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Episode 34: Cities and Extreme Events

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VOICEOVER
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SHANE HUNTINGTON
Hello and welcome to Up Close, coming to you from Melbourne University, Australia. I?m Dr Shane Huntington and today?s topic is Cities Under Extreme Conditions As we move further into the 21st century, the potential threats to our cities, both from natural and human activity are rising in number. The substantial age in addition to limited foresight in construction of many of our cities leads to serious concerns for the impact of future events.

Today on Up Close we are joined by two guests with particular insights into these concerns. Associate Professor Priyan Mendis and Associate Professor Nick Haritos, from the Department of Civil and Environmental Engineering here at the University of Melbourne. Welcome to Up Close gentlemen.

NICK HARITOS
Thank You.

PRIYAN MENDIS
Thank you Shane.

SHANE HUNTINGTON
Priyan let me start with you because your area of expertise is blasts or explosions. What I?d like to do first of all is get you to take us through what happens in a typical explosion such as say a car bomb. You know if you were standing a few metres away, what ? what are the effects that occur.

PRIYAN MENDIS
What is happens is that we know these explosions have a particular charge rate, that?s equal in TNT value. Now for example a typical car bomb can be started from

about 50 kilograms, equal in TNT to about, can be even up to 500 kilograms. So damage to a structure or a person depends on these charge rate. So whether it?s a large bomb or a small bomb. So when a bomb explodes there?s a shock wave forms and propagates. Now this shock wave hits the structure or a person, then of course the damage occurs. Now in a ? in a particular structure what happens is these blast waves travel and then in the ? in the normal air it travels and then when it hits the structure, then it gets reflected, or it comes back. Once it hits the structure then it?s stopped, then it comes back or reflected. Now that reflected wave can be about ? is magnified about 10 to 12 times. It can be ? can be very large, it can generate very large pressures. Now in [an] explosion the ? these gases expand and sometimes the temperatures can be, let's say, 30,000 centigrade, so it?s very large temperatures generated and also the expansion, the pressures generated. So these pressures damage the structure of people.

SHANE HUNTINGTON
And the shockwave itself, are we talking about a compression of air and temperature and debris. What actually is the shockwave?

PRIYAN MENDIS
That?s a very good question Shane. Now, what happens is this expansion of gases and so on. Now the shock wave propagates, through this expansion, so once one layer expands it just hits the next layer and so on. So that?s how the wave propagates and then ? then it hits the structure.

SHANE HUNTINGTON
You mentioned when it hits structures and so forth, and let?s take the case of building designs. What sort of things do you need to take into account to deal with a potential shockwave of this type. I mean, I know, just looking around the city of Melbourne here in Australia there is an incredible amount of glass on our buildings. I mean what - what sort of things should we take into account?

PRIYAN MENDIS
There are two or three issues there. The first one is that if a blast occurs in [the] middle of the city and in a, let?s say a street, what happens is this, gets confined, so because it?s within a narrow street and so on. The pressures increase due to that confinement effect. So that?s one issue. The second issue is that as we mentioned the debris and so on. Now we got also the ? the gases expand, but this debris and so on is picked up on the way, then hits the particular structure, so damage is lot more due to that. The third issue is about the glazing or they normally call it glasses and windows and so on, then they are very brittle. So if a blast pressure hits that, then you have seever consequences because of the fragment running everywhere and hitting people and so on. So, they have estimated that in many blast, it?s not the actual shockwave which kills people, it?s more of these fragments and so on kills ? kills people. Now, the other issue is that all those buildings or structures are not designed for any blast pressures because when we designed them, we just designed them for gravity loads, coming down. Now however, if there?s a blast, these blast pressures propagate upwards. So because of that none of our structures are

designed for this sort of loading. Again also we all remember the very unfortunate event in 2001 September - the World Trade Centre collapsed. What happened there in ? say if I explain very simply is that one floor fell to the next floor and ? and so on, and then the ? the whole building collapsed. Now that is called progressive collapse or cascade type of failure. Now, I had to qualify that by saying that you don?t have to have a very severe terrorist event for this type of failure. The first one happened in 1975 in UK (United Kingdom) called Running Point collapse. That was due to a ? just a simple gas explosion in a ? in [an] apartment in [the] 18th floor, and then the whole building collapsed and a few people got killed. Now so it can happen due to any event, this type of progressive collapse.

SHANE HUNTINGTON
Nick, let me move on to you now and one of the very interesting areas I guess in the last few years is the effects of water and the damage that water can do, particularly in the events of such as tsunamis. Take us through what a tsunami is, how it?s generated, and what sort of energies are dissipated when it hits the- the coastline.

NICK HARITOS
Well, there are a number of mechanisms for generating tsunamis. Often they are generated by seismic activity - earthquakes. The epicentre of an earthquake will generate waves through the soil and that can be transmitted into the water in an ocean environment, and that can create a surge which builds as it gets closer and closer to the coastline, shoaling effects of the coastline will magnify the effects of that tsunami and travel of the coastal areas, can inundate as we?ve seen in recent events, the Boxing Day tsunami for example ? can inundate the coastline and actually travel and funnel up canyons and high up into regions as high as mountainous parts of the country. So, there can be a lot of energy behind those tsunamis. Another trigger for tsunamis again could be a land slide, it could be a ? an under water one or ? or even a ? a coastal one. Enough energy being transmitted in ? in the push if you like of the water in the ocean to create a wave. In extreme situations, a meteor could hit the ocean and create a tsunami.

SHANE HUNTINGTON
As we?ve ? we?ve sort of been talking about Australia has some severe sort of weather in the northern states and ? and we?re very accustomed to the threat of bushfires. What about tsunamis? How is our coastline able to deal with that? Are we under ? under sort of threat from tsunamis and how would we stand up to it?

NICK HARITOS
The threat is not perhaps as major as it can be for some other countries. I mean we?re ? we?re used to observing the possibility of tsunamis in Japan and in Chile but we don?t have many records in Australia ? we?re young country ? and these events are very rare anyway, so we tend not to have a history of ? of defence against tsunamis in this country.

SHANE HUNTINGTON
Have our building codes at all considered that possibility?

NICK HARITOS
Not to my knowledge but certainly waves surge from other causes, including large tidal variations that we do get in our northern coastlines, as high as nine to eleven metres of tidal range combined with surges from hurricanes ? hurricane effects, the cyclones you were talking about earlier, can create storm surges in ? on the coastline and also on our offshore structures, which can be very significant and ? and approaching tsunami type conditions.

SHANE HUNTINGTON
And Nick, you?ve been looking at the effects of water, and I guess people often think of water as a relatively benign material, but it?s incredibly destructive when it?s moving rapidly and it has a lot of weight of it.

NICK HARITOS
I think it?s important to recognise that water as a fluid, is - is about a thousand times the density of air. So when we?re talking about wind speeds of 70 metres per second, you don?t need anywhere near that speed to create the same levels of pressures from water. And so wave kinematics on offshore structures, the wave forces that you get on offshore structures and coastal structures is significantly much higher than you would get from the wind acting on those structures.

SHANE HUNTINGTON
You?re listening to Melbourne University Up Close. I?m Dr. Shane Huntington and we?re speaking with Nick Haritos and Priyan Mendis about the effects of cities under extreme conditions. Gentlemen what sort of fortifications are needed in order to protect our structures against the ? the various natural and unnatural effects that we?ve been talking about?

PRIYAN MENDIS
Now, we are working even at Melbourne University on new materials and for protection. For example, for blast protection now the difficulties that exists in structures, they?re very difficult to retrofit or ? and refurbish and all that. So we are for example developing a new material which is a polymer based material ? a spray on ? so that it can be sprayed on concrete walls and like brittle masonry and ? and so on, so that ? that improves the blast resistance. But even on the glazing side, there?s some work done in ? in our group that is to use this laminated glazing. Now, we are used to that single skin normal windows, but we are now trying to use this very ductile or non-brittle type of laminated glazing, where they have more than one layer. So these solutions are being ? already being now being developed, and we?ll see in the future many more solutions. Now, another one which we are used to is called the ? using the - the carbon fibre materials to strengthen especially for existing structures. We know if it?s a new structure is easy, we can improve that, we can increase the ? the ? the sizes of members and ? and so on. But for existing ones, it?s very difficult to improve the capacity. So it?s a very efficient way of doing it, is using these carbon fibre materials.

SHANE HUNTINGTON

Nick, you know what things I guess do you see as being required in new structured development and augmenting existing structures?

NICK HARITOS
Well in terms of tsunami defence, the natural defence mechanisms of mangroves, trying to support mangroves in slowing down, if you like, the effect of the surge as it travels along the coastline and ? and attempts to go up into the higher regions of ? of the coast, encouraging that natural defence is seen as a good thing. In Japan, they actually have used mounds in some areas where they think it?s particularly important that they have defences. And the ideas that you slow the initial surge, and then try and capture it into a bigger basin where it?s slowed down and at the same time has less of an impact in creating damage to structures. They?re the manmade type but the natural type, wherever possible is ? is seen as a good thing. Don?t remove all our mangroves where you might have susceptibility of tsunami effects on a coastline, and replace then by, let?s say, tourist attractions which increase the threats.

SHANE HUNTINGTON
Moving on to you know the future, where climate change is a big issue, how do you foresee the effects of climate change on the requirements for ? for building design in the future, not just in Australia but ? but internationally.

PRIYAN MENDIS
Many buildings and other structures could be affected. Now I just want to give example, now Nick already mentioned about storm surges and ? and so on, sea level rise which Nick has covered. Now there are other issues as well like bushfires, more bushfire events and so on. When we designed these new structures and so on for the future, we need to incorporate all those effects. Then there?s a ? also a possibility of cyclones. Now today we are talking about 60 to 70 metres per second but in the future they?re expecting higher winds than that. So all those things can be incorporated, but ? but just for the future, just one other thing I?d like to mention that is now more and more, we have access to the super computers and so on, so we are using this advanced analysis techniques, so we should be able to predict more accurately the behaviour of structure and the effect of loading and so on in the future.

SHANE HUNTINGTON
Nick, anything to add there?

NICK HARITOS
Yes, just to take up the point that Priyan made about sea level rise. Certainly low lying coastal regions with a small sea level rise, or significant one for that matter will be susceptible to being inundated by the change in the sea level. If you then superimpose a surge on top of that, the coastline can now sort of go up further and further into the land base of your landmass, away from those mangroves that might be protecting the coastline. And also, taking up a point that Priyan made, the super computers of today, new modeling techniques like computational fluid dynamics can now be used to try and model interactions of structures and fluids ? wind structure interaction, but also tsunami and other wave type activity and its interaction with

structures.

SHANE HUNTINGTON
Professor Priyan Mendis, Professor Nick Haritos, thank you very much for being our ? our guests on Up Close today. It?s been a very fascinating session.

PRIYAN MENDIS
Thank you very much.

NICK HARITOS
Thank you Shane.

Relevant links, a full transcript and more information on this episode can be found on our website at upclose.unimelb.edu.au

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