Field Assessment Structural Team (FAST) Handbook

Version 1.2

Released August 27, 2019

Authored by:

Tracy Kijewski-Correa, University of Notre Dame, StEER Director
Khalid Mosalam, University of California, Berkeley, StEER Associate Director for Seismic Hazards
David O. Prevatt, University of Florida, Associate Director for Wind Hazards
Ian Robertson, University of Hawai'i at Manoa, Associate Director for Coastal Hazards
David Roueche, Auburn University, Associate Director for Data Standards

Note that StEER is responding to events while its policies, protocols and membership are still in active development. All policies, procedures and protocols in this handbook should be considered preliminary and will be refined with community input as part of StEER's operationalization throughout 2019.

PREFACE

The National Science Foundation (NSF) awarded a 2-year EAGER grant (CMMI 1841667) to a consortium of universities to form the Structural Extreme Events Reconnaissance (StEER) Network (see https://www.steer.network for more details). *StEER builds societal resilience by generating new knowledge on the performance of the built environment through impactful post-disaster reconnaissance disseminated to affected communities.* StEER achieves this vision by: (1) deepening structural engineers' **capacity** for post-event reconnaissance by promoting community-driven standards, best practices, and training, as well as their understanding of the effect of natural hazards on society; (2) **coordination** leveraging its distributed network of members and partners for early, efficient and impactful responses to disasters; and (3) **collaboration** that broadly engages communities of research, practice and policy to accelerate learning from disasters. StEER works closely with other extreme event reconnaissance organizations and the Natural Hazards Engineering Research Infrastructure (NHERI) to foster greater potentials for truly impactful interdisciplinary reconnaissance after disasters.

Under the banner of NHERI's CONVERGE node, StEER works closely with the wider Extreme Events Reconnaissance consortium including the Geotechnical Extreme Events Reconnaissance (GEER) Association and the networks for Nearshore Extreme Event Reconnaissance (NEER), Interdisciplinary Science and Engineering Extreme Events Research (ISEEER) and Social Science Extreme Events Research (SSEER), as well as the NHERI RAPID equipment facility and NHERI DesignSafe CI, long-term home to all StEER data and reports. While the StEER network currently consists of the three primary nodes located at the University of Notre Dame (Coordinating Node), University of Florida (Atlantic/Gulf Regional Node), and University of California, Berkeley (Pacific Regional Node), StEER aspires to build a network of regional nodes worldwide to enable swift and high quality responses to major disasters globally.

StEER's founding organizational structure includes a governance layer comprised of core leadership with Associate Directors for each of the primary hazards as well as cross-cutting areas of Assessment Technologies and Data Standards, led by the following individuals:

- **Tracy Kijewski-Correa (PI),** University of Notre Dame, serves as StEER Director responsible for overseeing the design and operationalization of the network and representing StEER in the NHERI Converge Leadership Corps.
- **Khalid Mosalam (co-PI),** University of California, Berkeley, serves as StEER Associate Director for Seismic Hazards, leading StEER's Pacific Regional node and serving as primary liaison to the Earthquake Engineering community.
- **David O. Prevatt (co-PI),** University of Florida, serves as StEER Associate Director for Wind Hazards, leading StEER's Atlantic/Gulf Regional node and serving as primary liaison to the Wind Engineering community.
- **Ian Robertson (co-PI),** University of Hawai'i at Manoa, serves as StEER Associate Director for Assessment Technologies, guiding StEER's development of a robust approach to damage assessment across the hazards.
- **David Roueche (co-PI),** Auburn University, serves as StEER Associate Director for Data Standards, ensuring StEER processes deliver reliable and standardized reconnaissance data suitable for re-use by the community.

DOCUMENT SCOPE & ACKNOWLEDGEMENTS

This document assembles guidance and instructions to support StEER members participating in Field Assessment Structural Teams (FASTs) and should be at minimum reviewed by all Level 2, 3 or 4 StEER members eligible to deploy to conduct field assessments. Appendix A of this document also lists supporting resources referenced throughout this handbook, archived in the Resources folder on the StEER Members Shared Drive on Google. In addition to this document, StEER will be releasing online modules and conducting webinars to assist in training FAST members. These will be available at https://www.steer.network/resources.

StEER is indebted to the open platform and support provided by Fulcrum Community, which is the primary data acquisition framework for its door-to-door damage assessments. StEER also acknowledges the Earthquake Engineering Research Institute (EERI), whose Fulcrum App provides the basis for StEER earthquake damage assessments.

StEER wishes to further acknowledge that these policies, which will continue to evolve with input from the community, were inspired greatly by the example of Geotechnical Extreme Events Reconnaissance (GEER) Association and the opportunities to exchange ideas and best practices among the members of the Natural Hazard Engineering Research Infrastructure (NHERI) Converge Leadership Corps.

This material is based upon work supported by the National Science Foundation under Grant No. CMMI 1841667. Any opinions, findings, and conclusions or recommendations expressed in this material are those of StEER and do not necessarily reflect the views of the National Science Foundation.

TABLE OF CONTENTS

PREFACE 2

DOCUMENT SCOPE & ACKNOWLEDGEMENTS 3

ABBREVIATIONS 6

StEER Products 6

FAST EXPECTATIONS 7

First Steps 7

FAST Deployments 8

Post-Deployment 8

CODE OF CONDUCT 10

GUIDELINES FOR FIELDWORK 12

Preparations 12

Field Coordination & Logistics 13

Securing Access 13

DATA COLLECTION PROTOCOL 15

MOBILE APPLICATION FOR DOOR-TO-DOOR ASSESSMENTS 17

Accessing StEER Apps within Fulcrum 18

Using the StEER Fulcrum Apps 19

Geolocating Records 21

Adding Layers 21

Android 22

iOS 22

StEER Building - US (Windstorm) App 23

Damage Ratings 24

Additional Tips and Strategies 27

StEER Non-Building - US (Windstorm) 27

StEER Earthquake 28

StEER Tsunami 29

REFERENCES 30

Appendix A: Checklist of FAST Resources 31

Appendix B: Identifying Opening Protection 33

Impact-Resistant Openings 33

Panel Protected Openings 33

Appendix C: High Wind-Rated Vinyl Siding vs. Standard Vinyl Siding 35

ABBREVIATIONS

ASTM	American Society for Testing and Materials (formerly)
EARR	Early Access Reconnaissance Report
EERI	Earthquake Engineering Research Institute
EF	Equipment Facility (part of NHERI)
FAA	Federal Aviation Administration
FAST	Field Assessment Structural Team
FEMA	Federal Emergency Management Agency
GEER	Geotechnical Extreme Events Reconnaissance Association
GPS	Global Positioning System
ISEEER	Interdisciplinary Science and Engineering Extreme Events Research
NEER	Nearshore Extreme Events Reconnaissance
NHERI	Natural Hazards Engineering Research Infrastructure
NSF	National Science Foundation
OSB	Oriented strand board
PI	Principal Investigator
PVRR	Preliminary Virtual Reconnaissance Report
RAPID	Type of NSF grant intended to support capture of perishable data Also refers to NHERI EF renting equipment to capture perishable data
StEER	Structural Extreme Events Reconnaissance
SGI	Special Government Interest
SMS	Short Message Service
SSEER	Social Science Extreme Events Research
TAS	Testing Application Standard
UAS	Unmanned Aerial Survey
UAV	Unmanned Aerial Vehicle
VAST	Virtual Assessment Structural Team

StEER Products

StEER mobilizes its membership as Virtual Assessment Structural Teams (VASTs) and possibly Field Assessment Structural Teams (FASTs) to assess damage to the built environment after notable tsunamis, earthquakes, hurricanes, tornadoes and other natural hazard events. The level of mobilization is determined by StEER's leadership based upon many factors including the intensity and size of the event, its impact on communities and the opportunity to observe unique phenomenon/performance issues. As part of its response, StEER produces up to three written products: Event Briefings, Preliminary Virtual Reconnaissance Reports (PVRRs) and Early Access Reconnaissance Reports (EARRs). The latter two reports are the most in-depth assessments of damage, with the EARR focused on initial observations gathered by the FAST. For additional information on these products, or StEER's response protocols, please refer back to the Member Guidelines.

FAST EXPECTATIONS

StEER's efforts to preserve perishable data following natural hazard events is an undertaking that requires committed effort of many. Field Assessment Structural Team (FAST) members make important contributions to this effort, working under stressful and challenging conditions, often traveling far from their homes, rescheduling classes, meetings and other appointments. The damage assessments collected in these efforts rely upon forensic engineering skills and tools specifically applied to natural hazards impacts. FAST members with Level 3 or 4 StEER designations have demonstrated such experience in conducting building inspections and documenting damage. However, it is expected that FAST members complement this experience with training in StEER's workflows and processes by reviewing this handbook and attending other webinars and training opportunities. FAST members will also benefit from the items assembled in **Appendix A: Checklist of FAST Resources**, which all reside in the Resources folder of the StEER Members Shared Drive on Google.

First Steps

All StEER members will be automatically added to StEER's Fulcrum Community account. It is expected that members at Levels 2, 3 and 4 will complete the following steps. Please DO NOT wait until you are activated on a FAST to take these actions; rather do so at your earliest convenience upon joining StEER:

1. Review the Member Guidelines and this Field Assessment Structural Team (FAST) Handbook.
2. You will receive a notification email from Fulcrum once the StEER Administrator has added you to the platform. Complete the process outlined in that email to set up your Fulcrum account and access the mobile application StEER uses for door-to-door (D2D) damage assessments;
3. Download and install the Fulcrum App (free from the Google Play store or the iOS App store) on your mobile device and log into your account using the credentials you created in Step 2 to begin to familiarize themselves with the App. See the **MOBILE APPLICATION** section of this handbook for more details.
4. Verify that your DesignSafe Slack account is active: https://designsafe-ci.slack.com. Contact the DesignSafe team of any issues with Slack.
5. Familiarize yourself with the Fulcrum web-interface on your computer: https://www.fulcrumapp.com/;
6. When available, access and complete the training modules or attend the webinars advertised by StEER. Modules (when released) and recordings of all webinars will be available at https://www.steer.network/resources.

FAST Deployments

1. When StEER is mobilizing an event response, it will reach out to eligible members to gauge their availability (and interest) to participate in the FAST. Initial outreach will be issued by email with interest tracked via a Google Form.
2. StEER Leadership will select the FAST, it Lead and when relevant, the affiliated Regional Node. Once accepted into a FAST, all coordination and communication will be managed in the secure Slack channel dedicated to that event's FAST.
3. It is expected that FAST members will interact on this Slack channel in pre-deployment planning and logistics, including securing their flights, reserving ground transport and lodging (as necessary), and preparing provisions, supplies and equipment needed for the assessment. Because availability of housing is often limited after major disasters, FAST members should expect to share rooms (of course respecting gender sensitivities). See inset box on the following page for additional tips for logistics before deployment.
4. FAST members should familiarize themselves with the Pre-Deployment Briefing issued by StEER as well as the Preliminary Virtual Reconnaissance Report (PVRR) created by the StEER Virtual Assessment Structural Team (VAST) within days of the event. These are emailed to all StEER members and disseminated on various Slack channels.
5. StEER's goal is to share its findings of its FAST as swiftly as possible, and generally within a week of their deployment. Given the speed with which StEER hopes to share its findings, FAST members must use StEER's data collection platforms, assessment protocols, and report templates.
6. StEER's mission is not to explore individual research questions or hypotheses but it is to collect and curate highly perishable evidence of the damage caused to the built environment, such as building and other civil infrastructure, as well as green infrastructure. FAST members are expected to coordinate their investigations on the ground to support the stated objectives and sampling targets communicated by StEER. StEER's objectives should be prioritized over FAST members' own research questions, though research interests between FAST members and StEER generally closely align.
7. While in the field, FAST members will be supported by a remote team of VAST members who will continue to gather publicly available information and process FAST's damage assessments for long-term curation and the Early Access Reconnaissance Report (EARR). To streamline this process, FAST members should participate in the preparation of the Daily Summary to be shared with the VAST supporting them remotely.

POST-DEPLOYMENT

1. Upon return, FAST members should participate in the authorship/review of the EARR assembled by their supporting VAST members.

2. FAST members should verify that all their data has transferred completely to the VAST Event Curator managing the DesignSafe project.
3. FAST members will be further asked to assist in the authorship/review of the Data Report, which accompanies the final curated dataset, for accuracy and completeness.
4. When appropriate, StEER will coordinate the publication of a Data Paper that introduces the curated dataset and overviews the reconnaissance effort with the community. In order to be included in the authorship of this paper, the FAST member must contribute to this manuscript.
5. Once the StEER reports are published, members are free to work on any aspects of the disaster as individual researchers; however, they must make it clear that these are individual contributions and do not represent the wider team and respect the attribution policies in the Member Guidelines. The published and curated datasets of observations in DesignSafee following the natural hazard are publicly available to be used, as long as proper attribution (citing the dataset with its full DOI) is provided.

LOGISTICS TIPS

- Do not exclusively rely on booking websites to secure hotels or rental cars. Always call the direct line and verify availability. Websites may not accurately reflect availability and functionality of the property following a natural hazard event.
- Make sure to request special rates as a government-funded project charged with assessing damage in the region. Hotels often only offer availability to government-related projects and crew if an area has been heavily impacted.
- Work when possible to rent SUVs or other large vehicles with sufficient clearance for work in heavily impacted areas.
- Satellite navigation systems do not always reflect the current conditions in an area impacted by a natural hazard event. Make sure to confirm access routes using state and local sources and allow ample travel time to get to, and move through, impacted areas.
- Always have your StEER badge, safety vest, hardhat and boots while in the field.
- Be aware that services including power, water and gas may not be available in impacted areas; plan accordingly to acquire these supplies well outside the impacted region. Cellular service may also be impacted so have redundant communications strategies available.
- Do not assume access ATMs or credit card networks; maintain sufficient cash on hand.
- During the immediate aftermath of a natural hazard event, people affected by the event and the responders, are likely to be emotionally and physically stressed. As such FAST members should be prepared to exercise patience and good judgment.

CODE OF CONDUCT

FAST members will interface closely with key stakeholders and the affected public during field assessments. StEER expects all FAST members to comply with this code of conduct and represent StEER and NSF well in these interactions, particularly with impacted property owners:

- Rescue, response and recovery activities shall always supersede StEER's reconnaissance efforts.
- Members will obey all laws governing the locale, including regulations enacted as part of emergency declarations, curfews, etc.
- Members shall respect the culture, customs, dignity, and circumstances of the communities that they survey and the potential personal challenges being faced by local stakeholders and collaborators who are under atypical obligations, pressures and constraints.
- Members will carefully and thoughtfully perform their field activities in a manner that promotes personal and team safety. Before entering any building, the FAST member should secure the permission of the owner. Exceptions can be made in the event that a property has been abandoned. Physical Samples should only be acquired with the expressed permission of the owner, unless it is part of a debris pile and no longer attached to a specific property.
- Members will act in service to StEER's objectives and not their own objectives or hypotheses, collecting data in a consistent and unbiased way in accordance with StEER standards.
- Members will collaborate in a manner that is neither discriminatory nor disrespectful to other team members or to individuals with other organizations.
- Members have professional and financial accountability to the National Science Foundation and public users of our data. As such, FAST members agree to share observations with each other and outside parties in a coordinated manner through their FAST Lead. All non-confidential data and information gathered by our FAST are to be shared with other reconnaissance teams and made publicly available in a timely manner.
- When deployed, FAST members are representing StEER and its sponsor, the National Science Foundation, on a community data collection effort. Thus while each FAST member retains their inherent right to free speech, StEER requests that on-the-record interviews be handled only by the FAST Lead or his their designated spokesperson. Inform the StEER Leadership promptly of any interview requests. Always request the right to review the piece before it goes to print/online/on-air to ensure your comments are not taken out of context.
- In media interactions as well as written and oral communications with the public or the research community regarding this mission, all FAST members should appropriately acknowledge their affiliation with StEER and sponsorship by NSF.

- Participants will protect the privacy of individuals' personal information, e.g., property owner's name, phone number, etc. These are to remain in the private notes of the team and not curated in the public dataset.

GUIDELINES FOR FIELDWORK

Preparations

All StEER members have volunteered for FAST assignments and assume all risks of participation. StEER members should ensure they have adequate health insurance coverage. StEER and NSF are in no way responsible for any injury or consequence of participation on a FAST; however, the guidelines below will help to minimize the risks associated with fieldwork:

- Debris and sharp objects are a concern -- appropriate footwear (work boots or hiking boots) are strongly recommended. FAST members are also advised to update tetanus shots before deploying; when traveling outside the US, please consult the CDC website for other recommended immunizations and preventative care for the region.
- Mosquitos may be a significant issue in some responses, particularly when heavy rainfall/flooding has occurred, pack ample repellent and protective clothing (long sleeves, long pants).
- Wear clothing suitable for the predicted conditions. Have sun protection appropriate for your skin type; hats are strongly advised when working in hot, sunny conditions; rain gear and water protective measures may be needed in some cases.
- Plan to hydrate frequently, stocking up on fluids (and ice in hot conditions) before entering the impacted region.
- Ensure at least one member of the team carries a basic first aid kit.
- All StEER personnel are expected to provide their StEER membership badge, their own fluorescent safety vest and hard hat. The vest must be worn at all times. Hard hats should be worn when overhead hazards are present, e.g., when entering a partially collapsed building.
- Since much of the data collection uses devices with rechargeable batteries, be sure to carry additional battery packs or portable power packs to recharge mobile devices. This is especially important for members using their mobile device for the Fulcrum App. While the app is not unreasonably battery-intensive, it is always best to bring a portable power bank and recharge your phone periodically in the field since low battery status can trigger a power-saving mode that will disable GPS, compromising your ability to geolocate in Fulcrum. Car chargers and lighter-compatible 110-volt inverter strips are also recommended for charging laptops and larger devices.
- StEER recommends the FAST have at least one handheld GPS available in the event that a GPS-enabled device (camera or phone) used for data collection or navigation malfunctions.
- It can be similarly useful to include short-range radios as cell coverage can be compromised. As internet access may similarly be limited in the field, team members are asked to provide their own redundant storage for any data they acquire.

- If providing UAV services, ensure your FAA license is up to date and that the UAV is registered with the FAA. Bring ample batteries to avoid down time while recharging.
- StEER has additional packing lists of recommended items to assist in preparations.

TIP: If you are a first time Fulcrum user, login and submit a few "dummy" assessments before going into the field so that you are comfortable with the workflow of the Fulcrum Apps. Direct message David Roueche, the Associate Director for Data Standards, on Slack to review the "dummy" assessments before going into the field to ensure proper use of the Fulcrum App.

Field Coordination & Logistics

- FAST members should use their FAST's private Slack channel for the majority of communications and exchange of information, including check-ins on this channel at the start and end of each day so the VAST and StEER Leadership Team are aware of the status on the ground.
- Teams will receive a complete Pre-Deployment Briefing with relevant information and the event strategy. This provides guidance for planning each day's activities, using the FAST's dedicated private slack channel to communicate with StEER leadership in the event this strategy needs to evolve.
- It is understood that connectivity may not support the use of Slack during fieldwork, in which case SMS messages (i.e., text) or short range radios should be employed. The mobile numbers of all StEER members associated with the FAST mission will be included in the Pre-Deployment Briefing provided by StEER. Most teams initiate a group text that is used for regular communication on status and location.
- If the FAST team plans to use multiple vehicles, one team member in each vehicle may wish to enable location sharing on their phone and set a rendezvous point in the event communications are disrupted.
- Each vehicle should maintain a basic first aid kit and provisions (water, food, gas) sufficient for one day. Cooler with ice is recommended, especially in hot conditions.
- Route selection -- continuously consult local authority websites (county, state, municipal) for updates on road closures or transportation issues. Make note of any route closures for inclusion in the EARR.

Securing Access

- There may be restricted access to and security around communities affected by the event; teams may be questioned by law enforcement, national guard or other officials at checkpoints or secured perimeters. In some instances, teams have been asked to register with municipal authorities to disclose the purpose of their activity.
- Note that some areas may have checkpoints, access control or curfews (these can be as early as 5 pm); be aware of this possibility when planning the day's work.

- In areas patrolled by police and security, disclose your purpose proactively before beginning work.
- Download, personalize and print (preferably in color) multiple copies of the Access Letter. Each member should have a copy of this letter on their person at all times in the event officials or property owners request additional documentation. Interested parties may request to keep a copy for their records.
- Before deploying, team members should download, customize, print (in color) and laminate the official ID badge they received upon joining StEER. This badge will fit in a 3" x 4" sleeve (commonly worn on lanyards around the neck or clipped to the safety vest). At minimum carry the badge in your pocket or wallet as a credential.
- Wear your fluorescent safety vest while acquiring data. This again increases legitimacy and odds of receiving access to secure areas.
- Seek permission even for an official assessment when owner is present; when permission is denied, the surveyor can either document the property from the street or elect to skip that assessment. When the owner is not present, best practices suggest the structure can be surveyed externally by walking on all sides of the building, unless the property is marked with a no trespassing or private property signage. In any case, do not enter a building unless the owner provides his/her permission to do so.

DATA COLLECTION PROTOCOL

The following guidance provides the daily data collection protocol developed for all StEER members. The protocol was developed to streamline communications with the FAST team's virtual support and to ensure data can be efficiently curated at the end of the mission:

1. Each morning: the FAST Lead announces the objectives/targets for data collection that day via the FAST's private Slack channel.
2. Before leaving a reliable WiFi zone, all FAST members should launch and synchronize their Fulcrum App (to load any changes made to the App and all records). Members should also scan the FAST Slack channel for any updates or new intel.
3. All manual ground-based observations and damage assessments each day will be collected by StEER's suite of Fulcrum Applications that run on Android/iOS-enabled mobile devices. (Please consult the **MOBILE APPLICATION FOR DOOR-TO-DOOR ASSESSMENTS** section of this handbook for additional information on the StEER Fulcrum Apps.)
4. The Fulcrum app should be used to the greatest extent possible to streamline data collection and curation. Team members may curate additional photos/videos as long as they are acquired with a GPS-enabled device. This can stored on the cloud or uploaded to the Folder dedicated to the event on the StEER Members Shared Drive on Google). Team members should regularly verify that GPS is tracking their location while acquiring any photos or videos outside of Fulcrum. When working outside of Fulcrum, it is advised to photograph a unique site identifier written on a whiteboard or notepad before beginning the photo sequence for that site to aid in annotating the photo or video dataset post-event.
5. Team members who wish to capture written notes, reflections or observations throughout the day are encouraged to do so using their mobile device, voice recorder, notebook, etc. Note that voice recordings can also be collected within the Fulcrum app.
6. If UAV flights are planned for that day, operators must first ensure they are authorized to do so. Check the FAA B4UFLY App to verify if any targets are in Class G airspace. If so, then express authorization from the FAA is not required. In all other cases, FAA approval must be secured prior to departure by contacting System Ops in Washington DC using the FAA Request Form. The Emergency Authorization process can take about 2 hours. In general, the following will be required by the FAA:
    - Licensed pilot with Operator Number and UAV registered with the FAA.
    - Specific latitude/longitude and radius of the flight area (capped at 2-3 miles, preferably); flight altitude (lower altitudes are more likely to be approved and no higher than 400 ft); the time of the flight; and the duration.
7. During the day, if a reliable cellular connection (or WiFi connection) is available, FAST members should sync their Fulcrum App periodically so that the locations of their records and survey forms stored locally on their device can be moved to the Fulcrum cloud server for access and updating by other FAST members. The VAST members can also

access your data collected to begin their data enrichment and quality control processes on your data. Photographs, videos and audio files will only sync on WiFi if the "Synchronize Photos", "Synchronize Videos" and "Synchronize Audio" settings are set to ON, as recommended later in the **MOBILE APPLICATION FOR DOOR-TO-DOOR ASSESSMENTS** section of this handbook.

8. Maintain local data backup: If possible, at lunch or other break during the day, those collecting data in Fulcrum should sync photos from the phone's gallery to a laptop or external storage as a backup. This is similarly advised for any other data collected on other platforms.
9. At the end of the day the team should hopefully be able to access a reliable WiFi zone. At this time, all data should be moved into its cloud storage, by synchronizing the Fulcrum App or initiating an upload of other data, e.g., to the DesignSafe project for the FAST or Event folder on the StEER Members Shared Drive on Google. Always verify the data has fully synchronized by viewing it in the Fulcrum web-interface (www.fulcrumapp.com) on your computer.
10. Photos or other data collected outside of Fulcrum should similarly be backed up, ideally by uploading them to the Event folder on the StEER Members Shared Drive on Google. Members should review photos and videos and remove poor quality, redundant or errant captures. Any photos or videos captured outside of Fulcrum should be logged and annotated by creating a copy of the Photo-Video Log (which has separate tabs for photos and videos) and saving it (as Photo-Video Log - LAST NAME, where LAST NAME is the name of the FAST member) in the Event folder in the StEER Members Shared Drive on Google.
11. At the end of the day, all FAST members should collectively debrief and share observations to complete the team's Daily Summary, which should be stored in the Event folder on the StEER Google Team Drive. A notification should be posted to the dedicated private Slack channel for this FAST when that Daily Summary is ready for review. See the Daily Summary Quick Reference Sheet for an example.
12. If individual members wish to keep their own digital notebook, a Field Journal template should be saved (as Field Journal - LAST NAME, where LAST NAME is the name of the FAST member) in the Event folder in the StEER Members Shared Drive on Google.
13. Before going offline, the dedicated FAST Slack channel should be used to interact with StEER leadership to confirm the objectives/targets for the next day.

TIP: FASTs may find it beneficial to appoint a team member to download the Daily Summary, template as a word document on their laptop and update it throughout the day while the team is driving between locations.

REQUEST: Take a moment to photograph your team together in the field (group shot) as well as action shots of the team at work. Please upload these to the event folder on the StEER

Members Shared Drive on Google for use in reports and communications about the event response.

MOBILE APPLICATION FOR DOOR-TO-DOOR ASSESSMENTS

StEER currently utilizes Fulcrum, a commercial form-builder and data collection platform produced by Spatial Networks Inc., for the bulk of its door-to-door data collection and processing needs. StEER is also exploring integration of the RAPID App, which is being developed by the NSF NHERI RAPID EF at the University of Washington, into the StEER FAST workflow at a future date. Fulcrum consists of both a mobile application, which must be downloaded from the iOS or Google Play app stores, and a web platform (www.fulcrumapp.com). Each FAST member must install the Fulcrum app from the appropriate app store to access the StEER data collection forms. After data has been collected and synced to the web platform, the data can be viewed, enriched, and downloaded through the web interface. The StEER assessment forms available through the Fulcrum platform to all StEER members currently include the following:

1. **StEER Building - US (Windstorm):** This app focuses on characterizing the post-storm condition of buildings, including their structural systems and envelopes, following the impacts of windstorm-related hazards, including high winds, storm surge, rainwater ingress, and flooding.
2. **StEER Non-Building - US (Windstorm):** This app focuses on characterizing the post-storm condition of non-building structures such as bridges, dams, and power infrastructure following the impacts of windstorm-related hazards, including storm surge, high winds, and inland flooding.
3. **StEER Earthquake:** This app is based on the form developed by the Earthquake Engineering Research Institute (EERI) and provides a means of assessing the performance of buildings, bridges, and lifelines, as well as documenting associated non-structural characteristics such as liquefaction and fault ruptures.
4. **StEER Tsunami:** This app focuses on tsunami damage to coastal structures, facilities and infrastructure. It is also designed for recording runup and inundation elevation measurements.

These assessment forms are stored as separate apps within the overall Fulcrum app. Each app captures geotagged records consisting of individually geotagged photographs, audio recordings, and an assessment form focusing on buildings or non-building structures (e.g., power infrastructure, signs, dams). The assessment forms provide a standardized, comprehensive, step-by-step process for documenting the investigator, the date of the investigation, the location of the record, the specific assessment type being conducted, and the details of the individual assessment.

As a general rule, FAST members should not fill out all the fields in the assessment form while deployed, particularly for building assessments. Instead, they should focus on:

1. capturing clear photographs from multiple perspectives,
2. accurately geolocating the assessment,
3. filling out fields that typically require on-site forensic investigation,
4. noting any unusual or unique characteristics of the structure that would affect its performance under the given hazard.

Accessing StEER Apps within Fulcrum

Once the app is installed on your Apple or Android device, an investigator must login to their account to access the individual StEER apps as shown below in Figure 1 (login credentials were created in response to an email from Fulcrum. See **First Steps** section of this handbook).

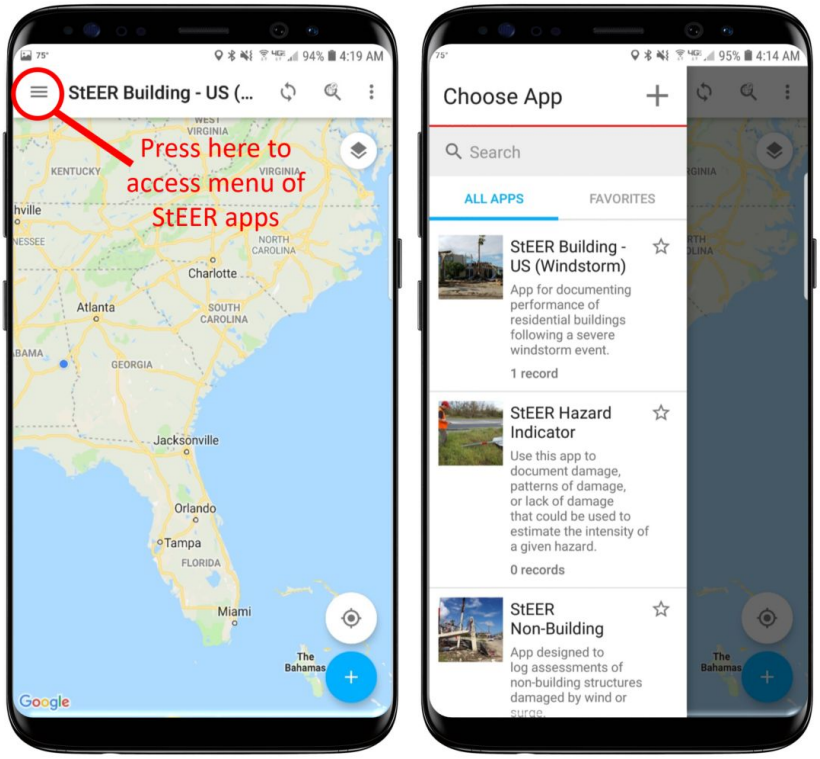


Figure 1. Accessing the StEER apps within the Fulcrum app.

Once logged in, users should configure their Fulcrum app settings as instructed in Table 1. These settings affect how and when data is synced from local storage on the smartphone to the cloud server, where it is then accessible through the web platform. If mobile connectivity is strong and the FAST member has a large or unlimited data allowance, records and photos can be synced in near real-time as records are created. Otherwise, records can be synced without the photos to conserve data but still allow team members to share in near real-time where assessments have been conducted. If no connectivity is present, all data is stored locally and

only synced once a reliable connection is obtained. Confirm these settings periodically or whenever network connectivity changes.

Table 1. Recommended Settings in Fulcrum for use by FAST Members

Network Connectivity	Strong		Limited
Mobile Data Access	Limited	Unlimited	Limited or Unlimited
Options and Recommended Settings			
Auto-Sync after Launch	On	On	On
Auto-Sync Record Edits	On	On	Off
Synchronize Photos	WiFi Only	Always	WiFi Only
Synchronize Videos	WiFi Only	WiFi Only	WiFi Only
Synchronize Audio	WiFi Only	WiFi Only	WiFi Only
Photo Quality	Native		
Save to Gallery	On		

Using the StEER Fulcrum Apps

Once an app has been selected and opened, it will show existing records (if present). There are two ways to view existing records: 1) in a list sorted by date updated or 2) in a map view showing the geolocated points. In either view, a new record is created by pressing the “+” icon, or by long-pressing on a location in the map view. Performing either of these two actions opens the assessment form.

The StEER Fulcrum apps are designed to provide a standardized, step-by-step process for capturing structural post-disaster data and metadata. Each app consists of a series of high-level sections and drill-down sections for detailed forensic assessments, with numeric, text, single-choice, multiple-choice fields and media attachments within each section. Throughout each app, guidelines and more information are provided by means of field titles and text labels above fields. The “More Information” icon has additional explanations and is provided with many of the fields (see Figure 2). Photographs can be captured in one of two ways:

1. Method 1: Press the camera icon within the Fulcrum app to activate the phone’s camera and take a photo while staying with the Fulcrum app.

2. Method 2: Upload a previously taken photograph to Fulcrum. Note that photos can only be uploaded one at a time.

Either method can be used and can be more efficient depending on the circumstances. Annotations can be made to the photographs if needed. Audio recordings follow a similar methodology for attachment.

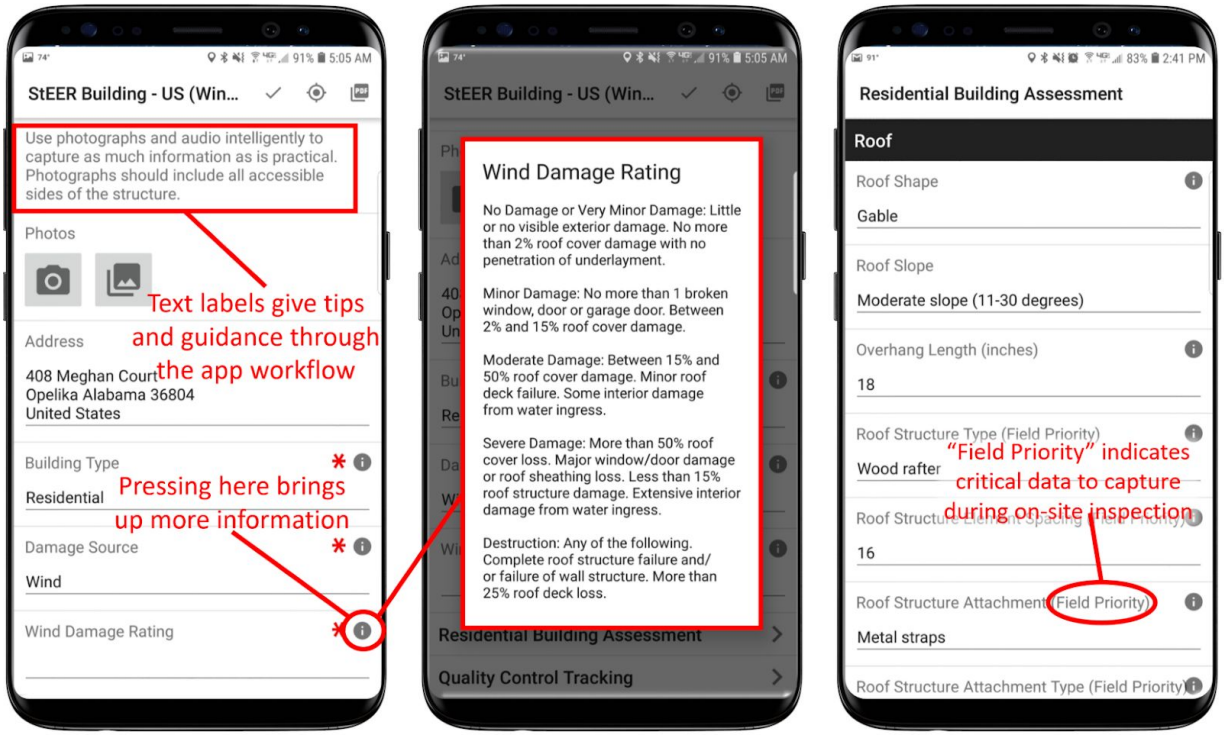


Figure 2. Examples of guidelines and tips provided within the app to guide the assessment workflow: (Left) text labels providing guidelines on what photographs to include in the assessment; (Middle) more information that can be accessed for a given field by clicking the "i" icon to the right of each field; (Right) certain fields are designated "Field Priority" to indicate they should be the focus of on-site assessments.

Throughout the various apps there are specific fields designated with **"Field Priority"** in their title (see Figure 2). These are fields that define critical information that typically requires on-site inspection, as opposed to information that can be readily defined by VAST members using the photographs attached to the record. The goal of this approach is to maximize the efficiency of the teams in the field. Outside of those designated "Field Priority," field investigators should rely upon their engineering judgment while on-site to complete as many assessment form fields as possible, but particularly focusing on the fields that will be difficult to define using only attached photographs or aerial imagery, if available. Each assessment typically requires a minimum of 10-15 minutes to complete, but will vary based on assessment objectives, damage levels, and access.

Geolocating Records

Records should always be geolocated so that they are centered on the object being assessed. This is accomplished by tapping the crosshairs icon while logging a new assessment or editing an existing assessment. Tapping the crosshairs icon brings up a map with a crosshair on it. Scroll the map until the crosshair is centered over the location of the object being assessed as shown in Figure 3. Correctly geolocating the record improves the accuracy of the built-in geocoding in Fulcrum (automatically converting GPS coordinates to a postal address), since geocoding is performed based on the location of the record. The geocoded address should be confirmed using any visible house numbers and street signs and corrected as needed.

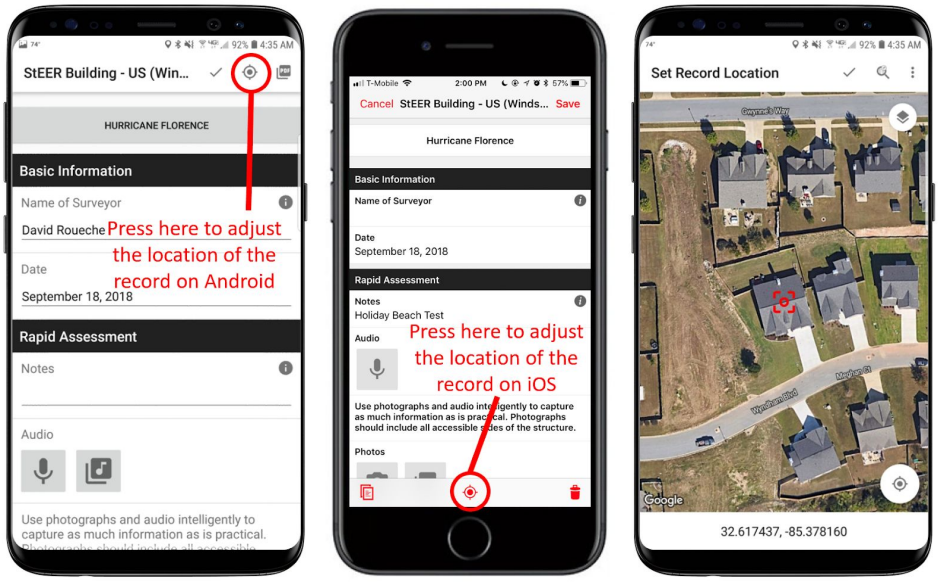
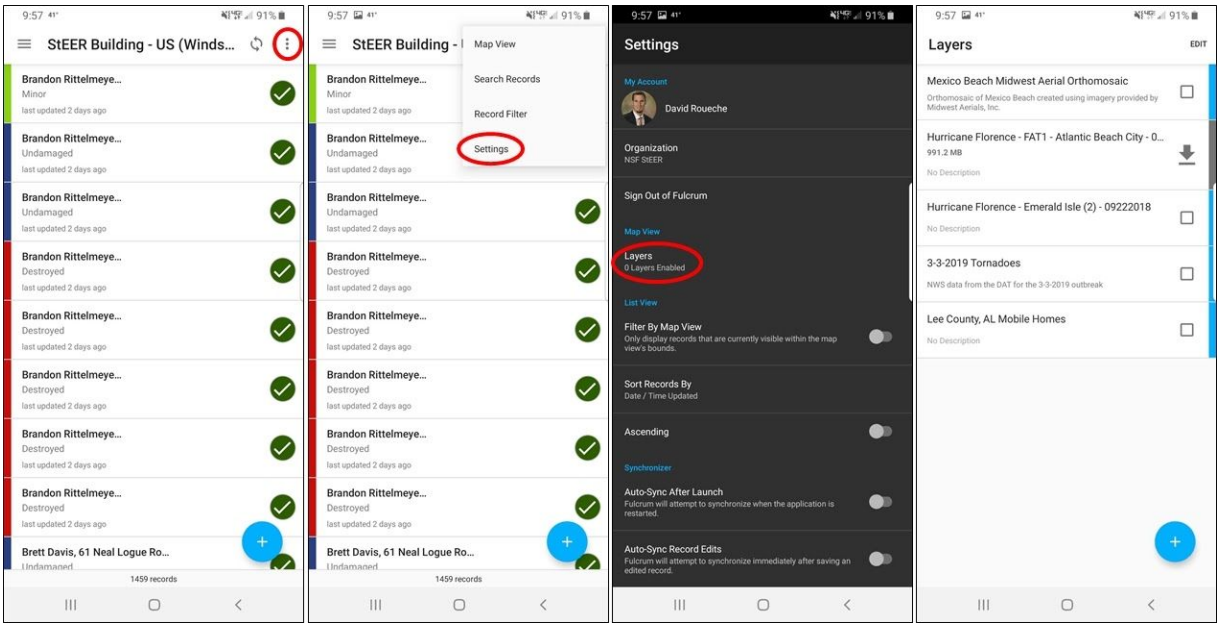


Figure 3. Manually set the record location when logging a new assessment using the crosshairs in Android (Left) or iOS (Middle) versions, centering the red marker (Right) on the building or other point of interest being assessed.

Adding Layers

Within the Fulcrum app, layers can be enabled to overlay external data sources such as aerial maps, polygons, or points. This process is illustrated for iOS and Android systems in Figure 4. StEER will use this feature to provide post-disaster layers such as detailed aerial imagery and parcel polygons indicating year built to FAST members for use in field deployments.

Android



iOS

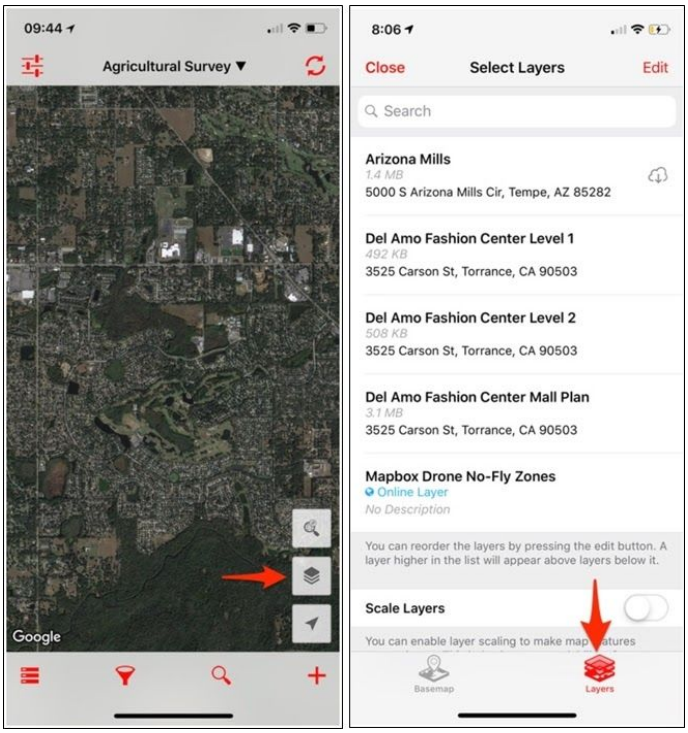


Figure 4. Views in Android (top) and iOS (bottom) for importing layers into the Fulcrum App.

StEER Building - US (Windstorm) App

The StEER Building - US (Windstorm) App is the primary app for assessing the performance of buildings in the US following windstorm-related events and their associated hazards: high winds, storm surge, water ingress, wind-borne and flood-borne debris, and tree-fall. The app consists of the following primary sections:

- **Basic Information.** This section contains the name of the investigator, the date of the assessment, and the assessment methodology.
- **Media Attachments.** This section provides a means for photographs and audio recordings to be attached to the geolocated record.
- **Overall Damage Assessment.** The overall damage to the structure is classified here. There is also a text box for free-form notes on the damage.
- **Building Attributes.** This section describes the basic attributes of the building, including building type, first floor elevation, year built, and orientation of the building.
- **Structural Attributes.** This section guides the assessor through defining the main wind force resisting system, the structural load path from roof to foundation, and fenestration characteristics.
- **Wind-induced Damage Levels.** Here the damage is quantified more precisely as damage ratios for seven building components: 1) roof cover (exposed, waterproofing layer of the roof), 2) roof substrate (roof sheathing or decking supporting the roof cover), 3) roof structure (structural roof members), 4) wall cladding (exterior facade), 5) wall substrate (sheathing or other elements supporting the wall cladding), 6) wall structure (structural wall members), and 7) fenestration (windows and doors).
- **Surge-induced Damage.** This section defines damage caused by storm surge, and is only applicable to windstorms with coastal hazards, such as buildings located near the shoreline in the case of a hurricane.
- **Building Retrofits.** This section allows the FAST or VAST member to document any known retrofits to the building that would affect its wind resistance.
- **Quality Control Tracking.** This section is dedicated to tracking the status and progress of the post-processing (data enrichment and quality control) of the field-collected data. This section is only used by VAST members after the field data has been collected and processed.

In total, there are 99 individual fields in the StEER Building - US (Windstorm) assessment form. It is generally not feasible, or possible, to define all 99 fields during the FAST deployment as many require supplemental data source (e.g., year built requires property assessor records, roof cover damage may require aerial imagery from before a protective tarp was installed). Instead, FAST members should focus on several key elements, designated as Field Priorities, along with clear, high quality photographs. These Field Priorities include the following:

- **Opening protection.** From post-windstorm photographs alone, it is often difficult to ascertain whether openings were protected or not during hurricanes. For example, wood

sheathing is often installed before a hurricane makes landfall to protect an opening from wind-borne debris, but is also used to cover breached openings after the storm. Wood sheathing protection may also have been removed after the threat passes. Impact resistant openings are also generally not possible to identify from photographs alone. Pressure ratings of large openings such as garage doors are also key details to obtain if possible. Taking a picture of any observed labels on windows, entry doors or garage doors will allow the VAST to follow-up to ascertain the proper classification. See **Appendix B: Identifying Opening Protection** for additional guidance.

- **Details of the structural load path.** Specific connection types, number of fasteners, material sizes, etc. are also typically not discernible from the photographs alone. Any observations that would help explain the performance of the structure should be documented in the assessment form either through predefined fields or the general notes sections.

Damage Ratings

The overall wind damage to a structure should be classified using the categories in Table 2. The damage descriptions for each category follow that of Vickery et al. (2006), summarized visually below. Note that a building is considered to be in the damage state if any of the shaded damage indicators in the corresponding row of Table 2 are present. These descriptions are primarily applicable to residential buildings, but the same guidelines can generally be applied to other building types. Surge/Flood overall damage ratings follow the criteria from Friedland and Levitan (2011) and are summarized in Table 3, while rainwater ingress damage is classified using the following general categories, described in Table 4, which assume access to the interior of the structure for a detailed forensic assessment. Even when access is not possible, debris piles in front of the structure can provide some evidence of water intrusion and should be noted in one of the free-form notes fields of the App, describing the volume and type of debris, along with photos of the debris pile. It should be noted that damage ratings currently adopted by StEER are taken from the literature/existing practice and a StEER Working Group is charged with improving upon these ratings and unifying a standard set of ratings for StEER.

Table 2. Wind damage states, primarily applicable to residential structures, from Vickery et al. (2006)

			Presence or Extent of Failure in:				
Damage State [1]	**Short Description**	**Illustrative Example**	**Roof or Wall cover**	**Window or door**	**Roof or Wall sub-strate**	**Roof struct.**	**Wall struct. [2]**
0 No damage or very minor damage	*No visible exterior damage*		0%	No	No	No	No
1 Minor damage	*Damage confined to envelope*		> 2% and ≤ 15%	1	No	No	No
2 Moderate damage	*Load path preserved, but significant repairs required*		> 15% and < 50%	> 1 and ≤ the larger of 3 and 20%	1 to 3 panels	No	No
3 Severe Damage	*Major impacts to structural load path*		> 50%	> the larger of 3 and 20% and ≤ 50%	> 3 and ≤ 25%	≤ 15%	No
4 Destroyed	*Total loss. Structural load path compromised beyond repair.*		> 50%	> 50%	> 25%	> 15%	Yes

Notes:
[1] A building is considered to be in the damage state if any of the shaded damage indicators in the corresponding row are observed.
[2] Wall structure refers to walls in living area only. The ground floor of elevated structures often have breakaway walls that can be easily damaged by storm surge. This damage should be ignored in assigning the overall damage rating.

Table 3. Surge/flood damage states and qualitative descriptions, from Friedland and Levitan (2011)

Damage State	Description
None or Very Minor Damage	No flood water impacts.
Minor Damage	Breakaway walls or appurtenant structures damaged or removed WITHOUT physical damage to remaining structure. No flood impacts to the building.
Moderate Damage	Some wall cladding damage from flood-borne debris. Breakaway walls or appurtenant structures damaged or removed WITH physical damage to remaining structures.
Severe Damage	Removal of cladding from "wash through" of surge without wall structural damage.
Very Severe Damage	Failure of wall frame, repairable structural damage to any portion of building, or < 25% of building plan area unrepairable.
Partial Collapse	House shifted off foundation, overall structure racking, > 25% of structure unrepairable
Collapse	Total structural failure (no intact structure).

Table 4. Rainwater ingress damage states and qualitative descriptions.

Damage State	Description
None visible	The interior is visible but no rainwater ingress is observed
Minor	Minor ingress through doors, windows, or isolated roof leaks
Moderate	Visible puddles of water or damaged contents around multiple doors and windows and multiple roof leaks leading to puddling or damage to contents
Severe	Severe inundation leading to partial collapse of roof ceiling, extensive puddling and interior contents loss
Complete	Complete inundation throughout the structure with majority of contents affected
Unknown	The interior is not visible

Additional Tips and Strategies

- Use text fields provided throughout the app to document other non-standard observations or findings as necessary.
- It is particularly helpful to identify some wall cladding types in the field, specifically vinyl siding and fiber cement lap siding. In photographs, these two systems can look the same, particularly when undamaged. See **Appendix C: High Wind-Rated Vinyl Siding vs. Standard Vinyl Siding** for additional guidance on classifying wall cladding types.
- Detailed assessments will typically be easier to perform on heavily damaged structures (since the structural system is more easily visible), but to avoid biased sampling, any detailed assessment of a heavily damaged building should be followed up by a detailed assessment, as best as possible, of a nearby building with less damage if present.
- When performing more detailed residential assessments, it may be most efficient to work in teams of two so that one person can focus on the assessment and the other on recording these observations within appropriate fields of the app.
- Photos attached to the records should be taken deliberately with a specific purpose for each one. At a minimum include all four elevation views of the structure (front, back and both sides), if visible/accessible. Include views of the roof as well, but depending on the height and slope of the roof, clear views may not be possible from the ground and roof damage may be underestimated. The use of a camera extension platform (e.g., “selfie stick”) may be beneficial to getting better views of roof damage or structural roof connections to alleviate this problem.
- Consider taking at least one upward angle photograph so that soffits can be properly identified. Document any soffit damage if present.

StEER Non-Building - US (Windstorm)

The StEER Non-Building App is designed to log assessments of non-building structures damaged by wind, storm surge, or other associated hazards. Because of the large number of structures and objects that fit within this category, the standard app fields for these assessments are generally more limited than those contained in the StEER Building - US (Windstorm) app. At present, this app contains the following sections:

- **Basic Information**, which includes the following:
    - Date the assessment was conducted
    - Assessment type
    - Damage state
    - Damage source (if damaged)
    - Option to upload geotagged photographs
    - Option to upload audio

- **Conditional sections for specific assessment types**. Depending on the type of assessment, sections conditionally appear below the Basic Information section for the following typologies:
    - General non-building
    - Power infrastructure
    - Bridges
    - Dams

  Each of the sections for specific assessment types contain fields to define the attributes of the structure or object being assessed, and fields to define the damage state, damage source, and damage frequency. If the structure or object being assessed does not fit into one of the pre-defined assessment types (power infrastructure, bridge or dam), there is a general section with open text fields to define the structure and any observed damage.
- **Quality Control Tracking.** This section is primarily used by the VAST members to track the progress of post-processing (data enrichment and quality control) of the data collected in the field.

StEER Earthquake

The current version of the StEER Earthquake app is based on the EERI Fulcrum app. StEER will be working with the community to further develop the earthquake assessment application as well as additional guidance, which will be released in subsequent updates to this handbook. At present the StEER Earthquake App includes the following primary sections:

- **User Information.** Describes the surveyor, including their name, affiliation, experience level and areas of expertise.
- **Basic Information.** Defines the record type, observation type, date and time of observation.
- **Detailed Information - Buildings.** Defines the location, structural load path, basic building attributes, and observed damage.
- **Detailed Information - Lifelines.** Defines the lifeline type, the source and extent of damage, and remaining functionality.
- **Detailed Information - Bridges.** Defines the physical characteristics, the location, presence of retrofits, extent and source of damage, and remaining functionality.
- **Detailed Information - Liquefaction.** Describes any observable liquefaction, including the dimensions of the affected area and other key features.
- **Detailed Information - Landslide.** Includes the landslide type and material, affected area and affected facilities.
- **Detailed Information - Fault Rupture.** Describes the rupture type and geometry.
- **Detailed Information - Tsunami.** Allows for description of wave arrival times, wave heights and presence of warnings.

StEER Tsunami

The StEER Tsunami app is still under development. This app and additional guidance will be released in subsequent versions of this handbook. Training opportunities will be announced once the app is completed.

REFERENCES

FEMA (2010) *Home Builder's Guide to Coastal Construction*, Technical Fact Sheet Series. FEMA P-499: https://www.fema.gov/media-library-data/20130726-1538-20490-2983/fema499web_2.pdf

Friedland, C. J., & Levitan, M. L. (2011). Development of a loss-consistent wind and flood damage scale for residential buildings. In *Solutions to Coastal Disasters 2011* (pp. 666-677).

Vickery, P.J., Skerlj, P.F., Lin, J., Twisdale Jr., L.A., Young, M.A., Lavelle, F.M. (2006) "HAZUS-MH Hurricane Model Methodology. II: Damage and Loss Estimation," *Natural Hazards Review,* 7(2): 94-103.

Appendix A: Checklist of FAST Resources

With the exception of the Badge, all of the items below can be found in the Resources folder of the StEER Member Shared Drive in Google. See the screenshot in Figure A.1 illustrating where your Shared Drives are displayed in Google.

Resource	Purpose	Usage
Access Letter	Standard letter of support to confirm affiliation and legitimacy of efforts	Customized and printed by each FAST member
Badge[1]	Identification badge for StEER Members	Customized, printed and laminated by each FAST member
Daily Summary	A standard daily report assembled by the FAST for rapid sharing of activities and observations.	Submitted by FAST daily (one per team per day)
FAA Request Form	Standard form for expedited SGI waiver or authorization for UAS operation.	Completed and submitted to FAA by FAST's licensed pilot in advance of UAV use
Field Journal	Template for recording individual notes and impressions (See Example)	Optional resource for individual FAST members
Pre-Deployment Briefing	Collection of relevant information including sampling targets and logistical details	Completed by StEER and shared with FAST prior to deployment
Packing List	Recommended inventory of items needed for field deployment	Optional resource for individual FAST members
Photo-Video Log	Metadata for photos or videos captured outside of Fulcrum	Used by individual FAST members ONLY when acquiring photo/videos outside of Fulcrum

[1] This resource cannot be accessed on the Google Drive since it is tied to your membership level. Please email admin@steer.network if you cannot locate your badge file.

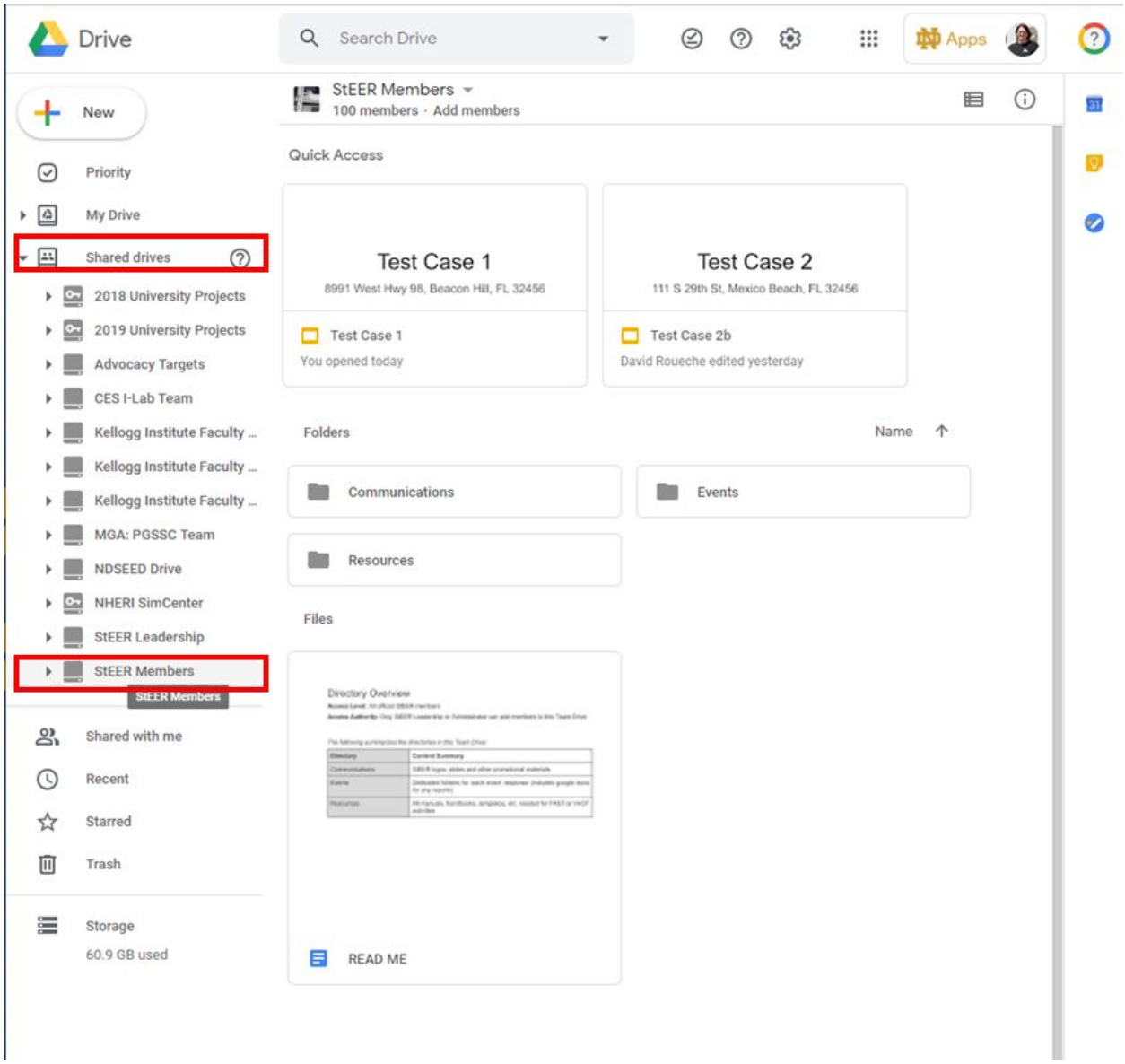


Figure A.1. Accessing StEER Members Shared Drive through the left hand menu of Google Drive.

Appendix B: Identifying Opening Protection

StEER assessments should include documentation of the level of opening protection whenever possible. Unfortunately, it is impossible to determine certain types of opening protection, particularly impact-resistant openings, from general photographs alone, so it is important to properly identify opening protection details during the on-site inspection. The following sections provide some tips and guidance for properly identifying opening protection in the field.

Impact-Resistant Openings

- Impact-resistant openings must have a certification label referencing the appropriate standards, which are typically ASTM E1886/E1996 or TAS 201/203. In windows this is typically a gold certification label provided in the frame head of the window. Examples are provided in Figure B.1.
- Impact-resistant openings typically use laminated or tempered glass, which is also required to have a permanent mark on the glass (typically in the corners or on the window label) indicating as such. Having laminated or tempered glass however does not necessarily indicate impact-resistant opening, as ASTM E1996 is for "whole product" qualification (glass and frame).

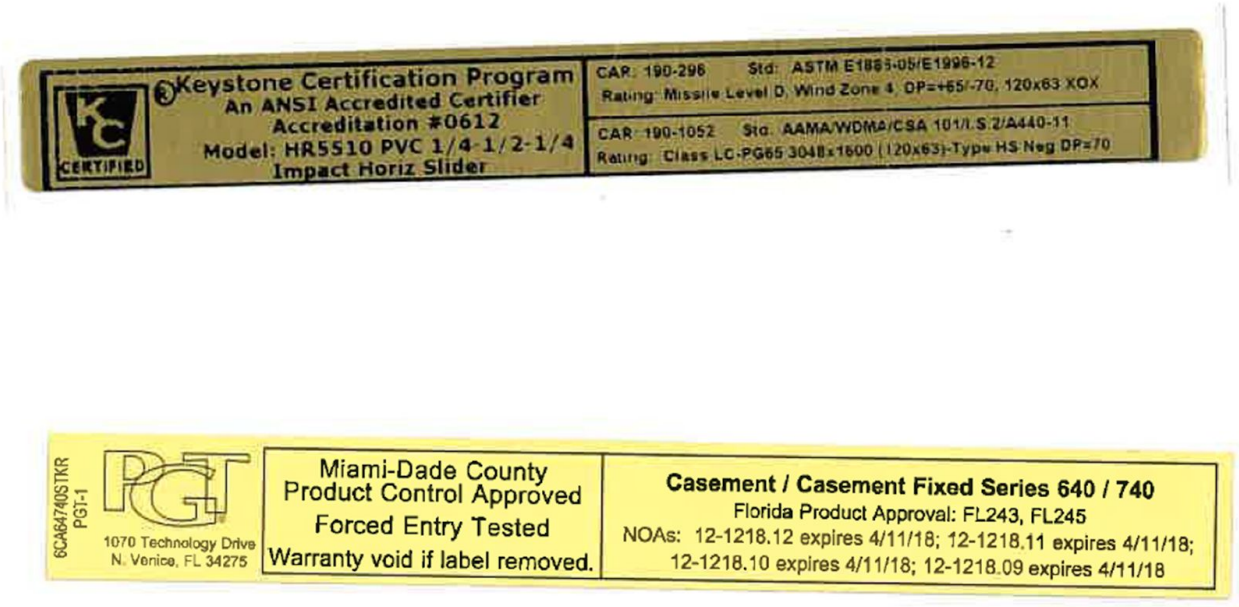


Figure B.1. Examples of labels indicating impact-resistant openings.

Panel Protected Openings

- The sooner an investigator arrives on site after a natural hazard event, the easier it is to assess opening protection.
- Panel-protected openings use plywood or OSB sheathing installed over the exterior of the window to protect against debris.
- From overall photographs alone it is sometimes not possible to evaluate whether a particular window was boarded up post-storm due to damage or protected pre-storm to protect against debris.
- The fastening pattern may be useful for properly identifying opening protection vs. covering post-storm damage. Noting how many nails/screws were used on a typical sheathing panel could help distinguish between these two possibilities.
- Damaged glass windows or doors may also have pieces of broken glass in front of or around the opening. These would be indications of panels installed post-storm and would be important to note during the on-site inspection.
- In addition to examining the context and evidence, talking to homeowners or other eye witnesses can be helpful in verifying if the openings were protected in advance of the storm.

Appendix C: High Wind-Rated Vinyl Siding vs. Standard Vinyl Siding

Cladding failures are common in high winds. It is important to try to identify whether the failed cladding products are high-wind rated or not. For example, high-wind vinyl siding will feature a double nailing hem and larger locking area, as shown in Figure C.1 from FEMA P-499. Properly identifying these features allows damage to be attributed to specific causes so that improvements, if needed, can be made.

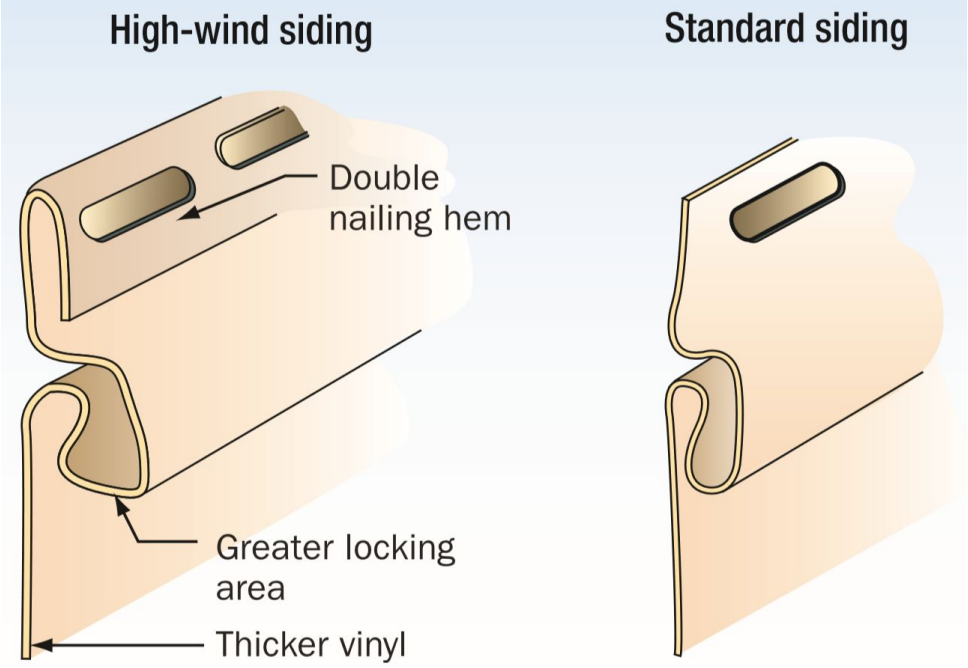


Figure C.1. Features of typical high-wind siding and standard siding (from FEMA P-499).