen in like a million years?

ASHLY CABAS [00:19:36] I'm not sure, Jonathan. I would have to just think to put on the hat of a geologist to understand how the depositional processes could, like, a river, could create a weak spot there.

JVN [00:19:56] Yes! Yes, you are a genius! I love it! It's just a separate episode. OK, so now another question. How much warning do people typically have for an earthquake? Like, can scientists, like, is there any sort of warning for it?

ASHLY CABAS [00:20:15] Yeah, yeah. That's a great question. So it depends. Not all earthquake prone regions have early warning systems. That's how they are called. Fortunately, here in the US, there is a program. It's called Shake Alert, and it is now working. And, and you can get a warning, early warning, of possible earthquake shaking within seconds. So basically, the warning will let you know when light or moderate ground shaking is coming your way in five or eight seconds. This, however, has some limitations, of course. For one thing, it's important for people to know that this is not a prediction. An earthquake has to start for an early warning system to work. And then it really depends on where you are. If you are really close to the epicenter, that is like that projection to the surface of where the fault started rupturing, then you will probably won't have enough time to get that notification, because that notification comes from understanding where the earthquake is located.

And you need at least three or four sensors to, to receive that signal first. Once you have that, that seismologists can figure out the location of the earthquake and send the early warning to people outside that very close area. So. So, yes, those exist and have also been very successfully implemented in Japan. And the seconds, people may think, “Well, what would you do with five seconds of warning?” But those have proved to be very, very helpful in people just to get into protective action. It just happened, in five seconds, it's coming, so you have to cover. And in California, they've done a lot of this drop, cover, and hold on publicity so that to create awareness of when you receive this early warning, then you have to drop to the floor, cover, and then hold on until the ground shaking stops.

JVN [00:22:14] Yes! And we're going to get into that more. Okay, wait, so I have another question, you're going to be so tired after this, you're going to be, like, “I've never been, like, interrogated with questions like this so much.”

ASHLY CABAS [00:22:23] Jonathan, you're doing a favor. I love talking about earthquakes. I can talk all day!

JVN [00:22:27] I love it, because we're not even like a third of the way through. OK, so what is, what's a seismic hazard?

ASHLY CABAS [00:22:34] So that's the characteristic of an earthquake to cause damage. So this can be, for example, a ground motion of a given intensity and, and that can have just the, the threat or the potential to cause physical damage to civil infrastructure or lives, yeah.

JVN [00:23:00] Can there be a sinkhole from an earthquake, like, could an earthquake-, could, like, the, "gah gah gah gah gah," could that cause, like, a part of the ground to, like, "boom!" and then stuff just falls through, like, sinkhole status.

ASHLY CABAS [00:23:11] So you're thinking about the effects of those earthquakes, and ground failures can happen. And there are many types of ground failures. One of the most pervasive ones is due to the soil losing all its strength and acting as a liquid. That's called liquefaction. So that happens in sands that are full of water and then they're very loose before the earthquake. You have those seismic waves arriving and then there's so much pore pressure or water pressure buildup that the soil loses all its strength. When that happens, you can imagine a foundation of a building embedded in that type of soil, they just would sink. Right. So that type of phenomenon can cause a lot of deformation in the ground. So we usually think about collapsing buildings or damage to the column or a beam of a structure. But we don't think much about what happens to the ground. And you can have very large ground cracks because of an earthquake. You can also have a lot of settlements, buildings that are just basically sinking in because of liquefaction happening as well. And then there are also other effects, like landslides, for example, that are triggered due to this earthquake motion.

JVN [00:24:27] So is a tsunami a seismic hazard, too?

ASHLY CABAS [00:24:31] Mm hmm. Yeah. Yeah. It has to be associated with the specific characteristics of that event. But, yes, it can happen in certain regions and they can be very, very damaging. So tsunamis are another important effect from earthquakes, to be sure.

JVN [00:24:46] So because the early warning is, like, "Yes, we love five to eight seconds, but it's not like-," you know, like a long-, and you've got to have the earthquake happen, is seismic risk something that can be mitigated, like, It is just, like, just, through architecture or, like, public planning? All of it?

ASHLY CABAS [00:25:02] All of it. All of it. All of the answers we need everybody involved. "Science," as, as I recently heard in a, in a workshop and I loved it, "is only half of the equation." You need community engagement. You need people and communities to understand the hazard. And this has been very, very eye opening experience for me, Jonathan, because all my academic life, let's say, I've been focused on the science and the technical aspects of earthquakes, how to analyze earthquake ground motions, how to understand when they are more damaging to civil infrastructure and when they're not. But then more recently, I've become more aware of how people react to earthquakes because it's their lives that we want to just save as well and not just preserve the integrity of the building.

So when you, when you think about how communities can, can reduce their risk and how civil infrastructure can reduce the risk, immediately, you go into just a connection or a combination of different areas. So you need earthquake scientists, but you also need social scientists, you need planners, urban planners. You need people connecting and translating the science to the public so that when I talk in terms of probability of hazard, what we're doing today, I think it's really important for people to, to understand the basics and how that can affect them. So, so, yeah, to, to mitigate the risk, that is the hazard and its consequences, we have earthquake engineers working on the technical aspects, how to make the building safer. And there is a lot of research on that, structural engineers have done a great job on understanding how different structural elements can be reinforced and improved for improved behavior under an earthquake motion.

And then you also have geotechnical engineers who work on stabilizing the ground so that that process I described earlier, the liquefaction, doesn't happen. And that combination should help reduce or mitigate that risk. And then the last part is the social aspect. And unfortunately, we don't do as much. In my personal case, I'm hoping to do more as I continue my, my career in academia, but from the technical aspect, we are a little bit not as connected to the community. There are social scientists who specialize in natural hazards, who have done an excellent job on preparedness, so that communities know the, you know, the very basics to improve their, their performance after earthquakes and recovery. That's very important.

JVN [00:27:35] So it's, like, we have-, the science side feels pretty covered, like, between people like you and then, like, the geologists and then the seismologists and then the structural engineers. What are the people called who study the dirt again?

ASHLY CABAS [00:27:48] The soil. You mean.

JVN [00:27:49] That's what I mean. Oh, that's when people say, like, "Oh, I'm going to I'm going to dye my hair." I'm like, "We color our hair, we dye Easter eggs!" Yes, it’s the soil, of course!

ASHLY CABAS [00:27:58] Awesome! I can connect to the story. I teach geotechnical engineering for my junior students in undergrad. And that's one of the first things I say is "You are not allowed to call this dirt anymore. This is a three-phase system. You have a solid portion, water, and air."

JVN [00:28:13] Yes! Which is soil, it's soil, honey! And that's, so, is that the technical engineer who studies soil?

ASHLY CABAS [00:28:22] So that's a civil engineer. Civil engineers, we have different subdisciplines, we call them. You have structural engineers, transportation, water resources, environmental engineers, and then you have geotechnical engineers. And we deal with Earth materials, rocks, and soils and how to incorporate civil engineering technology to to work with these materials.

JVN [00:29:46] I did just think of something because, like, obviously Haiti just had a huge earthquake. And it's like I definitely it's just coming up for me that, like, there are certain countries that are experiencing these seismic hazards and, like, they don't have the infrastructure of these like social engineers and seismologists and geologists to like help to plan for these?

ASHLY CABAS [00:29:03] I'm Venezuelan. And what you just explained was the reason I started to feel that I needed to do more and in my science. And that we would call disproportionate effects of earthquakes, you can have the same magnitude or the same size of earthquake happening in two different countries. And the effects can be very, very different because of the community preparedness and lack of resources and so on. I just wanted to say that I recently joined a team that we are doing virtual reconnaissance in Haiti, precisely because we believe that there is a lot of data that should be collected, documentation that we can provide and help, most importantly, help for Haitians to recover from, from the earthquake. So so, yeah, a lot of volunteers have, you know, started to work with Haitians to, to just help after this earthquake because they will continue to happen.

JVN [00:29:57] What's up with that, like, Atlantic Ocean ring of fire that, like, Haiti keeps having these earthquakes, like there's like a little active spot over there, too, I guess.

ASHLY CABAS [00:30:06] There's the interaction of four different plates right there. Yeah, it's an active zone.

JVN [00:30:11] Four! Dang! Okay, yes. Okay, so soil is, like, a three-dimensional, you said something about… [CROSSTALK] Face! Because it's the air, the water, and then, like, the-

ASHLY CABAS [00:30:26] The solid, the solid part. The grains.

JVN [00:30:27] The solid, yes, yes, yes, yes. Yes, I was, like, "I know it's not the dirt." Yes. So then what are some soil. So then, what are some, like, some common soil type classifications. And then also, like, how closely can they differ? Like, in one square block, can you go from like two totally different types of soil?

ASHLY CABAS [00:30:47] Yes, so you have coarse-grained soils, sands and gravels. Those are the ones that you can see the grains with your naked eye. So you go to the beach, that's, that's sand right there. And then you have fine-grained soils and those can be clays or silts. So clays can be sticky. They're moldable. They're plastic versus the granular soils, sands and gravels, they are not affected by water. You can have different sizes, particle sizes, and that defines much of their behavior rather than their interaction with waters. For clays, water is really, really important.

JVN [00:31:26] OK, so fine grain, coarse, is there any other ones? Or are those the main two types? And then that's the silts and the clay. Can you give me an example of, like, some big cities who have, like different ones, like, I wonder what Venice is made of, is that, like, clay 'cause it's sinking or something?

ASHLY CABAS [00:31:43] Yeah. So I can tell you about a very iconic study that we use in geotechnical engineering. You know the Leaning Tower of Pisa, of course. [CROSSTALK] So, so that's a geotechnical problem right there. It's really settlement that's different because of the different soil properties in that zone. So it started to tilt throughout its construction, really, it was just constructed in stages. And then what happens to clay is that with time, as you put more pressure on them, water escapes from the three-phase system and then the soil starts becoming stronger and stronger. Because they, they had to use different types of clays, then the towers started settling more on one end than the other. And then, it's funny, but engineers know how to deal with settlements by now. So you would think, "Well, you can definitely put it back, you know, to vertical." But the reason they don't do it is because of tourists. Nobody will go and take a picture with a vertical tower because it's not interesting. But now it has been engineered so that it remains tilted. But it all started because of a geotechnical issue.

JVN [00:32:52] Interesting. OK, I feel like I understand the soil. There's, basically there's coarse, which is your sand and then your gravel and then there's the fine-grained, which is, like, your silts and your clays. I wonder what, like, the Midwest is on?

ASHLY CABAS [00:33:05] This is the thing: you can use geology to have an understanding of the deposition of the environment. That means, is there a river close by, and then that transported some deposits and those were, you know, deposited in a given way? That can tell me something about the properties of those soils. I can, I can have an expectation. Let's say we are in Boston or in Alaska where there's glacial movement. Then I can also have an expectation from the type of soils that will be highly variable in particle sizes because of that glacial movement. So there's something about the history of that geology and those depositions that can tell me, in a general way, what to expect.

However, this is why you need geotechnical engineers. You don't know until you do a field investigation. So let's say you want to construct a building. You cannot just rely on geology to decide what type of foundations you're going to use, how deep they will-, they are going to be, or they're going to be shallow. So you need a geotechnical consultant to go to the site and actually dig some holes and take some samples with samples. Then we can understand that, that profile, what, what actual soils are there in that site, and then the properties. Can you take some of those samples to the lab and then take some tests or conduct some tests and learn more about the strength, properties of the soil, and so on.

JVN [00:34:34] How many holes would you have to dig, like, on a site for, like, let's say, like, an apartment building? Like, how many holes and how deep would they have to go?

ASHLY CABAS [00:34:41] It depends. It depends, because of budget and how critical your infrastructure is. So if this was a nuclear power plant, then you need to understand the spatial variation of that soil. If this is an apartment building or if this is a one-story home or two-story building, then you need less of that. I would put an asterisk because that's where a geotechnical engineer would look at the geology, because this is an area where I can expect high variability in soils, then I would do a little bit more of an investigation. If the budget allows. That's usually a constraint to understand how much soil layers are changing in the project-side area. Yeah, and then the depth it would also depend on when you find the bearing layer. So a strong enough soil that will be able to bear the load of whatever building or structure.

JVN [00:35:36] Oh, so that's, like, one of the buzzwords the geotechnical engineers are looking for is like, "Oh, we need to find, like, the bearing layer of this soil, like, what's the layer." Like, is that one hundred feet down or, like, what's like an average?

ASHLY CABAS [00:35:48] It depends, it varies a lot. And this is something, Jonathan, that I love about geotechnical engineering. We didn't have a manual. There isn't a recipe that you can follow. It's really engineering judgment, following soil mechanics, understanding the fundamentals, and accounting for uncertainty. You won't have the same project twice, even working for the same company, even for the same block, because the soils are that variable.

JVN [00:36:17] OK, so, like, an architecture firm comes to you and, like, they're going to go build a high-rise in Miami and they're like, “We need a geotechnical engineer. We need you to, like, go out into the field and dig these holes in our budget’s, like, a kajillion dollars.” Or what is the thing that like when you pull up the soil, go to the library like, “Oh, shit, this is like some clay ass fucking water.” Like, this is like, you know, like, you know, people in hell probably want ice water, but you can't have it because there's not there's not enough money, honey. What's the thing that when you go out in the field like, “Oh fuck, I don't want to see this!” or or is just going to make it way more expensive because it's, like, the worst type of thing to build on. Like, what's that stuff? Is it clay?

ASHLY CABAS [00:36:58] Yeah, it’s clay! It’s clay. So clays can be very tricky because they can compress, they're, they're very compressible and then they, they will create settlement, right, in your building. And if that settlement is not uniform, which is-, if you consider the variability, spatial variability of soils, then that will most likely be the case. And that's the main issue with, you know, a building having-, and that's when the door won't close, or your window won’t-, it will be tilted. It's not that the building will collapse because of this settlement, but the non-structural damage is pretty expensive. So you don't want that. So, yeah, clays would be one thing that makes you just say, “OK, what are we going to do about settlement?” There are two issues, actually, the settlement is one, so how much it can compress. And then also the strength. If they are not strong enough, then you may have to do a few remediation techniques to, to make it stronger. If, you know, we go back to the Leaning Tower of Pisa with time and some load, the clay will eventually become stronger. But for some projects, you don't have the time just to sit and wait for the clay to get stronger. And so there are a few things that you can do to preload the clay and get that ultimate strength that you want before you build.

JVN [00:38:20] Will they, like, shoot, like, iron down on the ground and then like mix it up or something?

ASHLY CABAS [00:38:25] There are ground improvement techniques that include mixing other agents that kind of strengthen the soil. Yeah, yeah. And the other types of soils you don't want to find are sands when they are loose and full of water, because when an earthquake happens, that's when liquefaction will happen as well. So even though from the pure geotechnical perspective they are clean sands, nothing wrong with them, when they are subjected to this very rapid loading, then sands will not drain that water. And then that's when the strength of the soil can really go to zero. And yeah, that's a big issue for, for geotechnical earthquake engineers. So that's, that's bad news.

JVN [00:39:06] So because, we know there's different soils, you got to, like, mitigate for all these different things that there are things you can do. You find it so that you don't love. And like I hear like the ground strengthening tech, there's some ground strengthening things. Is there any, like, really fierce new, like, innovations in the field of like, I don't know, like, magnet ass, like, unmovable, I don't know, geotechnical badassery that's going on?

ASHLY CABAS [00:39:30] Yeah, absolutely. And so, yes, there are, there are techniques that we know work to improve the performance of civil infrastructure during earthquakes. That's, that's for sure. And we go by components as well. So as structural engineers, they've done a lot of work on how to reinforce structural elements. So that's, that's there for, for one thing. And then you have geotechnical engineers who now understand how to strengthen our soil so that they, they can react better or behave better in earthquakes. And then you have seismologists and earthquake engineers working on the hazards side so that we can reduce that uncertainty. Because if you know, if you have a better understanding of what to design for it, then everything else should be improved as well.

In terms of what's really innovative in the field. So I think that there are a couple of developments that are important. So one is how we are sharing data now. Because we have multiple earthquakes and now a lot of instruments around the world, scientists are feeling more comfortable sharing that big data. And because of transparency, you want to make sure that the data I put forward, you can reproduce it and you can reproduce all my analysis. So there is an effort, I would say, by the community, that's called the Natural Hazard Engineering Research Infrastructure. And they have this basic cyber infrastructure component where we all put our data together and we can store it there, we can share it, and you can publish it. So this can be a game changer because scientists will be able to collaborate more easily. The data is right there. You can build up on somebody else's research so that on its own it has been a big investment and hopefully more and more scientists will continue to use it.

There are also very big advances in reconnaissance. So what we were just talking about: Haiti, you need special equipment to gather certain types of data. And now we're using drones, for example, to capture the extent of a landslide type of ground failure, whereas before you would have to go by foot and try to figure out where, where is the ground shaking more damaging. Now, you can use these type of techniques and get a better view. And then there are also modeling efforts, where because there's still so much that we don't have data on, for example, large magnitude earthquakes at short distances, those are the hardest to gather some data on. And then we have to do simulations. And then in that aspect, we also have, like, very innovative ways of modeling fault ruptures and, and how they can affect civil infrastructure.

JVN [00:42:20] So because there is, a lot of this has to do with, like, soil, and I would imagine, like, water, flooding, climate change could affect soils in some ways, maybe frequency, maybe intensity. Like, do you, does the, does the scientific community that studies seismic hazards see a threat from climate change? Do they see an increase, like, in seismic activity as a result of climate change, or-, yes, no, maybe?

ASHLY CABAS [00:42:53] If you recall our discussion on the driving mechanism of earthquakes, they happen in the interior of the Earth. So my intuition says that unless climate change can affect how those driving mechanisms happen, then I don't know how you would have a direct effect. Climate change does change the multi-hazard aspect. And that's something that we've seen more extreme events now. So Haiti is another example. Puerto Rico is another example where the earthquake happens, yes, it happens. And then follows a hurricane. So how can engineers-, because I am almost siloed in my seismic design with no awareness of other hazards that can also impact earthquakes. And there are, I should say, colleagues that do work in this multi-hazard space. It's really, really complex. But then we've seen it in recent history, how it can impact communities so badly and now during a pandemic.

So it's really clear how studying hazards, natural hazards is much more than understanding fault rupturing. We will need to understand how our seismic hazard interacts with other hazards, interacts with the social dimensions in a given region, the social, political and economic unrest and inequities, inequities as well, to fully get the picture ready. And this is for single sites or single buildings. But we also need to think in terms of systems, how our whole city is being damaged or affected by these multiple hazards. So, yeah, in that, in that respect, I think that we need to try to expand our perspectives to try to include these other dimensions that are definitely playing a key role, especially in recovery.

JVN [00:44:39] Hell yes. Love that. Didn't expect to learn that today. So I love that. OK, so wait, let's picture it. What do people that live in earthquake-prone zones, like, need to have in their house? Like, do you have, like, an earthquake, like, rescue pack in your closet? Like, do you have some, like, two-way walkie talkies and some like freeze dried food and shit and, like, a gun in case, like, everything's all fucked up and you got to, like, I don't know, I just saw an earthquake, like, we need to do to survive an earthquake. Like, what do we all need in our closet? Like, do we need like it's like NASA food, a sleeping bag, like, a secure Internet fucking thing, a generator. What do we need, queen?

ASHLY CABAS [00:45:20] I would say an emergency plan, Jonathan. That's the biggest. 'Cause you have, let's say your family members and maybe the earthquake will happen during the night and you're all together. That's great. But maybe not. Maybe, you know, the kids are at school, they're working, your partner's working. So you need to have a consensus in terms of "If that happens, we're going to be here." "If it happens…" This is how we understand how you would evacuate your office, for example, if it happens there, so that that would be one thing, the emergency plan. And then at your house, at your home, I would have a kit, a bag with some supplies or some food that will not perish on batteries. I remember in Venezuela, my mom used to have a bag full of the most amazing chocolates, like, my, my aunt would bring those from the US. And then she would say, "This is for the earthquake kit." And I'm like, "Mom!" and we never had an earthquake. And those went to waste. I had a negative reaction to that kit. I'm like, "We're just wasting amazing food in there."

JVN [00:46:17] So maybe once a year, just, like, a month before it goes back and clear it out, then you redo it. But you do think like that, like having, like, some sort of kit. And I know that there's, like, actually companies who do like prefabricated kits that have, like, a sleeping bag and have, like, some walkie talkies and stuff. So we can include that on the link of the specifics. I think that those are really cool and I want one. But you feel like this is important, like, it's, it's not a joke, like, everyone. And then do you think, it's all in your trunk? Like, if you have a car, like, should you have, like, a little mini one, maybe in your car if you were to get stuck in, like, a parking garage or, like, be at, like, a weird time when there was an earthquake, like, in your car? Am I paranoid?

ASHLY CABAS [00:46:56] I would have it in my house. You can definitely have some, you know, some supplies there. Water, just in case.

JVN [00:46:04] Living in L.A. for ten years, I-, every time I drove into a parking structure like in Target or wherever, like an underneath the ground parking structure, I was always like, "Ah, fuck, this is like the last place I want to be." If there's, like, I always just got, like, stress under there. The way moving on, because I know that, like, I could literally interview for six hours and I have like. More questions that I have to get through, so picture it: like, you're in your house or you're at work or wherever the thought and you like, because I because I think I've been through two earthquakes. One was, like, no, three. But they were all between like four and five. So they weren't, like, gigantic. But I definitely felt them. There was a one felt, like, a little, like, mini vibrate, like, horse hooves.

And then I like I was out to dinner and I, like, looked under the table because I thought that there was I was, like, "Where are those horses coming from?" And then it really started to shake for like literally three seconds. And what was hilarious was I was out to dinner with the husband and wife, were good friends of mine. The husband literally, like, jumped out of the table, almost flipped the table and started to run. And no one else in the restaurant, like, did anything. So it kind of was, like, he was, like, the George Costanza in that episode of Seinfeld when he, like, jumps over people, like, old ladies, like, pushes them down to, like, save himself. That was, like, a little bit our friend. We were like, “Oh, yeah, you're so big and tough in this earthquake.”

The other two, I was in my apartment, but in all three cases I wholeheartedly was, like, really scared because I also, like, didn't know what to do. Like, I grew up in Tornado Alley, like, I knew, like, you’ve got to get to the basement. Like, you go to a basement or a room with no windows. You go up against a wall, you crouch in the position, you cover your head and you, like, hope to God that you make it. But, like, in an earthquake, I've heard, like, go under a door jamb. I've heard hide under a table. I've also heard, like, run outside, like, run in the middle of the street. Like, I feel like I've heard all those things, like, what do you do if you're inside and you really start to feel like there is an earthquake? And how long can they last? Does the Richter scale account for, like, the longness of the shaking, or is it only the intensity?

ASHLY CABAS [00:48:58] Good question. So the recommendation is to drop, cover, and hold on until shaking is over. I would say that looking at there are some videos that you can find of people's actual reactions during earthquakes, the security cameras and things like that. And you can see how people will do that just for a few seconds. But when the, when the shaking lasts longer and starts to feel like a minute of shaking, that's an indication of a higher or larger magnitude earthquake. And those can be very, very destructive. So that's where I personally would just run outside just because it means that there's higher potential for damage in the building that I'm in.

JVN [00:49:42] And the aftershocks, if it's lasting for a long time, maybe you're going to have some keep going?

ASHLY CABAS [00:49:45] But those will take a little bit after the, the main shock. So I'm talking about the duration of that mainshock. The drop, cover, and hold, that's, that's what you should do. And then what I've seen in these videos is that when this is starts, like, this happened after the Tohoku earthquake in Japan, during an earthquake conference, by the way, and this earthquake, engineers right there and it was all captured on video, they would wait, but then they started to see that the earthquake shaking would continue. And that's when they knew that this was a very large magnitude earthquake and they left the room.

JVN [00:50:15] So, basically, what you feel the shaking, like, I felt like for me in both cases, because one of the times I was at an outdoor patio, like, eating, and that was the first of that time, I wasn't as scared for, like, around me because there was no roof. But the other times they were, like, within four days of each other, it was, like, 2015, I think in March actually saved me seventeen hundred dollars because my cat had eaten, like, eight hair ties and he was in the hospital about to have surgery. But the earthquake literally scared the shit out of him and he passed all the hair ties and he'd eaten, like, a seven-inch piece of scratching post that was like this, like, hey, and it, like, blocked him all up.

And he was so sick that the earthquake literally scared the shit out of him that morning. And so he didn't need surgery. So it's kind of amazing. But I was, like, in my apartment, I was like, "Oh, my God, I hope Larry's OK. He's probably so scared," but didn't, like, and both-. And actually one of them, I feel like the shaking did kind of last a while, but it wasn't that intense. It was, like, the slow. But I was like, "What do I do, if, like…" Because it was like a first floor apartment where it was like on stilts, you know, like over like the parking garage was like, what is this like fall? So if it does last more in a minute, you do recommend, like maybe grabbing your purse, if it's on the way out the door and like getting out of your apartment or your house.

ASHLY CABAS [00:51:23] Yeah, and what you're describing is that typical structure that, that we've seen collapsing multiple times when you have an open floor and then a change in that stiffness from a very small or short column and then the first floor of the building, those are very common in Venezuela as well. My mom and my dad lived in one and I told them, "You just have to get out because that may fall." I would like to, I think, it's, it's difficult to tell people what to do, especially as I'm not working and preparedness and urban planning. However, what I've said consistently been requested from people is to drop, cover, and hold until the shaking stops. So I think that's the safest you can be. Just from my personal experience, knowing how duration is linked to magnitude. It's not a direct link, but you can expect a larger magnitude earthquake to last longer, and the ground shaking to last longer than I would say, yeah, more than a minute and you're still feeling a strong ground shaking, that is probably a big one.

JVN [00:52:31] 'Cause I remember going to, I ran into a doorjamb, like, I ran, like, under a doorway, because I thought I remembered someone saying that. So that's, like, what I did. But like I said, if you're inside and you're just doing the immediate, like, drop cover thing, like, should you and maybe not like you personally because like I know, like, there's other people who, like, study this more. So I don't wanna, like, make you uncomfy but, like, would you like quickly like have the wherewithal. Obviously you don't know until you do it but would you, like, maybe, like, just look up to make sure that you're not, like, you know, drop and covering under, like, a plate of dishes or, like...

ASHLY CABAS [00:52:01] Oh absolutely, yes, yes, yeah. Basically be aware of your surroundings and everything that can fall down will fall down during a moderate earthquake. So. So yeah. Try to stay away from everything, anything that can fall onto your head or and that's when the cover part, you know, comes to play.

JVN [00:53:20] Oh, do you mean cover with your hands or like get under a desk cover.

ASHLY CABAS [00:53:23] So both under the desk and just try to protect as much as possible your head.

JVN [00:53:29] So what about that? Oh, yeah. I'm going to ask a little bit more of that pocket or triangle of safety, whatever it's like it's next to the desk or whatever, as opposed to, like, under it, because if something falls, it might make, like, a triangle?

ASHLY CABAS [00:53:41] I've seen it. But again, the most recent recommendations, there are, like, earthquake drills in California and probably in the Pacific Northwest as well. But I've seen these drills and that's what they recommend to kids in school, for example, drop cover and hold on. So, the science after earthquakes are-, the issue with me is that I do all my work before the earthquake happens and then after there's so much work and not only reconnaissance, but also in the recovery. "What could we have done better, right, in terms of the social response to the earthquake?" That's the part where I am not as experienced with. But I think that from research and observations from past earthquakes, the, the current recommendation is to cover, not to stay away because then something can fall.

JVN [00:54:31] Yeah. If you're not covered. So, OK, obsessed. And you mentioned a little bit of this earlier, but what inspired you to get into this field?

ASHLY CABAS [00:54:42] So I wanted to be a traditional geotechnical engineer. I wanted to do foundations and wanted to do slope stability, that type of stuff. However, there is a social benefit that's very clear from earthquake engineering, another that's not just technical engineering and civil engineering in general. But it was just such an obvious motivation that it was hard to run away from it. Whenever I work on those issues, I feel that responsibility. But I also feel the, the empowerment of "I'm doing this and this is going to help someone." If this model works, then someone in Latin America will have a better seismic resistant infrastructure or my community will be better prepared for the next big one. So it very quickly connects you to a sense of belonging and need in the community. And that was really important for me, especially with my students. And I'm coming from Latin America where I've seen the devastating effects of earthquakes. It just connected with me and gave me that purpose beyond my curiosity in science and engineering.

JVN [00:55:54] And so when you were little, did you, like, so have you always kind of been a little bit prone to like math and like thinking that, like, the Earth was, like, cool and stuff?

ASHLY CABAS [00:55:02] I love math. I really, really like calculus. I'm very logical. I like everything that you can analyze and divide into parts. I wasn't as good programing, or that's what I used to think, maybe because we're not as exposed in Venezuela to that. So when I came to Virginia Tech to do my PhD, my advisor just said, "Oh, we're going to do earthquake engineering projects, and it's a program." And my immediate reaction was, "I'm not good at that." However, now I understand how this was wrong. Right. It was just a perception of my own ability. And now programming is pretty much a big chunk of what I do. And it only took practice. It only took, as with everything else in life. Right. For you to learn.

JVN [00:56:47] I'm sorry to ask this question. And I hope you don't kill me asking after an hour, but programming means you're programming into computers?

ASHLY CABAS [00:56:56] Coding, yes, coding. Using software, yes, coding.

JVN [00:57:00] To tell the computer, like, what could happen if, like, a plate shifts, or, like, you're coding, like, different, like, models of different, like, seismic stuff.

ASHLY CABAS [00:57:08] Yeah, to, to create a model of the reality of whatever process. We have, the natural process, and then you use the data from observations and to fit your model, and your model is a representation of the reality. But then with the model, it's almost like you have your own lab because then you can tweak it, you can change certain parameters, values, and see what happens. So with earthquakes, we have ground motion models. And if you remember, it's not just the event, but the actual earthquake shaking. So the models put together all observations from the sensors around the world for us engineers to understand what type of acceleration would be possible within a certain range coming from a magnitude A and a distance B, so that type of modeling. And it's just something that you need. It's a tool, so you can use a programming language like Matlab, for example. Python is another one for many things, really. In my case, that's those where the platforms that was used for ground motion modeling. But, but I just wasn't exposed to it before. So I thought that I couldn't, I couldn't do it.

JVN [00:58:20] But you're amazing at it, as it turns out, which we love. OK, this is my first to last question. There's only two more. So what excites you the most about the next generation of engineers studying earthquakes and soil?

ASHLY CABAS [00:58:32] Oh my God? Can we have ten more minutes? I'm very excited about the next generation. I see a diverse group of genuinely interested students and early career scientists looking at reducing seismic risk equitably and understanding all the different dimensions that we've been talking about. Traditionally, that hasn't been on the table, and I've seen more and more people aware of how we can better understand the seismic hazards in this context. These next generations are so passionate they have fewer limitations. I think that we are understanding bias, implicit bias, more personally. My group, I have a lot of female students who are fantastic.

They-, I learn from them so much every time. And, and it's just inspirational to see their growth and their ethics; how, how they will work tirelessly to understand a concept and how they understand the benefits to society. So we are in very good hands, I think in terms of how they deal with data. Big data is one thing, how they deal with uncertainties. They're getting more and more ready to understand those and how they add that dimension from the social aspects. I think it's, it's a very good sign that we-, our future will be bright. So, yeah, it's, it's one of the highlights of my job to work with those next generations, actually.

JVN [00:59:58] I actually accidentally lied because I realized I had one more question. I'm sorry. That was kind of back to the stuff that we're talking about earlier. But I got to ask, if someone lives in a high earthquake area, can someone find out what kind of soil they live on?

ASHLY CABAS [01:00:08] Oh, yes, yes, yes, and even their seismic hazard. And this is a good question, Jonathan, because we can also provide people with resources to the USGS, the U.S. Geological Survey, because they provide what's called a national seismic hazard model. And that you can go right now and figure out what the seismic hazard would look like for a given city. Or if you have the latitude and longitude of your house, you can, you can do that.

JVN [01:00:34] That's amazing.

ASHLY CABAS [01:00:35] And it can tell you that it has different layers, let's say, and you can have a lot of information there. But the USGS does a great job with that science communication. So you will have what you need to understand what that product is telling you and how to use it, either for research or for your own understanding of your seismic hazards in your site or site of interest. And then the soil, yes. As I said before, there are, like, geologic maps available publicly that you could find online. But then if you really, really want to know what's below your house, then you need a geotechnical consultant to go and take a look at it and dig some holes, take a sample, and figure out what the profile looks like. And that should have been done when the house was built, so that they, you know, identify any potential problematic soils and so on. So maybe those are already available. If you ask.

JVN [01:01:30] So this is where: you made it. That was, like, I don't know if I've ever been like that. Tuned in for an interview my entire career, like I'm obsessed with earthquakes. This was, like, so much fun. But now we've gotten to the point where it's, like, teachers recess. Like, is there anything that we would just be remiss that you as a literal educator of earthquake, stuff, like, epicenter, we know that's, like, right where it happened, honey, we talked about the Richter, honey, we talked about the Ring of Fire. We got induction. That was our wrong name. We got subduction. We got all this stuff. We got all the terms. Is there anything else that would just be remiss if we didn't mention, or is there any place where you want people to follow your work that you all are doing, or is there anything that's coming up that you really want to talk about? It's, like, the floor is yours where you're not being interrogated, you can take as long as you want. So if there's a few things that you just feel like we wish that we mentioned and we didn't, the floor is all yours.

ASHLY CABAS [01:02:26] Good. I was trying to think about how, how much we talk about the hassard aspect of it. I did talk about the USGS. Yes, they are a prime example of how to reduce seismic risk, they, they are a group of scientists and geoscientists or engineers, geologists who, who work really on creating products that serve the community. So I think we can highlight how, how great the national seismic hazard model works for the U.S. I think that's good because that's an important product that's used in the building code, for example. So one thing that we didn't get to was: "How do we translate that?"

The hazard to the load that we use in the structural engineering for constructing your building, for example. So that, that link is usually a collaboration between USGS and the building community. So all the people working on the codes and what engineers ultimately uses that recipe for, "Oh, you got this clay. It's very soft and you should understand A, B, and C." So that type of connection between the research, the science and the application is important in earthquake engineering. So, so that's happening very well. And I think I saw another comment on what's, what's, what are we doing well, to reduce seismic risk. And I think that collaboration is something that we are doing very well. We see more and more seismologists talking to geotechnical earthquake engineers like me, and translating that to structural engineers and so on. So I think that that is key for solving or reducing seismic risk. And I hope that that also came from, you know, come across from our discussion.

JVN [01:04:14] And so really, it's a matter of, like, making sure that we take what's working well for us here in the US and trying to create a model that other countries and other governments can use to protect, to protect themselves from seismic hazards, because it's not, like, an equitable thing, like, not everyone has access to that model. So being able to share those resources with people sounds like a really interesting and important frontier and learning about seismic hazards and how we can help prevent them.

ASHLY CABAS [01:04:41] And you remind me, Jonathan, there are organizations that do just that. Because I just recently started to think about it, how an earthquake happens in Japan and New Zealand and a lot of science is done there, a lot of collaboration, a lot of, you know, "Let's learn from this earthquake." But then you see an earthquake in Haiti, Ecuador, Colombia, and there isn't the same level of response. And that, that happens because of many reasons. One of the reasons is the lack of resources, lack of connections. In my work in Haiti right now, we're struggling to find an earthquake engineer there that that has seen liquefaction, that has seen a ground crack before and can help us get the picture. That is the, the limitation of our study right now, because we cannot, we are not connected. But I don't think it's because they don't have earthquake engineers. They are there. We just haven't done that homework.

We haven't connected to that community the same way we've connected with the Japanese. So there's definitely a lot for us to do in terms of that equity, in terms of understanding tectonics, why are the tectonics in the Caribbean not as well understood. So how can we-, and of course, there are limitations to the government stability, economy, and all of that. But from the science perspective, I think that we can do a lot of education, inspiring the next generations. I wouldn't have chosen earthquake engineering if I had stayed in Venezuela. I would have done soil mechanics and that was it. But coming here, it just broadened my perspective. And now I understand that Venezuela would have seismic hazards that should be studied and we just don't do it as well. So. So, yeah, that's a great point. And I did have some recommendations of these organizations that are nonprofit and they look at the most vulnerable communities to this hazards and-

JVN [01:06:34] Tell us!

ASHLY CABAS [01:06:35] Yes, yes. And there, there's one in particular, the CEO is a young woman from Mexico. And I just love her. She is amazing. Her name is Veronica Cedillos. Yes. And it's just, it gives me another, like, if I weren't, if I wasn't doing this, I would go directly to her company and help the people, the community right there, just showing them what an earthquake looks like, how to deal with it, how to construct a better house, and so on. So I think that work should be highlighted. And the other piece, if you are interested in, like, very innovative aspects of geotechnical engineering, people are working with bacteria. And you may like this, there, there are bacteria in the soil, naturally. And people have studied, like, bio-inspired methods to make the soil stronger, for earthquake-related problems, but also in general, right. So I have this colleague at NC State, her name is Brina Montoya. And she basically studies how to feed the bacteria, how often, how deep, and so on, so that she can create these connections in the soil.

So we talk about soil, water, air. The main idea for soil to be strong is for those grains, the solid part, to be touching each other. So the more interlocking you have, the better, the stronger your soil is. And she's trying to create those connections by feeding this bacteria because they kind of create as they grow, they create these additional clusters. She would explain it better. But it's really interesting because there's a new wave in geotechnical engineering, when everything is bio inspired. And I think that you will find it interesting if you look at that type of work, because it's definitely forward looking. It involves biology, chemistry. It's really multidisciplinary. And fun, I would say.

JVN [01:08:26] And it's, like, we've, we've learned a little bit about how sand is, like, such a fleeting resource and how it's really there's only that one type of sand that can do concrete and glass and it's, like, rapidly depleting. So that's amazing that we're coming up with more and new ways to make more sustainable things. I love that. Also, Ashly, we could literally have you back for, like, five more episodes. I love talking to you. You're amazing. And we really will have to have you back to talk more things earthquakes, because I feel like we just, like, scratched the surface and there's more things that I know you can share with us. Ashly Cabas, thank you so much for coming on the show and for sharing your time and all of your brilliant scholarship with us. And just thank you so much for your work and everything that you're doing. We can't wait to keep following you and cheering you on and definitely having you back on Getting Curious. So thank you so much.

ASHLY CABAS [01:09:11] Thank you so much.

JVN [01:09:14] You've been listening to Getting Curious with me, Jonathan Van Ness. My guest this week was Ashly Cabas. You'll find links to her work in the episode description of whatever you're listening to the show on.

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