21-22 March 2022 Tornado Outbreak

21-22 March 2022
Released: 28 June 2022
DesignSafe Project ID: PRJ-3443

DATA REPORT

FAST Imagery: (from top left, clockwise) D2D assessment of a partially collapsed building at Arabi, LA by a FAST team member, namely, Alejandro Palacio-Betancur (yellow vest). A FAST group, namely, Garrett Demaree and Alejandro Palacio-Betancur are setting up a Surface-Level Panoramic Imaging device. FAST team members (namely, Sabarethinam Kameshwar and Guillermo Escoto) are reviewing D2D assessments in the Fulcrum app.

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Mariantonieta Gutierrez Soto, Penn State University (FAST-2)
Trung Do, University of Louisiana at Lafayette (FAST-3)
Sabarethinam Kameshwar, Louisiana State University (FAST-3)

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Garrett Demaree, University of Kentucky (FAST-2) Alejandro Palacio-Betancur, Penn State University (FAST-2) Guillermo Escoto, Louisiana State University (FAST-3) **Data Librarians** Morgan Aldridge (Auburn University) Hannah Bartels (Auburn University) Andrew Golson (Auburn University) Fox Harris (Auburn University) JD Holt (Auburn University) Cason Stevens (Auburn University)	Jordan Nakayama, Auburn University David Roegner, Univ. of Illinois at Urbana-Champaign
Mission Coordinator: Tracy Kijewski-Correa, University of Notre Dame	**DE/QC Coordinator:** David Roueche, Auburn University

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), Social Science Extreme Events Research (SSEER), and SUstainable Material Management Extreme Events Reconnaissance (SUMMEER) 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 Coastal Hazards, serving as a primary liaison to the coastal engineering community and ensuring a robust capacity for multi-hazard assessments.
- **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.

ATTRIBUTION GUIDANCE

Citing Images, Data or Data Derivatives from this Dataset

The use of images from this published data set and the use of these or any other data to conduct additional analyses or prepare various visualizations or data derivatives should use the full citation information and DOI from DesignSafe (these are available at https://www.steer.network/products).

ACKNOWLEDGMENTS

This material is based upon work supported by the National Science Foundation under Grant No. CMMI 2103550. 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. All authors and editors listed on the cover page participate as volunteer professionals. Thus, any opinions, findings, conclusions or recommendations expressed herein are those of the individual contributors and do not necessarily reflect the views of their employer or other institutions and organizations with which they affiliate.

The estimated path and intensity of the Arabi, LA tornado developed by the National Weather Service New Orleans Weather Forecast Office was invaluable in planning the response strategy and is gratefully acknowledged.

For a full listing of all StEER products (briefings, reports and datasets) please visit the StEER website: https://www.steer.network/products

TABLE OF CONTENTS

1.0 Event Summary and Team Configuration

A tornado outbreak between 21-22 March 2022 spawned tornadoes across Texas, Louisiana, Mississippi, Alabama, and Florida. While the number of tornadoes and their intensity was not at the level of other historical outbreaks, extensive damage and loss of life still occurred, which is a stark reminder of the need for tornado-resilient communities. In particular, two tornadoes - one that struck Jacksboro, TX on 21-March, and a second that struck Arabi, LA, part of the New Orleans metro on 22-March - were worthy of further study given the initial damage reported, due to the impacts to a school in the first tornado, and the impacts to post-ICC homes in a hurricane-prone region in the second tornado.

Event Briefing	https://doi.org/10.17603/ds2-9xvm-6667

In response to the outbreak, StEER member Doug Allen (FAST-1) conducted D2D performance assessments in Jacksboro, TX, which was struck by an EF3 tornado on 25 March 2022. Two teams of StEER members (FAST-2 and FAST-3) visited Arabi, LA, impacted by an EF3 tornado event, to assess the performance of buildings (i.e., Surface-Level Panoramic Imaging and D2D assessment) impacted by the tornado, while a collaborating team, not funded by StEER, also deployed to Arabi, LA and shared the collected data with StEER, i.e., D2D assessments, Forensic Load Path Assessments, Hazard Indicators Assessments, and collecting panoramas and imagery using Unmanned Aerial Systems (UAS). The majority of the damage in Arabi was sustained by single-family one and two-story residential wood buildings built after Hurricane Katrina (2005).

Table 1.1: Field Assessment Structural Team Members .

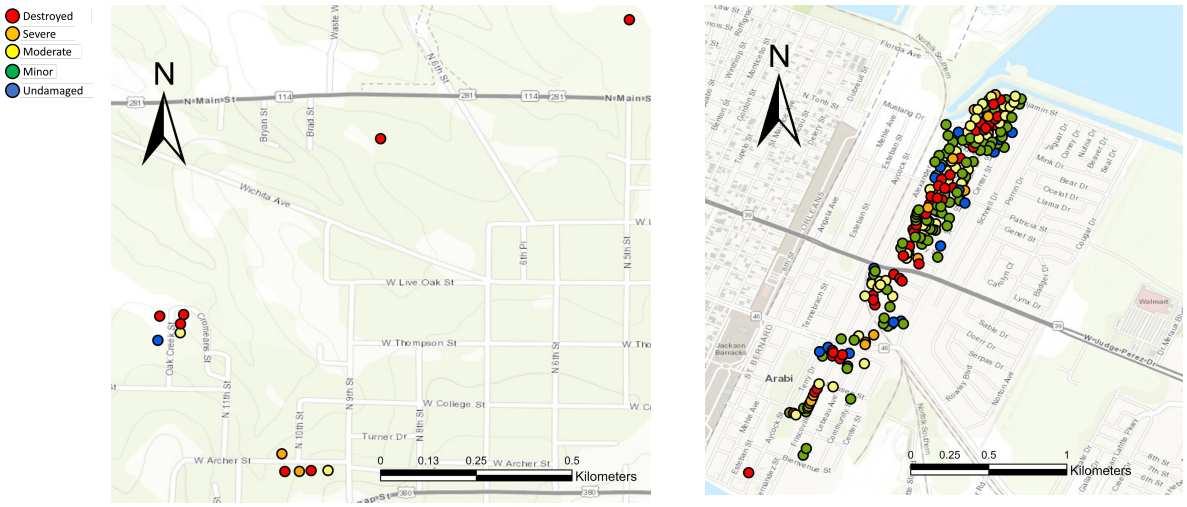
Team Member	Affiliation	PA	SLP	UAS	HIA
FAST-1: 25 March 2022					
Doug Allen	Simpson Strong-Tie	●			
FAST-2: 26 and 27 March 2022					
Mariantonieta Gutierrez Soto	Penn State University	●			
Garrett Demaree*	University of Kentucky	●	●		
Alejandro Palacio-Betancur*	Penn State University	●	●		
FAST-3: 28 and 31 March 2022					
Trung Do	University of Louisiana at Lafayette	●			

Sabarethinam Kameshwar	Louisiana State University	●			
Guillermo Escoto*	Louisiana State University	●			
External Collaborators: 28 and 29 March 2022					
David Roueche	Auburn University	●		●	
Guangzhao Chen*	Univ. of Illinois at Urbana-Champaign	●		●	●
Daphne LaDue	University of Oklahoma	●			
Frank Lombardo	Univ. of Illinois at Urbana-Champaign	●			●
Jordan Nakayama*	Auburn University	●		●	
David Roegner*	Univ. of Illinois at Urbana-Champaign	●		●	●
Amir Safiey	Auburn University	●			
* denotes a student research assistant					

Table 1.2: Data Librarians		
Name	**Affiliation**	**QC ID**
Hannah Bartels	Auburn University	HBD
Andrew Golson	Auburn University	AG
Morgan Aldridge	Auburn University	MA
Fox Harris	Auburn University	FA
JD Holt	Auburn University	JDH

2.0 Data Collection Methodology

FAST-1 conducted a limited set of performance assessments in Jacksboro, TX on March 25, 2022, approximately 4 days after the tornado occurred. The impacts of the tornado that struck Arabi, LA were assessed by three separate teams (i.e., FAST-2, FAST-3, and Collaborators) through D2D assessments, Forensic Load Path Assessments, Hazard Indicators Assessments, Surface-Level Panoramic Imaging, and collecting panoramas and imagery using UAS. The majority of the damage in Arabi was sustained by single-family one and two-story residential wood buildings built after Hurricane Katrina (2005). In addition,. Figure 2.1 provides an overview of the regions sampled by the three field teams.



(a) (b)

Figure 2.1. A visual summary of surveyed communities (a) Jacksboro, TX; and (b) Arabi, LA.

2.1 Door-to-Door (D2D) Performance Assessments

IMPLEMENTATION: FAST-1, FAST-2, FAST-3, and External Collaborators
PUBLIC ACCESS POINT: DesignSafe-CI

Performance assessments in Jacksboro, TX, and Arabi, LA were documented using the Fulcrum mobile app: *StEER Building - US (Windstorm),* which focuses on primary structural typologies and component types, construction materials, and damage levels. These assessments, including adopted damage ratings, followed the *StEER Field Assessment Structural Team (FAST) Handbook* (2019) available at https://www.steer.network/resources. Appendix A lists the fields acquired by this Fulcrum Application.

2.2 Surface-Level Panoramic Imaging

IMPLEMENTATION: FAST-2
PUBLIC ACCESS POINT: DesignSafe-CI, Mapillary

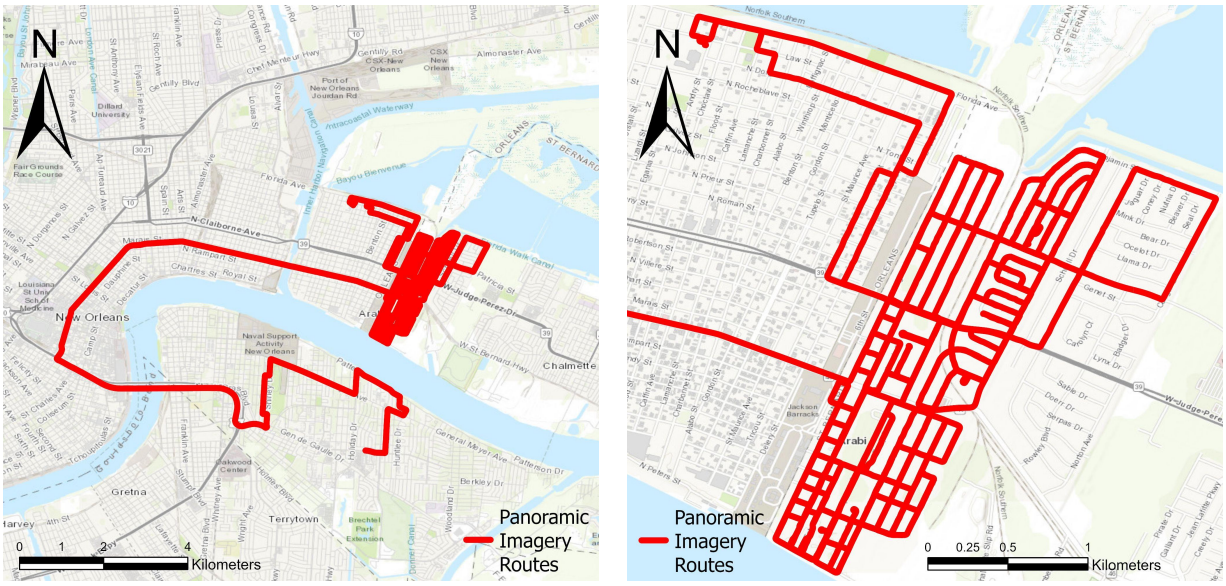
FAST-2 employed an NCTech iStar Pulsar system leased from the RAPID EF facility. The system consists of four cameras mounted together to capture a 360 x 145 degree field of view. Each camera has a resolution of 12.3 MP, a sensor size of 3042x4062, and uses fisheye lenses with a fixed focus and aperture size of f/2.6. GNSS-tracking via a U-BLOX Neo M8N receiver geotagged each image location with ~2.5 m accuracy. Frames were captured every 4 m along the routes driven, capturing near-continuous coverage of exterior building performance.

Collectively, FAST-2 cataloged just over 79 km of imagery as summarized in Table 2.1 and mapped in Figure 2.2. The images collected from the system were stitched together into 19,855 seamless 360 degree panoramas at 4 m spacing. The panoramas are available on DesignSafe under this project (PRJ-3443), and are also now available publicly via Mapillary platforms (Mapillary.com).

Table 2.1. Summary of surface-level panorama data collections

Team	Date	Number of Routes	Total Length (km)	Approximate Panoramas Count*
FAST-2	3/25/2022	9	47.6	11,900
FAST-2	3/26/2022	9	31.8	7,950
	Total	**18**	**79.4**	

* Approximate panoramas count based on 4 m capture interval



(a) (b)

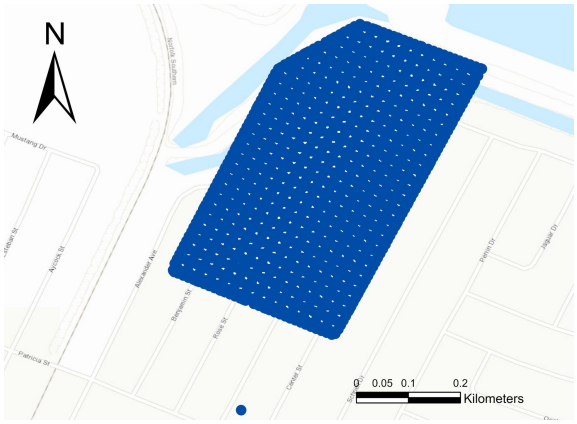
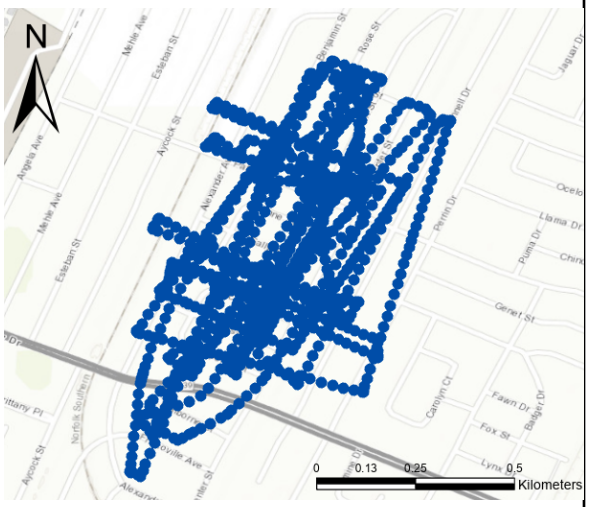
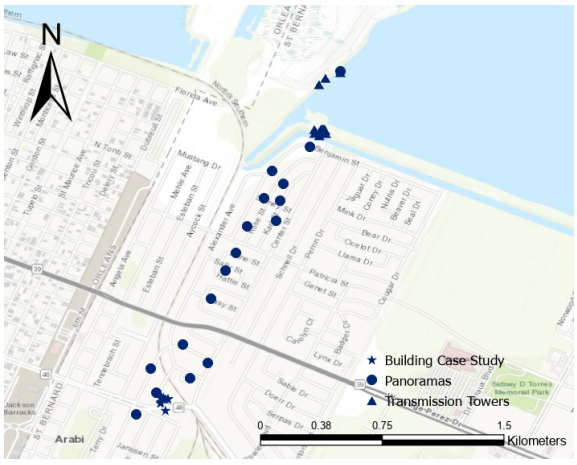
Figure 2.2. Surface-level panoramic imagery routes related to preliminary 21-23 March 2022 Tornado Outbreak track in Arabi, LA (a) overview of routes; and (b) zoomed-in view of Arabi, LA.

2.3 Unmanned Aerial Systems

IMPLEMENTATION: External Collaborators
PUBLIC ACCESS POINT: DesignSafe-CI

External collaborators used UAS to capture aerial views along the tornado path through Arabi, LA. The collections included aerial photographs suitable for reconstruction of orthomosaics and 3D point clouds, in addition to sixteen panoramas, as documented in Table 2.2. Appendix C includes estimated flight altitudes, resulting ground sampling distance (GSD), and other flight metadata. All images are JPG formatted and include required data such as GPS coordinates embedded in the image EXIF for future processing.

Table 2.2: Geospatial summary of the UAS missions.

Flight Name	Flight Type	Number of Photos	Map
20220328_Arabi North	Double Grid, Automated	1782	
20220328_Arabi South	Free-Flight	1322	
20220328_Arabi_Building Case Study, 20220328_Arabi_Panoramas, and 20220328_Arabi_Transmission	Panorama and Free-Flight Image	14, 26, and 22	

2.4 Hazard Indicators

IMPLEMENTATION: External Collaborators
PUBLIC ACCESS POINT: DesignSafe-CI

Select hazard indicators are considered and recorded by taking pictures and providing a short description of the indicator. Hazard indicators are: anchor bolt, sign pole, felled or snapped trees, fence posts, rebar, and light poles.. For failed hazard indicators, the direction of failure (if known) is recorded using meteorological convention (0 degrees pointing south, 90 degrees pointing west). Further, the Enhanced Fujita Scale method (McDonald et al. 2012) is performed for select buildings, including assignment of the Damage Indicator class, the Degree of Damage, and the estimated wind speed.

2.5 Other Ground-Based Observations

IMPLEMENTATION: FAST-3 and External Collaborators
PUBLIC ACCESS POINT: DesignSafe-CI

While on-site, investigators also acquired photos/videos on their personal mobile devices or DLSR cameras outside of Fulcrum. These media typically captured broader views of the impacted areas, or captured team members in action. The model of DSLR cameras used include 1) CANON EOS 80D with 18-135mm f/0 lens, and 2) NIKON D5300 with 18-55mm f/3.5-5.6 lens.

3.0 Chronology and Geospatial Distribution of Data Collection

The approximate chronology and geospatial coverage of the FAST are summarized in Table 3.1.

Table 3.1: FAST and External Collaborators (EC) Daily Data Collection Activities

Date	Geography	Teams	Technology				
			D2D	UAS	SLP	FLPA	HIA
25 March 2022	Jacksboro, TX, Arabi, LA	FAST-1, FAST-2	●		●		
26 March 2022	Areas in both north and south Arabi, LA	FAST-2	●		●		
27 March 2022	Areas in north Arabi, LA	FAST-2	●		●		
28 March 2022	Areas in both north and south Arabi, LA	EC	●	●		●	●
29 March 2022	Areas in both north and south Arabi, LA	FAST-3, EC	●			●	●
31 March 2022	Areas in both north and south Arabi, LA	FAST-3	●				

4.0 Data Processing

4.1 Door-to-Door (D2D) Performance Assessments

Each record in the Fulcrum database underwent StEER's Data Enrichment/Quality Control (DE/QC) process outlined in *Virtual Assessment Structural Team (VAST) Handbook: Data Enrichment and Quality Control (DE/QC) for US Windstorms* (2019). Records were updated by the Data Librarians denoted in Table 1.2 and were immediately available within the Fulcrum Community portal at each stage of the DE/QC Process. As each record completed one of these stages, the code is updated within the record. A QC notes field is also provided for the Data Librarian to include any relevant information regarding changes made to the record in the process.

For all data captured by *StEER Building - US (Windstorm)* app**,** the StEER DE/QC process was executed at a minimum to Stage 2 for all individual records (N=222), meaning basic attributes such as location, building type, damage ratings, and number of stories were assessed with reasonable confidence. Where insufficient information was available to have a reasonable degree of confidence in the Stage 2 fields, a Stage 2e code is used to warn potential users of the data that the information therein may be more incomplete or uncertain than typical records. Where high quality data was available for a given record, typically through overlapping data sources (e.g., audio recordings, on-site photographs, aerial imagery, and/or surface-level panoramas), Stage 3 was executed, which includes more fine details of the building attributes, structural load path, and component-level damage assessments. Table 4.1 summarizes the number of records for which each Stage was executed. Once each record was advanced to its final Stage in the DE/QC process, the final database was downloaded from Fulcrum for curation in DesignSafe in XLSX and GeoJSON formats.

For the majority of assessments, at least two data librarians participated in the DE/QC process of each record separately to help catch errors and reduce uncertainties. In addition, the entire dataset underwent a number of macro-level QC checks to identify potential errors, such as filtering the dataset for blank entries in the number of stories, searching for invalid field entries (e.g., 72 was entered for first floor elevation (ft) due to unit error), and more. Despite the best efforts of the data librarians, there are likely to be small errors in a few records, and there is also uncertainty present due to incomplete data and/or use of engineering judgment. Despite these, additional QC should not be necessary for most research applications, but may be warranted for any analysis particularly sensitive to errors and uncertainties. Consumers of the data are encouraged to conduct additional stages in the DE/QC process in accordance with StEER's *Virtual Assessment Structural Team (VAST) Handbook: Data Enrichment and Quality Control (DE/QC) for US Windstorms* (2019) available at https://www.steer.network/resources.

The PA dataset includes both photos taken within the Fulcrum app and photos taken using DSLR cameras by collaborators Roueche and Safiey. The DSLR photos were organized by postal address and geolocation, then added to the appropriate record in the PA dataset as an additional Detailed Photograph (column header = detailed_photos).

Table 4.1: Breakdown of records by DE/QC stage executed

Stage	Brief Description	Number of Records
1	The location of the record has been verified and existing attributes QC'd, but the record is unsuitable for further enhancement. This field is generally reserved for general area assessments that are not specific to a single building or structure.	**0**
2	The minimum information required for a completed assessment has been verified or added. For example, the correct building type is assigned, overall damage ratings are confirmed to be in agreement with the quantitative guidelines, and basic building attributes, e.g., number of stories, are identified.	**11**
2e	There is insufficient information to meet the minimum data standards for a complete assessment, or there is considerable uncertainty in assignment of one or more critical fields. If a record is at 2e, it may not be possible or worthwhile to advance into additional stages and caution should be used in conducting analysis that includes this data.	**2**
3	The majority of fields up through Stage 3, as described in the DE/QC handbook, have been completed and validated with reasonable confidence in accuracy and precision.	**205**
3e	Some or all Stage 3 fields have been completed, but lack of data (e.g., only 2 sides of the structure are visible) or other circumstances adds high levels of uncertainty.	**4**

4.2 Street-Level Panoramic Imaging

Individual images from the panoramic imaging platforms were processed into seamless panoramas using the NCTech Immersive Studio software for FAST-2. Panoramas were stitched and output at 4m intervals. No objects in the images were blurred during processing. All panoramas were uploaded to the Mapillary platform under the username **steer360network** using the Mapillary command line executable and custom MATLAB scripts. The final resolution of the processed panoramas is 11000 x 5500 pixels.

4.3 Unmanned Aerial Systems

In cases where imagery from a UAS was acquired sufficient to generate other data products, the geolocated dataset is ingested into a standard UAS-compatible photogrammetry desktop application, in this case with Pix4DMapper (Arabi North dataset) and ArcGIS Pro Drone2Map (an ESRI wrapper for the Pix4D photogrammetry engine) software (Arabi South dataset), which:

1. Checks the photo dataset for its integrity and positional accuracy based on the geolocation coordinated in the metadata of each image.
2. Establishes desired coordinate system (i.e., WGS 1984 or others) and units of measurement.

3. Establishes options for processing quality, processing speed, data outputs, and other related parameters.
4. Generates data outputs consisting of point clouds, 3D models, Digital Elevation Models, and Orthomosaics using proprietary Structure-from-Motion algorithms.

Resulting data products can be ingested into a variety of proprietary and non-proprietary software, including Potree (available through DesignSafe Workspace) for points clouds and QGIS (also available through DesignSafe Workspace) for Digital Elevation Models and Orthomosaics. Area, Linear, and Volumetric measurements can also be generated from the point cloud.

The 20220322_ArabiLA_North project outputs consisted of a high-resolution orthomosaic, Digital Surface Model, 3D point cloud, and meshed model. The 20220322_ArabiLA_South project outputs consisted only of a high-resolution orthomosaic and Digital Surface Model.

4.5 Hazard Indicators

Hazard indicators are classified and the associated observations are summarized in an Excel sheet including the corresponding geo-coordination and linked to an image number. Geotagged photographs associated with the hazard indicators are also included in the dataset. For the Degrees of Damage based on the Enhanced Fujita Scale (McDonald et al. 2012), estimated wind speeds were added using the expected wind speed for each Degree of Damage.

4.6 Other Ground-Based Observations

Media acquired outside of Fulcrum was reviewed to remove poor quality, redundant, ambiguous or irrelevant photos/videos. did not include a geo-tag. GPS coordinates can be extracted from the metadata of each geotagged photo and are also available in a CSV file.

5.0 Archived Data Products

This section details the directory structure created in DesignSafe-CI and the contents therein.

□ Directory D0. Planning Documents

FORMATS = PDF

Pre-deployment briefing used to plan the mission and data collection strategy.

□ Directory D1. Structural Assessments

FORMATS = XLSX, JPG, GEOJSON

This directory contains the final enriched and quality controlled dataset (as XLSX and GeoJSON) with all the response fields in Appendix A. Not all response fields have values, for reasons described in Section 4.1. Each media file (e.g., photograph, audio file in “Media Files” folder) is linked to a specific record by a unique alpha-numeric string. This unique string is both the filename of the media file, and also listed in the corresponding data field (e.g., overall_photos, detailed_photos, audio) for the record it is associated with in the XLSX or

GeoJSON database. The folder also contains the database of “No Damage” points (as XLSX and GeoJSON). The folder also contains a photo log containing all available photo metadata for each photograph associated with a record.

□ Directory D2. Surface Level Panoramas

FORMATS = JPG, CSV, GEOJSON, KML, TXT

This directory contains subfolders for **Processed** and **Raw** data and a GEOJSON containing all SLP routes. The **Raw** folders contain subfolders for each route (the name of which corresponds to a polyline in the route GEOJSON file), which in turn contain the raw .mkv files from each of the four camera sensors of the Pulsar along with timestamp files, GPS metadata, and Inertial Measurement Unit (IMU) data files as delimited text files. These data files can be used to stitch new 360 panoramas, if needed, using the Immersive Studio software from NCTech. The **Processed** folder contains output folders for each route, with the name of each folder corresponding to a route in the GEOJSON. Each output folder contains the 360 panoramas as geotagged .jpg files.

□ Directory D3. Unmanned Aerial Systems

FORMATS = JPG, .TIFF, .TFW, .OBJ, .LAS, .P4D, .D2MX

This directory contains files organized in two folders called Raw and Processed. Within each of these two directories are two subdirectories defining different locations where UAS data was acquired, with the following naming convention for north Arabi, LA: YYMMDD_Locale where YY=year, MM=month, DD=day, and Locale=shorthand for location where data was captured. The following naming convention is used for south Arabi, LA: UIUC_YYMMDD_Locale where YY=year, MM=month, DD=day, and Locale=shorthand for location where data was captured. The Raw folder contains the raw images (.JPG) acquired at each site. The Processed folder contains the processed photogrammetric data products. These include:

- .P4D executable (Pix4D Mapper software) or .D2MX (ESRI Drone2Map software) executable
- Data products including point clouds (.LAS), orthomosaics and Digital Elevation Model (.TIFF with associated .TFW providing georeferencing details)
- Various supporting files, logs and reports documenting the data processing

□ Directory D4. Other Ground Imagery

FORMAT = JPG

This directory contains additional photos captured by investigators outside of Fulcrum. **Structural Assessments** contain photographs (.JPG) capturing damage to buildings or other structures. **Team Members** contains photographs (.JPG) of various team members in action. A photolog of containing the metadata for each photograph is also included.

□ Directory D6. Hazard Indicators

FORMAT = XLSX, JPG

This directory contains three Excel worksheets and two folders of photographs summarizing hazard indicators. “EF Scale DoD Descriptions.xlsx” provides the location, associated image number (.JPG) in the **EF Scale - Degrees of Damage** subdirectory, Latitude and Longitude, DOD, house number and street name (if applicable), HAZUS Damage Rating, and short description. The “EF Scale DoD Summary.xlsx” file contains the final Latitude, Longitude,

Building Number (linking to the EF Scale - Degrees of Damage.xlsx sheet), DI, DOD, EXP Wind Speed (mph), HAZUS Damage Rating, and Address. DI = Damage Indicator, DOD = Degree of Damage, and EXP Wind Speed = Expected Wind Speed, all of which refer back to the Enhanced Fujita Scale.

The “Wind Indicators Description.xlsx” file contains the Image Number (linking to the **Wind Indicators** subdirectory), Indicator Types (anchor bolt, rebar, sign pole, etc), Latitude, Longitude, Direction (meteorological convention), and Description.

□ Directory D7. Daily Summaries - StEER

FORMAT = PDF

This directory contains PDF files presenting daily summaries prepared by FAST-2 and FAST-3 using the StEER standard format.

6.0 Contacts

For inquiries on specific sets of data, please contact the following individuals:

Hazard Indicators	**D2D Structural Assessments**
Frank Lombardo lombaf@illinois.edu	David Roueche dbr0011@auburn.edu
360 Imagery	**UAS Assessments**
Mariantonieta Gutierrez Soto mvg5899@psu.edu	David Roueche dbr0011@auburn.edu
General Inquiries	
Tracy Kijewski-Correa tkijewsk@nd.edu	

7.0 References

McDonald, J. R., K. C. Mehta, D. A. Smith, and J. A. Womble. 2012. “The Enhanced Fujita Scale: Development and Implementation.” Forensic Engineering 2009: Pathology of the Built Environment, 719–728. Washington, D.C.: ASCE.

Roueche, D. Bagheri Jeddi, A. Do, T. Prevatt, D. Alam, M. (2022) "Texas and Louisiana March 2022 Tornado Outbreak Event Briefing", in StEER - 21-22 March 2022 Tornado Outbreak. DesignSafe-CI. https://doi.org/10.17603/ds2-9xvm-6667.

Kijewski-Correa, T., Roueche, D., Mosalam, K., Prevatt, D., Robertson, I. (2019) “Field Assessment Structural Team (FAST) Handbook,” Version 1.0 (available at www.steer.network/resources)

Roueche, D., Kijewski-Correa, T., Mosalam, K., Prevatt, D., Robertson, I. (2019) “StEER: Virtual Assessment Structural Team (VAST) Handbook: Data Enrichment and Quality Control (DEQC) for US Windstorms,” Version 1.0 (available at www.steer.network/resources)

Appendix A. Buildings - Windstorm App Fields

Column		Column Header	Field	Format	Response Choices/ Description	Percent Filled
1	A	fulcrum_id	Record ID	Text	Auto-populated	100%
2	B	status	Damage State	Single Choice	0=No Damage 1=Minor 2=Moderate 3=Severe 4=Destroyed	100%
3	C	project	Project	Text	<Auto-populated list of all StEER Projects in Fulcrum>	100%
4	D	latitude	Latitude	Decimal	Auto-populated	100%
5	E	longitude	Longitude	Decimal	Auto-populated	100%
6	F	name_of_investigator	Name of Investigator	Text	user-supplied name of investigator	100%
7	G	date	Date	MM/DD/YYYY	Auto-populated	100%
8	H	general_notes	General Notes	Text	user-supplied general notes	24%
9	I	assessment_type	Assessment Type	Single Choice	Aerial Drive-by On-site Remote General Area Other	100%

10	J	sampling_method	Sampling Method	Classification Field	Biased - Damaged Structure Biased - Unique failure Biased - Case study Biased - Other Unbiased - Random Sample Unbiased - Within a Cluster Unbiased - Critical Facility Unbiased - Unique Structure Unbiased - Other	100%
11	K	elevations_assessed	Elevations Assessed	Multiple Choice	All Left Right Front Back Roof	78%
12	L	overall_photos_front_left_right_back	Overall Photos (Front, Left, Right, Back)	Photos	user-supplied photos	99%
13	M	overall_photos_front_left_right_back_caption	Overall Photos Captions	Text	User-supplied photo captions	0%
14	N	overall_photos_front_left_right_back_url	Direct Path to Photo Hosted on Fulcrum	URL	Auto-populated	99%
15	O	detailed_photos	Detailed Photos	Photos	user-supplied photos	46%
16	P	detailed_photos_caption	Detailed Photos Captions	Text	User-supplied photo captions	0%
17	Q	detailed_photos_url	Direct Path to Photo Hosted on Fulcrum	URL	Auto-populated	43%

18	R	audio	Audio	Audio	user-supplied audio	1%
19	S	audio_caption	Audio Captions	Text	User-supplied audio captions	0%
20	T	audio_url	Direct Path to Fulcrum Entry	URL	Auto-populated	1%
21	U	overall_damage_notes	Overall Damage Notes	Text	user-supplied damage notes	29%
22	V	hazards_present	Hazards Present	Multiple Choice	Flood Rain Surge Tree-fall Wind Wind-borne debris Unknown Other	100%
23	W	wind_damage_rating	Wind Damage Rating	Single Choice	-1=Not Applicable 0=No Damage 1=Minor 2=Moderate 3=Severe 4=Destroyed	100%
24	X	surge_damage_rating	Surge Damage Rating	Single Choice	0=No Damage or Very Minor Damage 1=Minor 2=Moderate 3=Severe 4=Very Severe 5=Partial Collapse 6=Collapse	0%
25	Y	rainwater_ingress_damage_rating	Rainwater Ingress Damage Rating	Single Choice	-1=Unknown 0=None Visible 1=Minor Ingress 2=Moderate 3=Severe 4=Destroyed	0%

26	Z	damage_indicator	Damage Indicator	Numeric	User-supplied value defining the type of structure,relating to the Enhanced Fujita Scale (primarily used for tornadoes)	0%
27	AA	degree_of_damage	Degree of Damage	Numeric	User-supplied value defining an overall damage state, relating to the Enhanced Fujita Scale (primarily used for tornadoes).	0%
28	AB	attribute_notes	Attribute Notes	Text	User-supplied attribute notes	3%
29	AC	address_sub_thoroughfare	House Number	Text	House number supplied by user	100%
30	AD	address_thoroughfare	Street Name	Text	Street name supplied by user	100%
31	AE	address_suite	Suite Number	Text	Suite number supplied by user	0%
32	AF	address_locality	City/Town	Text	City or town supplied by user	100%
33	AG	address_sub_admin_area	County	Text	County supplied by user	100%
34	AH	address_admin_area	State	Text	State supplied by user	100%
35	AI	address_postal_code	Zip Code	Text	Zip code supplied by user	100%
36	AJ	address_country	Country	Text	County supplied by user	100%
37	AK	address_full	Full Address	Text	<Auto-populated by Fulcrum>	100%

38	AL	occupancy	Occupancy	Single Choice	Assembly-Small building and tenant spaces Assembly-Theater Assembly-Restaurant Assembly-Religious facility Assembly-Indoor sports facility Assembly-Outdoors sports facility Assembly-Other Business Educational-School Educational-Daycare facilities Educational-University/ College Educational-Other Factory and industrial-Industrial Factory and Industrial-Factory Factory and Industrial Other High-hazard-Hazardous materials storage High-hazard-Contains detonation hazard High-hazard-Contains deflagration hazard High-hazard-Contains materials that are health hazard High-hazard-Semiconductor fabrication facilities High-hazard-Contains materials posing multiple hazards High-hazard-Other Institutional-Assisted living facilities %Institutional-Alcohol an%d drug rehabilitation Institutional-Medical Care on a 24-hours basis (Hospital/psychiatric hospital) Institutional-Correctional	100%

					centers/jails/prisons/etc Institutional-Other Mercantile-Department al stores Mercantile-Drug stores Mercantile-Gas/service station Mercantile-Retail or wholesale stores Mercantile-sales room Mercantile-Other Residential-Single family Residential-Multi-family homes (duplex, triplex, townhome) Residential-Mobile/Man ufactured homes Residential-Apartment houses/dormitories/frat ernities and sororities Residential-Hotel/motel/ boarding houses/congregate living facilities Residential-Other Storage-Moderate-haza rd storage Storage-Low-hazard storage Storage-Other Utilities and miscellaneous-Agricultu ral building Utilities and miscellaneous-Aircraft hangers Utilities and miscellaneous-Barns Utilities and miscellaneous-Carports Utilities and miscellaneous-Fences > 6ft Utilities and miscellaneous-Grain silos Utilities and miscellaneous-Greenho uses Utilities and miscellaneous-Livestoc k shelters	

					Utilities and miscellaneous-Private garages Utilities and miscellaneous-Retaining walls Utilities and miscellaneous-Sheds Utilities and miscellaneous-Stables Utilities and miscellaneous-Other	
39	AM	number_of_stories	Number of Stories	Integer	1-25	100%
40	AN	understory_pct_of_building_footprint	Understory Area(% of Building Footprint)	Single Choice	0% - 100%	0%
41	AO	first_floor_elevation_feet	First Floor Elevation in Feet	Decimal	0-13	100%
42	AP	year_built	Year Built	Integer	User-supplied Four-digit year	96%
43	AQ	roof_shape	Roof Shape	Multiple Choice	Complex Flat Gable Gable/Hip Combo Gambrel Hip Mansard Monoslope Unknown Other	97%
44	AR	roof_slope	Roof Slope	Integer	User-supplied numerical value (angle relative to horizontal)	92%
45	AS	front_elevation_orientation	Front Elevation Orientation	Integer	User-supplied numerical value (degrees with 0=North, 90=East, etc.)	95%

46	AT	structural_notes	Structural Notes	Text	User-supplied structural notes	11%
47	AU	building_type	Building Type	Multiple Choice	Wood Light Frame;W1 Wood Frames, Commercial and Industrial;W2 Steel Moment Frames;S1 Steel Braced Frames;S2 Steel Light Frames;S3 Steel Frames with Concrete Shear WallsS4 Steel Frame with Infill Masonry Shear Walls;S5 Steel (unknown) Concrete Moment Frames;C1 Concrete Shear Wall Buildings;C2 Concrete Frame with Infill Masonry Shear Walls;C3 Precast/Tilt-up Concrete Shear Wall Buildings;PC1 Precast Concrete Frames;PC2 Concrete (unknown) Reinforced Masonry Bearing Wall Buildings with Flexible Diaphragms;RM1 Reinforced Masonry Bearing Wall Buildings with Stiff Diaphragms;RM2 Unreinforced Masonry Bearing Wall Buildings;URM Masonry (unknown) Wood (unknown) Unknown Other	93%

48	AV	foundation_type	Foundation Type	Single Choice	Slab-on-grade Cast-in-place concrete piers Ground anchors and strapping Reinforced masonry piers Reinforced masonry stem wall Unreinforced masonry piers Unreinforced masonry stem wall Wood Piers <= 8 ft Wood Piers > 8 ft Unknown Other	80%
49	AW	wall_anchorage_type	Wall Anchorage Type	Multiple Choice	Anchor bolts with nuts and washers Anchor bolts with missing nuts and washers Metal straps Concrete nails Unknown	9%
50	AX	wall_substrate	Wall Substrate	Multiple Choice (Comma separated text)	Wood, sheathing (continuous) Wood, sheathing (corners only) Wood, dimensional planks Insulated sheathing Insulated foam board Non-engineered wood panel Metal panels Not Applicable Unknown	15%

51	AY	wall_cladding	Wall Cladding	Multiple Choice	Aluminum siding Brick Curtain Wall EIFS Fiber-Cement Board Corrugated steel panels Plywood Siding Stucco Vinyl Siding (standard) Vinyl Siding (high wind rated) Vinyl Siding (unknown) Wood Boards Wood Shake/Shingle Unknown Other	70%
52	AZ	soffit_type	Soffit Type	Multiple Choice	None Vinyl Metal Wood Unknown Other	7%
53	BA	fenestration_protection	Fenestration Protection	Single Choice	Front Left Back Right None Other	17%
54	BB	fenestration_protection_type	Fenestration Protection Type	Multiple Choice	None Unknown Impact Resistant Plywood/OSB Panel Hurricane Shutter Other	18%
55	BC	large_door_present	Large Door Present	Yes/No	Yes No N/A	95%

56	BD	llarge_door_opening_location	Large Door Opening location	Multiple Choice	Front Left Back Right Other	14%
57	BE	large_door_opening_type_	Large Door Opening Type	Multiple Choice	None Single garage door (standard) Double garage door (standard) Single garage door (wind-rated) Double garage door (wind-rated) Single garage door (unknown) Double garage door (unknown) Sectional door Roll-up door Other	2%
58	BF	roof_system	Roof System	Multiple Choice	Steel, cold formed Steel, hot rolled Steel, joists Concrete slab Wood, rafter Wood, trusses Wood, unknown Unknown Other	27%
59	BG	r2wall_attachment	Roof to Wall Attachment	Multiple Choice	Toe-nails Metal ties Metal straps Bolted connection Welded connection Unknown Other	7%
60	BH	r2w_attachment_type	Roof to Wall Attachment Type	Text	User-supplied description	5%

61	BI	roof_substrate_type	Roof Substrate Type	Multiple Choice	Plywood/OSB Dimensional lumber Metal deck Concrete None Unknown Other	18%
62	BJ	roof_cover	Roof Cover	Multiple Choice	Asphalt shingles (3-tab) Asphalt shingles (laminated) Built-up with Gravel Built-up without Gravel Clay tiles Concrete tiles Metal shingles Metal, corrugated Metal, standing seam Roll roofing Single ply Wood shake Wood shingle Unknown Other	90%
63	BK	secondary_water_barrier	Secondary Water Barrier	Multiple Choice	None Closed-cell urethane foam adhesive Fully adhered membrane High performance underlayment Self-adhering membrane over joints Unknown Other	1%
64	BL	overhang_length	Overhang Length	Integer	User-supplied numerical value	4%
65	BM	parapet_height_inches	Parapet Height in inches	Integer	User-supplied numerical value	1%

66	BN	wind_damage_details	Wind Damage Details	Text	User-supplied wind damage notes	15%
67	BO	roof_structure_damage_	Roof Structure Damage (%)	Numeric	0%-100%	95%
68	BP	roof_substrate_damage	Roof Substrate Damage (%)	Numeric	0%-100%	94%
69	BQ	roof_cover_damage_	Roof Cover Damage (%)	Numeric	0%-100%	95%
70	BR	wall_structure_damage_	Wall Structure Damage (%)	Numeric	0%-100%	95%
71	BS	wall_substrate_damage_	Wall Substrate Damage (%)	Numeric	0%-100%	94%
72	BT	building_envelope_damage_	Building Cladding Damage (%)	Numeric	0%-100%	94%
73	BU	_damaged_windows	Damaged Windows (%)	Numeric	0%-100%	86%
74	BV	l_damaged_doors	Damaged Doors (%)	Numeric	0%-100%	82%
75	B W	location_of_damaged_fenestration	Location of Damaged Fenestration	Multiple Choice	Front Left Back Right Other	32%

76	BX	large_door_failure	Large Door Failure	Multiple Choice	None Front Left Back Right All other	90%
77	BY	soffit_damage	Soffit Damage (%)	Numeric	0%-100%	6%
78	BZ	fascia_damage_	Fascia Damage (%)	Numeric	0%-100%	9%
79	CA	tarped_roof	Tarped Roof	Numeric	0%-100%	87%
80	CB	foundation_damage	Foundation Damage	Single Choice	Yes No Unknown	95%
81	CC	stories_with_damage	Stories with Damage	Text	User-supplied notes on affected stories	16%
82	CD	reroof_year	Reroof Year	Numeric	User-supplied four-digit year	0%
83	CE	retrofit_type_1	Retrofit Type (1)	Text	User-supplied descriptive text	10%
84	CF	retrofit_1_year	Retrofit (1) Year	Numeric	User-supplied four-digit year	3%
85	CG	retrofit_type_2	Retrofit Type (2)	Text	User-supplied descriptive text	0%
86	CH	retrofit_2_year	Retrofit (2) year	Numeric	User-supplied four-digit year	0%
87	CI	data_librarians	Data Librarian	Text	User-supplied name	100%

88	CJ	qc_progress_code	QC Progress Code	Single Choice	1 1e 2 2e 3 3e	97%
89	CK	qc_notes	QC Notes	Text	Notes from Data Librarians regarding the DE/QC process	47%

Note: % filled ignores blank or unknown fields

Appendix B. Properties of Unmanned Aerial Surveys

Location ID: **Coordinates:** **Drone Type:** **Flight Date:** **Flight Type:** **Flight Altitude:** **Camera Angle:** **Overlap:** **No. Photos:** **No. Flights:** **Area Covered:** **Average GSD:**	20220322_ArabiLA_North 29.969, -89.993 DJI Mavic Pro 2 3/29/2022 Double-grid ~ 140 ft Varies N/A 1781 3 0.09 sq. mi. 0.5 in	
Location ID: **Coordinates:** **Drone Type:** **Flight Date:** **Flight Type:** **Flight Altitude:** **Camera Angle:** **Overlap:** **No. Photos:** **No. Flights:** **Area Covered:** **Average GSD:**	20220328_ArabiLA_South 29.962, -89.997 DJI Mavic Pro 2 3/29/2023 Free flight ~ 150 ft Varies N/A 1321 1 0.17 sq. mi. 0.46 in	

Appendix C. Standard StEER Glossary

Version Number	1.1	**Updated**	22-Aug. 2022
Term	**Acronym**	**Class**	**Description**
Response Levels			
Level 1 Response	L1	Response Level	virtual mission gathering and synthesizing publicly available online data, including high resolution satellite imagery; used in major hazard events that have potential to generate new knowledge relevant to StEER's mandate
Level 2 Response	L2	Response Level	field scout; wide-canvassing smaller FAST operating out of regional node for a rapid survey of the entire affected area to collect highly perishable data; used in major hazard events with ability to generate new knowledge relevant to StEER's mandate
Level 3 Response	L3	Response Level	full field investigation with systematic target selection using interdisciplinary teams with the objective of developing detailed case studies through Forensic Load Path Evaluation (FLPE) or Direct Quantification of Component Performance (DQCP) conducted on a robust statistical sampling of the inventory; used in major hazard events where knowledge can be gained through in-depth evaluation of select structures
Mission Document Classes		Sub-division	Standard StEER sub-division of data, focused on written products
Planning Documents		Document Class	Standard StEER document class, encompasses assets produced to guide a Level 2 or Level 3 response
Pre-Deployment Briefing	--	Internal Document	Standard StEER document, defines mission scope, target areas and structures to visit, technologies, and team configuration
Daily Summaries	--	Document Class	Standard StEER document, submitted daily to document mission coverage and observed performance
Data Classes		Sub-division	Standard StEER sub-division of data, focused on observations and measurements
Performance Assessment	PA	Data Class	Standard StEER data class, direct evaluation of structural performance using StEER's standard assessment frameworks (often using StEER mobile apps)
PA: Coastal Buildings	PA-CB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of buildings under coastal hazards

PA: Coastal Non-Buildings	PA-CNB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of non-buildings under coastal hazards
PA: Earthquake Buildings	PA-EB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of buildings under seismic hazards
PA: Earthquake Non Buildings	PA-ENB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of non-buildings under seismic hazards
PA: Windstorms Buildings	PA-WB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of buildings under wind hazards
PA: Windstorms Non-Buildings	PA-WNB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of non-buildings under wind hazards
Surface-Level Panoramas	SLP	Data Class	Standard StEER data class, rapid imaging technique collecting 360 photographic evidence
SLP: car-mounted systems	SLP-C	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using cars
SLP: boat-mounted systems	SLP-B	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using boat
SLP: backpack-mounted systems	SLP-BP	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using backpack mounts
SLP: handheld systems	SLP-HH	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using handheld
Unmanned Aerial Systems	UAS	Data Class	Standard StEER data class, common mode of aerial data collection in the field
Free-Flight	UAS-FF	Data Subclass	Standard StEER data subclass, unmanned aerial system in free flight
Panoramas	UAS-P	Data Subclass	Standard StEER data subclass, unmanned aerial system generating panoramas
3D Models	UAS-3D	Data Subclass	Standard StEER data subclass, unmanned aerial system generating 3D models
LiDAR-Based Imaging	LBI	Data Class	Standard StEER data class, Light Detection and Ranging measurements collected by various platforms
LBI: Fixed	F-LBI	Data Subclass	LBI subclass; fixed/stationary mode for ground-based data collection
LBI: Mobile	M-LBI	Data Subclass	LBI subclass; mobile mode for ground-based data collection
LBI: Aerial	A-LBI	Data Subclass	LBI subclass; aerial mode for data collection

Site Hazard Assessment	SHA	Data Class	Standard StEER data class, forensic evidence of hazard intensity
SHA: Coastal Surveys	SHA-C	Data Subclass	SHA subclass, documenting coastal impacts after hurricanes/tsunamis
SHA: Windfield Indicators	SHA-W	Data Subclass	SHA data subclass, documenting evidence of wind speed such as tree fall patterns
SHA: Earth Movement/Rupture	SHA-E	Data Subclass	SHA data subclass, documenting evidence of earthquake intensity and ground shaking in ground surface
Other Ground-Based Observations	GBO	Data Class	Standard StEER data class, general category of observations using other data collection platforms beyond those in other standard data collection platforms such as photographs and videos captured outside of StEER mobile apps
Digital single-lens reflex camera	DSLR	Data Subclass	GBO subclass, documented using DSLR cameras
Other camera	--	Data Subclass	GBO subclass, documented using other types of cameras
Geospatial Positioning Data	GPD	Data Class	Standard StEER data class, coordinates or tracks that define locations of data collection
GPD: GPS Locations	GPD-L	Data Subclass	Standard StEER data subclass, coordinates of point data collection
GPD: GPS Routes	GPD-R	Data Subclass	Standard StEER data subclass, coordinates of data collection routes
Sampling Strategies			
Statistical Sample		Sampling Strategy	Sampling every Nth building in a cluster or along a route for performance assessment
Critical Case Sampling		Sampling Strategy	Sampling buildings that meet specific criteria, e.g., instrumented, or performance characteristics
Cluster-Based Sampling		Sampling Strategy	Sampling buildings within a defined radius of a point, e.g., ground motion station
Transect-Based Sampling		Sampling Strategy	Sampling buildings along a path that moves across the hazard intensity gradient
Quota-Based Sampling		Sampling Strategy	Sampling buildings to achieve a representative sample based on characteristics of underlying building inventory
Opportunistic Sampling		Sampling Strategy	Assessment of structure not included in initial sampling strategy, based upon unique features or performance observed in the field

Activities			
Rapid Assessment	RA	Activity	Lowest fidelity performance assessment, includes high-level global damage assessment for identifying damage gradient in affected communities following a hazard event
Load Path Assessment	LPA	Activity	Moderate fidelity performance assessment, includes in-depth performance assessment of Critical Load Path Elements (CLPE) including identification of (a) geolocation of damaged elements, (b) damage measures/modes, (c) component damage ratings
Detailed Component Assessment	DCA	Activity	Highest fidelity performance assessment, involves collecting detailed information on components, including dimensional data and/or material properties, as well as hazard intensity measures
Reconnaissance Engagement and Communication Hub	REACH	Activity	Communication and dissemination of findings to audiences in academia, policy and practice
Data Enrichment Quality Control	DEQC		Review and supplementing of assessment data to improve its quality and richness
Dissemination Products			Outputs of StEER Missions
Standard StEER Products			
Data Report	--	Product	Standard StEER Product; accompanies curated data in DesignSafe to detail the scope and structure of data
Event Briefing	EB	Product	Standard StEER Product, released in Level 1 response to synthesize the findings from VAST efforts
Early Access Reconnaissance Report	EARR	Product	Standard StEER Product, released after FAST-1 in a Level 2 or Level 3 response, summarizes the data collection process and major observations
Preliminary Virtual Reconnaissance Report	PVRR	Product	Standard StEER Product, released in Level 1 response to synthesize the findings from VAST efforts
Other Academic Products			
Conference Paper		Product	StEER document subclass, external communications of findings at conference venues
Journal Papers		Product	StEER document subclass, external communications of findings in journals
Other Products		Product	StEER document subclass, external communications of findings in other venues/audiences

Personnel Models			
Field Assessment Structural Team	FAST	Personnel Model	Standard StEER personnel model, comprised of StEER members charged with field data collection in a Level 2 and Level 3 response; may be multiple sequential or parallel teams numbered FAST-1, FAST-2, etc.
Virtual Assessment Structural Team	VAST	Personnel Model	Standard StEER personnel model, comprised of StEER members charged with virtual data collection and synthesis
Data Librarians		Personnel Model	Undergraduate students responsible for data enrichment and quality control tasks
Research Associates		Personnel Model	Postdoctoral scholars who support overall operations and research/development activities
Student Administrator		Personnel Model	Undergraduate student who manages member records, correspondence
Board of Directors		Personnel Model	Highest unit of governance, includes director, associate directors for each hazard, associate director for data standards (PIs on NSF Award)
StEERing Committee		Personnel Model	10-person governing body, which includes a representative from each Working Group (2) and Hazard Advisory Board (3), two elected at-large StEER members and three elected regional node representatives will be responsible for making activation decisions under the tiered regional response model and will lead the science planning activities
Hazard Advisory Boards		Personnel Model	5-member elected boards dedicated to wind, coastal and earthquake hazards, led by the respective Associate Directors, to guide StEER activities/protocols from each hazard perspective
Working Groups		Personnel Model	Collaboratives focused on specific tasks/capabilities, open to StEER members at all ranks, with an appointed chair

Appendix D. Standard StEER List of Acronyms

--	DesignSafe	Data Repository
--	DesignSafe-CI	Academic Organization within NHERI
ASCE	American Society of Civil Engineers	Professional Organization
ASTM	American Society for Testing and Materials (now ASTM International)	Standards Body
ATC	Applied Technology Council	Professional Organization
BOCA	Building Officials and Code Administrators	Code Body
CC-BY	Creative Commons Attribution License	Code/Standard
CESMD	Center for Engineering Strong Motion Data	Governmental Agency
CI	Cyberinfrastructure	Research Asset
CLPE	Critical Load Path Elements	StEER Term
CMU	Concrete Masonry Unit	Building Material
DBE	Design Basis Earthquake	Design Terminology
DEQC	Data Enrichment and Quality Control	StEER Term
DOI	Digital Object Identifier	Common Term
EARR	Early Access Reconnaissance Report	StEER Term
EERI	Earthquake Engineering Research Institute	Professional Organization
EEFIT	Earthquake Engineering Field Investigation Team	Professional Organization
EF	Enhanced Fujita Scale	Hazard Intensity Scale
EF	Equipment Facility	Academic Organization within NHERI
EIFS	Exterior Insulation Finish System	Building Component
FAA	Federal Aviation Administration	Governmental Agency

FAQ	Frequently Asked Questions	Common Term
FAST	Field Assessment Structural Team	StEER Term
FEMA	Federal Emergency Management Agency	Governmental Agency
GEER	Geotechnical Extreme Events Reconnaissance	Academic Organization within NHERI
GPS	Global Positioning System	Measurement Technology
GSA	Government Services Administration	Governmental Agency
HVAC	Heating, ventilation and air conditioning	Building System
HWM	High Water Mark	Intensity Measure
IBC	International Building Code	Code/Standard
ICC	International Code Council	Code Body
IRC	International Residential Code	Code/Standard
ISEEER	Interdisciplinary Science and Engineering Extreme Events Research	Academic Organization within NHERI
LiDAR	Light Detection and Ranging	Measurement Technology
MCE	Maximum Considered Earthquake	Design Terminology
ME&P	Mechanical, electrical and plumbing	Building System
MMI	Modified Mercalli Intensity	Hazard Intensity Scale
NBC	National Building Code	Code/Standard
NEER	Nearshore Extreme Event Reconnaissance	Academic Organization within NHERI
NFIP	National Flood Insurance Program	Government Program
NHERI	Natural Hazards Engineering Research Infrastructure	Academic Organization within NHERI
NIST	National Institute of Standards and Technology	Governmental Agency
NOAA	National Oceanic and Atmospheric Administration	Governmental Agency
NSF	National Science Foundation	Governmental Agency
NWS	National Weather Service	Governmental Agency
OSB	Oriented strand board	Construction Material
OSEEER	Operations and Systems Engineering Extreme Events Research	Academic Organization within NHERI
PEER	Pacific Earthquake Engineering Research center	Academic Organization (Earthquakes)
PGA	Peak Ground Acceleration	Intensity Measure
PHEER	Public Health Extreme Events Research	Academic Organization within NHERI

PVRR	Preliminary Virtual Reconnaissance Report	StEER Term
QC	Quality Control	Oversight process
RAPID	RAPID Grant	Funding Mechanism
RAPID-EF	RAPID Experimental Facility	Academic Organization within NHERI
RC	Reinforced Concrete	Building Material
SAR	Search and Rescue	Standard Hazards Terminology
SGI	Special Government Interest	FAA Process
SLP	Surface-Level Panoramas	Measurement Technology
SMS	Short Message Service	Communication Modality
SPC	Storm Prediction Center	Governmental Agency
SSEER	Social Science Extreme Events Research	Academic Organization within NHERI
StEER	Structural Extreme Events Reconnaissance network	Academic Organization within NHERI
SUMMEER	SUstainable Material Management Extreme Events Reconnaissance	Academic Organization within NHERI
TAS	Testing Application Standard	Technical Standard
UAS/V	Unmanned Aerial Survey/System/Vehicle	Measurement Technology
USD	US Dollar	Standard Currency
USGS	United States Geological Survey	Governmental Agency
VAST	Virtual Assessment Structural Team	StEER Term
WS	Windshield Survey	Measurement Technology