

LIFE Forms Review

WHIP Center (Texas Tech University) - November 10th, 2022

Project Updates: Progress Ratings					
Title	GP	OnC	NC	OffC	A
(01) Empirical vulnerability model to asses ... - Amal Elawady and Jean-Paul Pinelli (FIU and FIT)	5	2	0	0	0
(02) Prediction of wind and surge damage to ... - Douglas A. Smith (Texas Tech University)	4	2	0	0	0
(03) Integration of field damage, hazard, a ... - Nezamoddin Kachouie and Jean-Paul Pinelli (Florida Institute of Technology)	0	4	0	0	1
(04) Development of Fragility Curves for To ... - Dr. Delong Zuo (Texas Tech University)	4	1	0	0	0
(05) Wind-induced loads on irregular shaped ... - Ioannis Zisis and Seung Jae Lee (Florida International University)	3	2	0	0	1
(06) Wind effects on ballasted rooftop phot ... - Adrindam Gan Chowdhury, Ioannis Zisis and AmalElawady (Florida International University)	0	4	0	0	0

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WHIP Center (Texas Tech University) - November 10th, 2022

Project: (01) Empirical vulnerability model to assess impact of windborne tree debris on lowrise construction

Project Phase: Project Update

Project PI: Amal Elawady and Jean-Paul Pinelli (FIU and FIT)

Progress Ratings

Great Progress - 5

On Course - 2

Needs Change - 0

Off Course - 0

Abstain - 0

Summary of Responses to IAB Comments

Questions

- How can the trunk defect information be applied to real world applications? IS this something that is pragmatically knowable? Is impact energy alone sufficient to indicate damage? Does angle of impact and where it impacts the roof (e.g. roof corner vs center) need to be considered?
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Response 1: Thank you for your question. The below is the answer for each part of your question: How can the trunk defect information be applied to real world applications? Before answering this one, lets agree on a fact that defects in tree trunk are inevitable. Thus, for practical application/implementation of that inside a risk probabilistic model (like the one we are developing here), the easiest and direct way is to adopt a loss factor with known distribution (to represent the real distribution of defects in each species) inside the developed MC engine. The developed results can be then quantified for the uncertainty exists in the developed fragility from this factor. To achieve that, field and experimental research is needed. Methods as simple as visual inspection to sophisticated decay detection methods involving tomography, strain gauge and inclinometers etc. can be used for that purpose.

- Is this something that is pragmatically knowable?

It is not pragmatically knowable for all species. However, as we mentioned it can be achieved by field tests/observations. In the current study, due to the lack of data and inevitable existence of defects, we will consider either (1) a range of reduction in the capacity which will be randomly considered inside the Monte Carlo Simulation Engine (0% to 20% reduction) or (2) several discrete values for the reduction factor to assess their effect on the trees' vulnerabilities. -Amal Elawady

Is impact energy alone sufficient to indicate damage?

We agree that the severity of tree damage to buildings is dependent on both the tree impact energy and the structure's impact resistance. To have accurate results, the limited experimental drop tests conducted in 1996 need to be extended to consider more buildings components. This could be included as a part of next years research plans.

Does angle of impact and where it impacts the roof (e.g. roof corner vs center) need to be considered?

The answer could be yes. However, with the available limited knowledge, we do not have a firm answer. However, since all the roof components and frames are the same along the entire roof, we can assume that the impact energy will cause the same damage regardless of the location.

Hurricane Ian - automated damage detection using satellite imagery as opposed to panning and zooming manually?

Automation of the proposed framework is very important; however, it is not part of year 2 objectives. Furthermore, the manual survey is still needed at this stage to help us figure out the real response and explain any discrepancy exist between the observed and predicted damage. Moreover, for automating damage detection, a data set of damaged trees, which will be collected manually (if available), are needed for the training/development of the damage detection algorithm.

Root plate models can help with tree uprooting. Are we happy with the branch failure models that are sources of debris?

So far, we are not considering any model for branch failure. Existing models for windborne debris reached very advanced stage where we can track failed roof shingles and their trajectory till impacting the nearby houses. Same techniques can be adopted for branch failures. However, to do that, extensive research is needed to understand the behavior of tree branches during extreme wind conditions. That is, resistance, wind loads, geometry, and distribution of branches for each species are needed. Such knowledge is not available till now. One objective of this project is to identify the existing gaps in this area so researchers can further advance that.

How will your simulation approach account for the concurrent failure of multiple trees surrounding the property?

In the proposed framework, we have two parts describing the damage / risk to buildings. The first is the exposure index and the second is the fragility curves describing the tree-induced damage to buildings.

First, the proposed house exposure index represents the probability of a house to be hit by at least one tree of the surrounded ones. Additionally, the ratio between the tree height and distance to the house is considered to modify the tree failure probability effect on the house.

In the second part, where fragility functions for several discrete damage states will be developed for the houses at risk of being hit from trees will consider the concurrent failure of multiple trees as follow:

- 1- Inside the Monte Carlo simulation (MC) engine, failure of each tree around the building will be defined.
 - 2- For failed trees, based on their features (i.e., height, distance), the possibility to hit the building will be identified.
 - 3- For trees that are expected to hit the building, the impact energy from falling will be identified based on the pre-defined tree features (i.e., height, size, mass, etc.).
 - 4- Based on the impact energy from each tree, the expected damage to the building will be determined.
- An overall damage state will be assigned for the house based on prescribed damage criteria (will be using HAZUS criteria with modifications to link the different damage states for trees).

***What is the failure mechanism for the tree fragility curves showed - slash pine trees?
How were these validated?***

Only Stem breakage failure mode is considered in these curves (as we mentioned, the uprooting model at that time was not accurate enough). Currently, we are working on improving these models to get more accurate fragility functions.

The developed Monte Carlo simulation (MC) engine is used to estimate the fragility of the selected seven tree species. For each tree species, several crown diameters are assumed (based on collected database) and utilized to test the developed MC engine. The results of two species (i.e., Mahogany and Oak Live) are validated against the damage data collected by the Florida Urban Forest Strike Team in Naples city, FL after Hurricane Irma in 2017.

- None at this time
-Erica Sherman (GAF)

In the building fragility piece, are you looking at differences associated with different roof slopes and masonry vs. wood framed buildings?

At this stage, we are focusing on wood framed buildings. According to the experimental study at Clemson University, the damage is linked to the impact energy by the falling tree/steel tube. Thus, the roof slopes were not considered as a parameter.

Have the PIs looked at the tree fall work being done by Frank Lombardo, Daniel Rhee, Godfrey and Peterson. Lots of work there trying to estimate winds required to produce treefall, including evaluating root plate resistance.

-Jim LaDue (NIST)

Thanks for the information. Drs. Lombardo and Rhee works on forest trees subjected to tornados. We have discussed with Drs. Lombardo and Rhee about their work. Also, we discussed and met with their co-author Dr. Peterson. Our goal at that time was to discuss with them possible ways to include the branch failure in our proposed framework, but, unfortunately, they did not include that in their work.

They included the root plate resistance based on real damage data of forests during tornados (which we do not have here particularly for the seven species). We will check if there is any recent work published in this regard and the possibility to include their root plate resistance.

Suggestions

- Generalizing the results into guidance for risk assessment and planning would be useful.
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Thank you! We will discuss with our mentors to develop such guidance.

- None at this time
-Erica Sherman (GAF)
- My partner Jim LaDue noted to me that Daniel Rhee (from Illinois, now at NIST ad of last week) has published some papers on root failure and tip over that may assist you with this portion of the fragility model. In addition, I can distinctly remember instances of protective actions of trees in assessing Hurricane Harvey damage in 2017. StEER data are not available but there may be some aerial image archives that could be helpful.
-Tanya Brown-Giammanco (NIST)

Thanks for the information. Drs. Lombardo and Rhee works on forest trees subjected to tornados. We have discussed with Drs. Lombardo and Rhee about their work. Also, we discussed and met with their co-author Dr. Peterson. Our goal at that time was to discuss with them possible ways to include the branch failure in our proposed framework, but, unfortunately, they did not include that in their work. We will continue this effort to improve our model.

Comments

- Lots of positive aspects of this project. Inclusion of tree protection is an important consideration. Quantifying results via impact energy makes sense, and it is good to see other experimental work being leveraged.
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Thank you for such encouraging feedback!

- Very interesting project and we at Verisk cannot wait to see the final results and find ways to use this in our workflow.
-Karthik Ramanathan (Verisk)

Thank you for such encouraging feedback!

- You are making great progress on a very complex topic. This is extremely important research. Thank you for adding the protective aspect to the research. Can you imagine the advantages to homeowners to be able to identify tree risk on their property and also design tree protection for their home when they live in a high wind region?
-Eric Haefli (State Farm Insurance)

Thank you for such encouraging feedback! We hope this work homeowners better protect their home investments.

- Great progress. The next steps to refine the process, incorporate reconnaissance data, and further develop the home exposure index seem to be highly valuable. Additionally the effort to further understand the potential protective effects of the trees seems be interesting.
-Erica Sherman (GAF)

Thank you for the constructive feedback!

- I like the framework direction that has been developed for this project. I appreciate the approach of looking at fragility of the trees and the buildings separately.
-Tanya Brown-Giammanco (NIST)

Thank you for such encouraging feedback!

- Good progress, this work is creating a valuable tool and knowledge to help separate the effect of wind and surge damage.
-Erica Sherman (GAF)

Thank you for such encouraging feedback!

- Its interesting to see their project producing a needed treefall risk product and I like the direction in which this project would go in an objective of providing guidance on tree planting to maximize protection.
-Jim LaDue (NIST)

Thank you for such encouraging feedback!

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WHIP Center (Texas Tech University) - November 10th, 2022

Project: (02) Prediction of wind and surge damage to buildings by hurricane

Project Phase: Project Update

Project PI: Douglas A. Smith (Texas Tech University)

Progress Ratings

Great Progress - 4

On Course - 2

Needs Change - 0

Off Course - 0

Abstain - 0

Summary of Responses to IAB Comments

Questions

- How did the overall validation go with the claims from Texas Dept. of Insurance?
• You said you are abstracting wind damage from the claims? Can you please elaborate?
• The % roof cover and % wall cover damage you note in the tables are from the claims file - can you confirm?
-Karthik Ramanathan (Verisk)

Response 1: Overall the validation is progressing well. The number of comparisons for the 24 combinations of solution options generates a very large quantity of data. Wind damage that is being used for validation at this point comes from 2 sources: (a) from my previous work on the TDI project where we used EagleView remote sensing data to quantify the visible damage (the observed damage to the building components was reported as a single number e.g. 10% roof cover damage) and (b) from the claims data where the total observed damage is separated by surface (e.g. 7% on wall 1, 3 percent on Wall 2, etc.) -Douglas A Smith

- This is really interesting work. NIST may be interested in investigating surge impacts on buildings from Ian if funds arrive. I'd be interested to talking to you about this at

some point.

-Jim LaDue (NIST)

Response 1: Let me know what a good time for you for us to visit. -Douglas A Smith

Suggestions

- It would be useful to have some documentation of the changes you are considering based on the validation work. For example, the adjustments to the roof that you mention.
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Response 1: I think a lot of you suggestion will be accomplished during calibration where we strive to minimize errors between observed and predicted damage. As I go through the validation process I will document where I think changes can/should be made and dhare it with the IAB. -Douglas A Smith

- This project should be very important to FEMA. Suggest broadening the conversations with that agency to speak to the NFIP folks as well to advertise benefits of center membership.
-Tanya Brown-Giammanco (NIST)

Response 1: Good suggestion. -Douglas A Smith

Comments

- No specific concerns as such
-Karthik Ramanathan (Verisk)

Response 1: OK -Douglas A Smith

- Great progress! Please keep moving it forward.
-Eric Haefli (State Farm Insurance)

Response 1: Thanks -Douglas A Smith

- Comparisons to the TWIA claims is very helpful. The uncertainty is expected, but the observations will be useful to refining process and setting performance expectation.
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Response 1: I agree that the uncertainties are expected and the results will be useful for refinement -Douglas A Smith

- For GAF I think will be important and interesting to further explore the gap between predicted damage and observed damage on the roof. Are there opportunities to incorporate learnings from the Year 1-2 research on residential roofing done by WHIP in this area?
-Erica Sherman (GAF)

Response 1: Yes, I think there is an opportunity to incorporate that research into the damage prediction algorithms. -Douglas A Smith

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WHIP Center (Texas Tech University) - November 10th, 2022

Project: (03) Integration of field damage, hazard, and exposure data for potential use in risk models

Project Phase: Project Update

Project PI: Nezamoddin Kachouie and Jean-Paul Pinelli (Florida Institute of Technology)

Progress Ratings

Great Progress - 0

On Course - 4

Needs Change - 0

Off Course - 0

Abstain - 1

Summary of Responses to IAB Comments

NezamoddinKachouie's Response: A major challenge that we have faced is temporal, spatial, structural, and formatting inconsistencies among data sources. The main objective of this pilot project is to build an integrated database for exposure, hazard, and damage for a case study. This provides us with the opportunity to assess the feasibility of scaling up, and how and to what extent such integrated database can be automated in future.

Questions

- Is the goal to create an automated process to do this, rather than just a manual case study approach? What will happen if the sources of the data change their formats, access, etc. or they don't always collect data and/or make it available?
-Tanya Brown-Giammanco (NIST)

Response 1: Well, ideally an automated process is desired. However, this is a pilot project to identify available resources for building, hazard, and damage for an event (hurricane Michael), collect the data, integrate them and make them available in one place. You are right, not only there is temporal change, i.e. data formats and data structures have changed over time, but also there are spatial differences in data formats. For example, different counties collect the data in different formats. By identifying the

resources and facing the challenges during this project regarding hurricane Michael, we will assess how this project can be scaled up and to what extent can be automated. - Nezamoddin Kachouie

- *â€¢ The wind stations you mentioned are the ones that didnâ€™t fail right? What QAQC was done to make sure station data was good? â€¢ Per our understanding, the ARA wind field does not consider terrain effects. Those could play a major role in location level damage prediction, right?
-Karthik Ramanathan (Verisk)*

Response 1: - Right, those are the stations that didn't fail and we could access them through NOAA. We assumed the QC (to some extent) is done by the party that shares the data. So, we trust that has been done by NOAA. - And right, terrain effects could play a major role. However, the objective here is to integrate the available data, those are the concerns that must be addressed in modeling, simulation, and damage assessment. So, the purpose is to have all data available in one place for potential risk/damage assessment and modeling. -Nezamoddin Kachouie

- *Are there any new data sets types (e.g. drone footage) that are available now that you do not have for Hurricane Michael?
-Tim Doggett (Berkshire Hathaway Specialty Insurance)*

Response 1: There are some commercial data resources out there that are not publicly available and in turn we do not have them. -Nezamoddin Kachouie

Suggestions

- *The National Structure Inventory, an initiative between FEMA and USACE, recently published an update. We haven't dug into all the data yet, but could be worth exploring for building attribute data, since you indicated there wasn't a lot available for the Microsoft data.
-Tanya Brown-Giammanco (NIST)*

Response 1: Thanks for letting us know about this new update. We'll check this out. - Nezamoddin Kachouie

Comments

- I had to attend another meeting so I could not listen to watch the presentation.
-Eric Haefli (State Farm Insurance)

*Response 1: Sorry that you could not make it. Several great projects were presented. -
Nezamoddin N. Kachou*

Response 2: Hope to see you in the next meeting. -Nezamoddin Kachouie

- I am still a little unclear about the final deliverables from the project.
-Karthik Ramanathan (Verisk)

Response 1: With regard to the risk/assessment/prediction of the damage, it is essential to have access to exposure, hazard, and damage data. But, the required/useful data is not readily available on a universal platform/portal/server. Multiple resources are in different places/platforms/ servers and have different formats. The main objective of this project is to collect data for exposure, hazard, and damage using multiple resources for case study hurricane Michael and make them available in an integrated database. Such integrated database will drastically help with creating queries about buildings, hazards, and damages, for risk/damage assessment and prediction, as well as modeling and simulation. -Nezamoddin N. Kachou

- This appears to be a valuable project in unifying and connecting data from the existing databases.
-Erica Sherman (GAF)

Response 1: You are spot on. Integration of building data with hazard and exposure, and make them available in a single platform/portal/database is essential for damage assessment and modeling. -Nezamoddin N. Kachou

- The framework discussed makes sense. The data completeness will vary and will be challenging. I look forward to seeing how this progresses
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Response 1: You are absolutely right! We have faced many challenges so far with the incomplete and scattered data sources with inconsistent form and structure. Different States collect the data in different formats and structures. Even there in not consistency among counties in a state. There is similar challenge with damage data, as the format of collected data is not the same for different events. -Nezamoddin N. Kachou

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WHIP Center (Texas Tech University) - November 10th, 2022

Project: (04) Development of Fragility Curves for Tornadoic Loading on Low-Rise Buildings

Project Phase: Project Update

Project PI: Dr. Delong Zuo (Texas Tech University)

Progress Ratings

Great Progress - 4

On Course - 1

Needs Change - 0

Off Course - 0

Abstain - 0

Summary of Responses to IAB Comments

Questions

- Would it be possible to try to validate with damage investigations when the type of tornado (single vs. Multi vortex) is known maybe from some radar-based cases?
-Tanya Brown-Giammanco (NIST)

Response 1: We think the results from the study will be helpful to the understanding of the damage especially if we know the type of tornado that has caused the damage. This can also help confirmation of the identification of tornado type. However, this needs to be incorporated with other influencing factors, such as building geometry. We think it will be very important to test building models of other geometries, such as models with other roof shapes. -Delong Zuo

- Do you think you have enough information to inform the wind to damage relationship as a function of the vortex attributes? What else would you need to be confident enough to produce general guidance?
-Jim LaDue (NIST)

Response 1: We think the results we have produced are a good basis on which we can build the connection between damage and tornado attributes. We still need to test building models of other geometries and test the models in vortices of other swirl ratios. In addition, we will need to see what happens when there are a cluster of buildings. We are currently working on a NSF/NIST project that looks into the effects of suddenly created openings in the building and envelope. Results from that project can probably shed some light on what people are seeing in the field. Like the study of building performance in straight line winds, a lot of things still need to be done. -Delong Zuo

Suggestions

Comments

- Brilliant work and extremely insightful - no specific comments or concerns or questions as such.
-Karthik Ramanathan (Verisk)

Response 1: Thanks for the support! -Delong Zuo

- This project is showing fascinating results that challenge traditional lines of thinking. This work is so important to continue to drive forward progress on tornado resilience.
-Tanya Brown-Giammanco (NIST)

Response 1: Thanks! -Delong Zuo

- Really interesting developments and observations regarding the influence of tornado structure in addition to speed, and pressure profiles. Additionally, I think there's good value in studying and separating the horizontal loading and vertical loading effects. It would be interesting to see further connections to field observations.
-Erica Sherman (GAF)

Response 1: Thanks! We also believe it will be very interesting to connect the findings from this project with field observations of tornado-induced damage. -Delong Zuo

- These results are interesting and set the stage for additional investigations related to damageability. Some open questions such as explaining impacts of building openings still need to be looked into.
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Response 1: Thanks! We are working on the impact of building openings to the loading and the loading effects. -DeLong Zuo

- I wasn't here for the last time but this is very valuable with the considerations that have to be taken in evaluating wind to damage relationships.
-Jim LaDue (NIST)

Response 1: Thanks! Please let us know if additional information is of interest. -DeLong Zuo

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WHIP Center (Texas Tech University) - November 10th, 2022

Project: (05) Wind-induced loads on irregular shaped buildings

Project Phase: Project Update

Project PI: Ioannis Zisis and Seung Jae Lee (Florida International University)

Progress Ratings

Great Progress - 3

On Course - 2

Needs Change - 0

Off Course - 0

Abstain - 1

Summary of Responses to IAB Comments

Questions

- Do you have a method to compare ballast with other types of solar panel anchoring? Also, will you be able to evaluate against gusts of 1-3 sec duration?
-Jim LaDue (NIST)

Suggestions

- In addition to reviewing Microsoft building database, recommend you look at the National Structure Inventory from FEMAUSACE. We just got access a few weeks ago, so not sure how valuable it will be for you, but worth a look to get building properties.
-Tanya Brown-Giammanco (NIST)
- Would be interesting to see if there is correlation to roof shape and damage observed during Ian
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Comments

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- Really interesting project and excited to see the final results. Any insights that could be provided to show how shape affects the load and therefore the vulnerability can be extremely helpful. What is the possible role of the height along with geometry of the roof?

-Karthik Ramanathan (Verisk)

Response 1: Thank you. Yes, we will examine the correlation between the shape and the wind-induced loading. The effect of the height is beyond the scope of this research but it is part of a more comprehensive proposal we prepared. -Ioannis Zisis

- Very interesting projects and results.
- Tim Doggett (Berkshire Hathaway Specialty Insurance)

Response 1: Thank you. -Ioannis Zisis

- Great progress on this project. Exploring the shape factor index as a measure of risk looks promising. Also, I believe a question during the talk brought this up, but understanding how building shape affects the zone locations will be really interesting. Additionally, I understand the complexity of incorporating 3D shapes, but understanding the influence of the roof dimensions and slope would also be of high value.

-Erica Sherman (GAF)

Response 1: Thank you. ASCE 7 like zones is indeed, one of the most promising early findings. We expect to be able to present more detailed findings when we test more cases in the wind tunnel. Roof shape is critical but it needs a lot more effort to be able to study/incorporate it in the shape indexing exercise. -Ioannis Zisis

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WHIP Center (Texas Tech University) - November 10th, 2022

Project: (06) Wind effects on ballasted rooftop photovoltaic systems

Project Phase: Project Update

Project PI: Arindam Gan Chowdhury, Ioannis Zisis and AmalElawady (Florida International University)

Progress Ratings

Great Progress - 0

On Course - 4

Needs Change - 0

Off Course - 0

Abstain - 0

Summary of Responses to IAB Comments

Questions

- Got my questions answered post the talk. No other questions.
-Karthik Ramanathan (Verisk)

Response 1: Thank you! -Arindam Gan Chowdhur

Response 2: Thank you! -Arindam Gan Chowdhur

Suggestions

Comments

- Very interested and very needed due to the increase in solar installations. I like the three phases of research.
-Eric Haefli (State Farm Insurance)

Response 1: Thank you! Yes, we will do (1) aerodynamic pressure testing, (2) dynamic testing (for vibration), and (3) destructive testing (to study possible failure modes and ballast design effectiveness). -Arindam Gan Chowdhur

- Interesting and relevant topic area. Looking forward to seeing the test results.
-Tim Doggett (Berkshire Hathaway Specialty Insurance)

Response 1: Thank you! We would like to make the results useful to all IAB members. - Arindam Gan Chowdhur

- Would be interested to learn the findings from this research in terms of what wind speeds and orientation would lead to non-performance of the ballasts and cause the panel arrays to move.
-Karthik Ramanathan (Verisk)

Response 1: Thank you! We will capture wind speeds and wind directions that would lead to non-performance of the systems in terms of uplift, sliding, overturning, excessive vibrations, etc. -Arindam Gan Chowdhur

- I think this project has great value due to the scale of the testing and breadth of the data that will be collected. This is a great step in generating information that can be translated into best practices and eventual code development
-Erica Sherman (GAF)

Response 1: Thank you! The large-/full-scale testing has the potential to improve design and installation practices. -Arindam Gan Chowdhur