Confederation Bridge in eastern Canada

Good afternoon, everyone. Today, I want to talk about the problems that engineers face when designing large structures. In particular, I mean the environmental ones. You know, how you deal with nature when building your structures and, more importantly, building them to last. Let's think about a few of these obstacles, like wind for instance. Think about building a skyscraper- an engineer must take into account the effects of wind on the skyscraper, or else a heavy gust could dangerously weaken the structure. Or temperature, like many of you have learned if you have taken the materials class, building materials have different properties depending on the temperature. Certain materials are better suited to warmer conditions than cooler ones and vice versa. With these ideas in mind, let's take a look at this picture. It's the confederation bridge in Canada. It was designed to link Prince Edward Island with new Brunswcik on the eastern part of the Canadian main land. Engineers faced several environmental challenges when building this bridge. Freezing temperatures, heavy ice, snow, you name it. Oh, I should know about this. These are the same sorts of conditions I grew up with. Needless to say, it took quite a while to build this bridge about 5 years in all. Why was the cold that big of a problem for the engineers working on the confederation bridge? I mean, look at Norway, they have a ton of bridges there, and that place is known for glaciers and fjords and its frigid temperatures. It seems like they have it worse. And they've been building bridges for hundreds of years. Your point is well taken. The confederation bridge isn't the longest in the world. But it is the longest bridge in the world that spans ice covered waters. The, ah, sheer scope of this project sets it apart from other cold weather bridges. So, let's talk about the difficulties this ice posed for the engineers. First and foremost, the northumberland strait. The body of water that the bridge spans, well, it's completely frozen for 5 months out of the year. It's covered with ice from December to April. This causes problems because you know, a bridge must be anchored to the seabed. How can the construction workers plant the support columns of a bridge into the bottom of the strait, if it's completely frozen through. It's impossible. So the engineers decided to prefabricate the entire bridge. They assembled some smaller pieces off-site and used special floating crane to lift the various sections into place. They did the majority of this work in the warmer summer and fall months. Just because the sea ice caused too many problems. The actual construction of the bridge wasn't the only thing negatively impacted by the ice. Once it was in place, the bridge would have to withstand the structurally weakening effects of ices as well. Well, every spring, when the temperatures get

warmer and all the river ice starts to melt, it starts breaking off in big junks and floating downstream. This is dangerous enough as it is even when there is not a bridge traversing the water. Now, couple of this with the fact that there are over one hundred thaw free cycles in this part of Canada. You have a bunch of floating ice that stops, refreezes, thaws and starts floating again. And with the bridge going across the northumberland strait, that means there are dozens of big bridge support piers, 62 to be exact, where this ice wants to gather up and collect. Obviously, this would hinder any sort of boat traffic trying to go up the river, because it would be prevented from getting between the piers with all of the built up ice. In a maritime location like eastern Canada, boats and ships are essential to people survival. Block river traffic is one problem that the ice causes, but it can also damage the bridge. Think about the water freezing over in the winter. This can cause lots of stress for the piers supporting the bridge. Because of the forces exerted by the water expanding as it freezes. And then when the ice starts to thaw and float down river, it will bang into the piers, which isn't good either. The engineers recognize that this would be a major problem and they made sure to build the bridge in such a way as to minimize the negative impact of ice upon the bridge supports. This is the reason why engineers exist after all. How did they do it? They designed conical ice shields to sit at water level on all of the piers These shields extend upward from the pier at a 52 degree angle, which causes the forces imparted by the ice to be partially deflected away from the bridge itself. In the case of the river freezing over, the angle of the ice shield causes an upward force to be applied to the ice, which breaks it up and prevents it from freezing around the pier. This saves the bridge from being damaged when the ice expands and also allows boats to navigate the area between the piers. Also, in the case of floating ice heading the piers, the ice shields deflect the impact. Think about someone karate chopping a board if they chop straight down on the board, it'll break right? But let's say they hit the board at an angle, say..., a 52 degree angle will it break? Probably not. Their hand will glance off and probably hurt quite a bit. It's the same principle with the ice shields. They make it so that the piers don't feel the entire brunt of the ice impact.