Condemnation, or the Wrath of the Gulf of Mexico

Project Site with Riviera I, Riviera II, West Beach Grand post-Hurricane Ike

- Site of the engineering project: City of Galveston, Texas
- Condominiums, which had experienced significant beach erosion, following 2008 Hurricane Ike
- Following the 2021 Champlain Towers collapse, City of Galveston building officials revisited these condominiums
- Another civil/structural engineer declared the condos “UNSAFE” per 2018 IEBC Codes

Condemnation, or the Wrath of the Gulf of Mexico

Project Site with Riviera II, West Beach Grand, and Sands of Kahala - Galveston

Governing Codes and Applicable Standards (Not necessarily comprehensive):

- ASCE/SEI 7-16, Minimum Loads;
- ASCE/SEI 76-23, Standard for Mitigation of Disproportionate Collapse Potential in Buildings and Other Structures;
- ACI 318-19, Code Requirements for Structural Concrete;
- IBC 2018;
- IEBC 2018;
- Miami-Dade Co, Florida, 40-Yr Recertification Program;
- NIST, Preliminary Report, “Collapse of Champlain Towers at Surfside, FL”
- State of Texas, General Land Office, Rules and Regulations for Shorelines;
- USACE, Coastal Engineering Manual, Vols 1 through 6;
- USACE, Design of Coastal Revetments, Seawalls, and Bulkheads;
- USACE, (w/ FEMA) Flood Insurance Study: Coastal Counties, Texas Intermediate Submission 2, Scoping and Data Review
- USACE, Sabine to Galveston (S2G) Feasibility Study;
- USACE, Texas Coastal Storm Risk Management and Ecosystem Restoration Feasibility Study;
- USN, NAVFAC, Design Manual for Shore Facilities, DM-01, DM-02, others as applicable

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Riviera I Condominium

- 2008 Hurricane Ike significantly eroded the beach front the condominiums and the subdivision, “Sands of Kahala – Galveston” to the northeast of the condominiums.
- State of Texas claims the land between the Mean Low Water (MLW) and 200 feet landward.
- This 200-foot offset now clips the three condominiums and the lots of the “Sands of Kahala”

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West Beach Grand Condominium

- City of Galveston, County of Galveston, State of Texas General Land, and US Army Corps of Engineers all have interest in this project.
- Because of previous declaration as “UNSAFE” per 2018 IEBC, the City of Galveston moved to condemn the buildings.
- USACE was called in as consultants and advisors.
- Texas GLO demands that the buildings be demolished and lands returned to natural state.

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Sands of Kahala Subdivision: 13 homes on 16 lots

- Mark E Haas Engineering, LLC, with extensive experience in coastal and offshore engineering projects, was retained by the condominium HOA's to reassess their buildings.

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Composite LiDAR scan of Riviera I Condominium

To show that condominiums are “SAFE”:

- First step in saving the condominiums is to show that they are operating well.
- Proposed to the three HOA’s, one for each condominium, to execute a LiDAR scan of each condominium
- Proposal was accepted.

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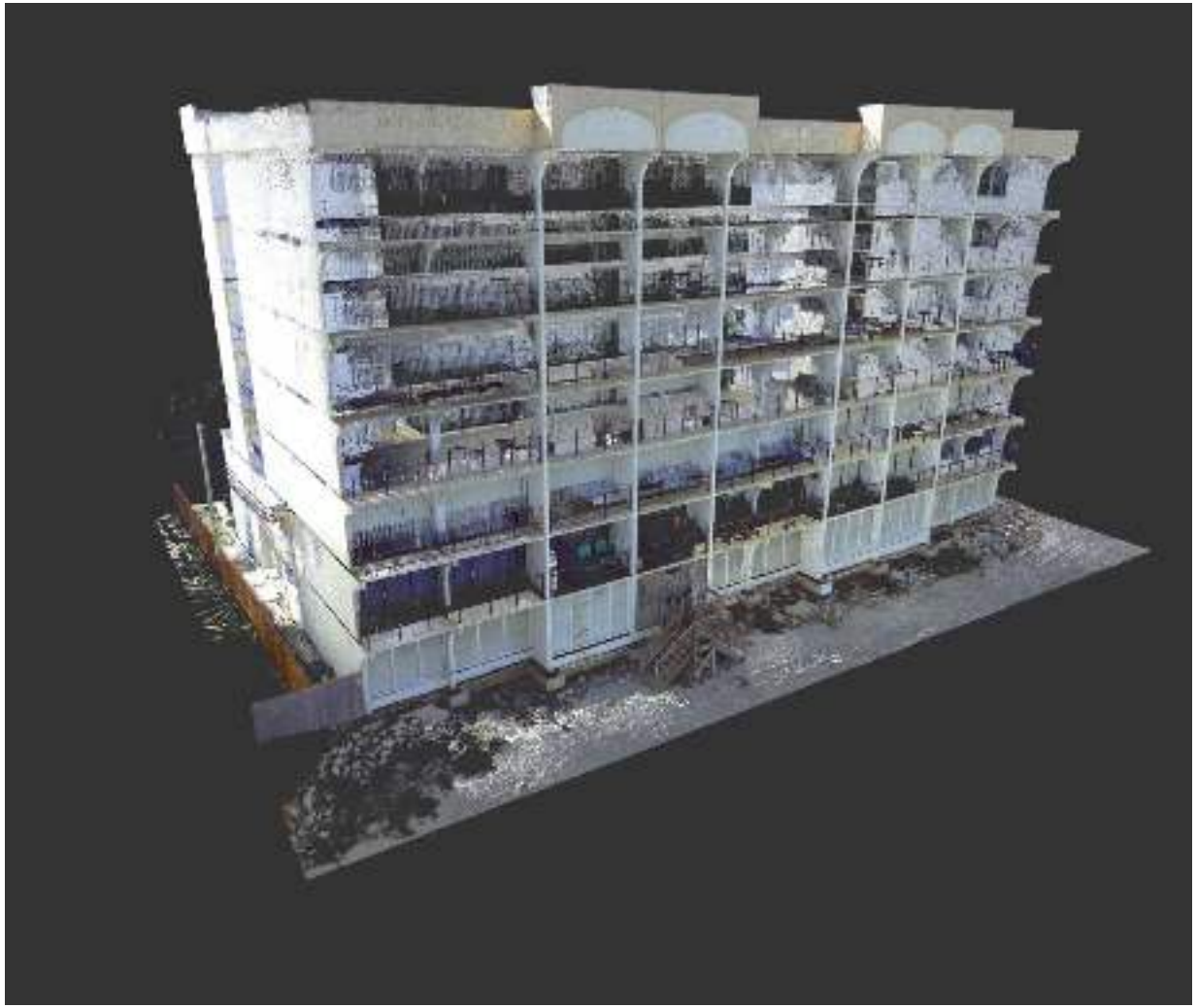

Composite LiDAR scan of Riviera II Condominium

- Targets were applied to each condominium
- With a survey crew, target points across the face elevations around the perimeter were measured
- LiDAR measurements and the surveyed points were compared and the millions of images were processed

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Composite LiDAR scan of West Beach Grand Condominium

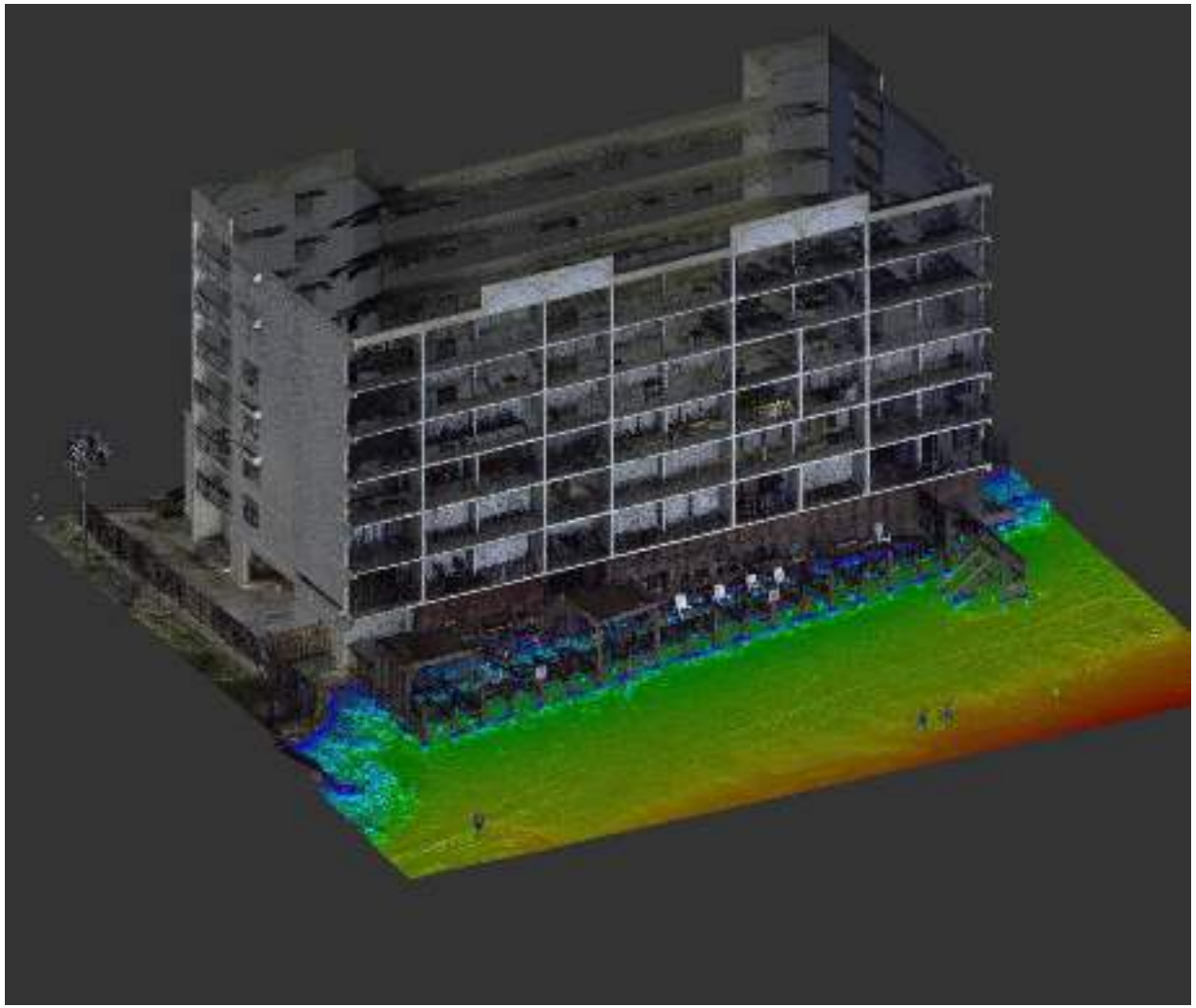
- The computer imaging and images were used to create 3-D models for each condominium.
- Deflections and displacements were then derived from the models for each condominium

World's Bestest Dog Ever

Tried to save my life three times:

- Alerted me to and pushed me away from a rattlesnake while hunting quail south of Victoria, Texas
- Pushed me away from a Texas Coral Snake, while walking him through Memorial Park
- When I stopped swimming near the beach at my Doha, Qatar residence, and started treading water, Chisum jumped into the water, swam to me, and started pulling me to shore.

Condemnation, or the Wrath of the Gulf of Mexico



Composite LiDAR scan of West Beach Grand Condominium

- The computer imaging and images were used to create 3-D models for each condominium.
- Deflections and displacements were then derived from the models for each condominium
- Deflections were plotted on Elevation views of each condominium
- Deflections were compared against applicable construction and operability tolerances per ASCE, ACI, and IBC Codes

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Riviera I – Section Cut - Plan View

Composite LiDAR scan of Riviera I Condominium

Condemnation, or the Wrath of the Gulf of Mexico

Riviera I - Ocean side – Elevation looking North

Composite LiDAR scan of Riviera I Condominium

Condemnation, or the Wrath of the Gulf of Mexico

Riviera I - Elevation View Looking East

Composite LiDAR scan of Riviera I Condominium

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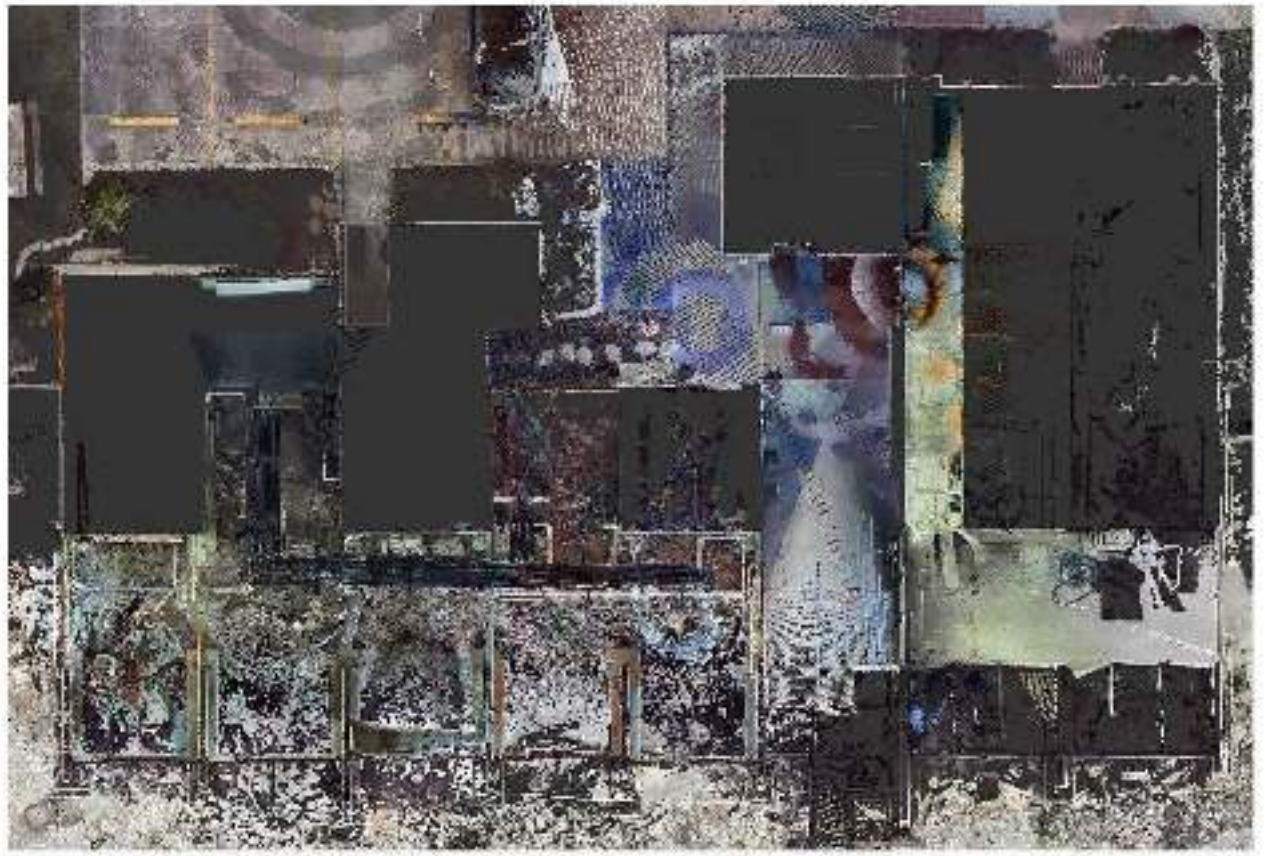

Riviera I - Plan view with section cut through ground floor

Composite LiDAR scan of Riviera I Condominium

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Riviera I – Isometric View of Ground Floor

Composite LiDAR scan of Riviera I Condominium

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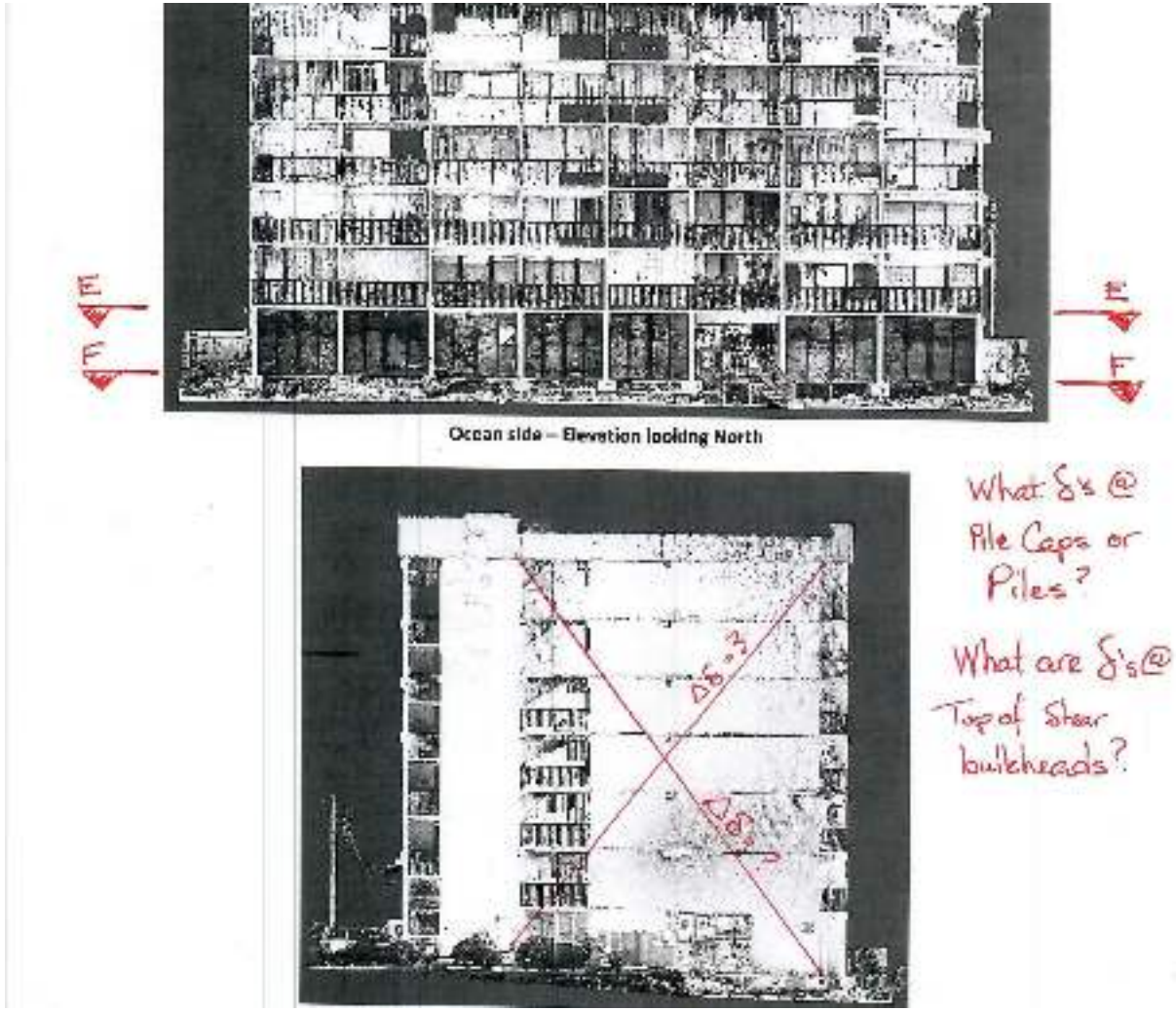
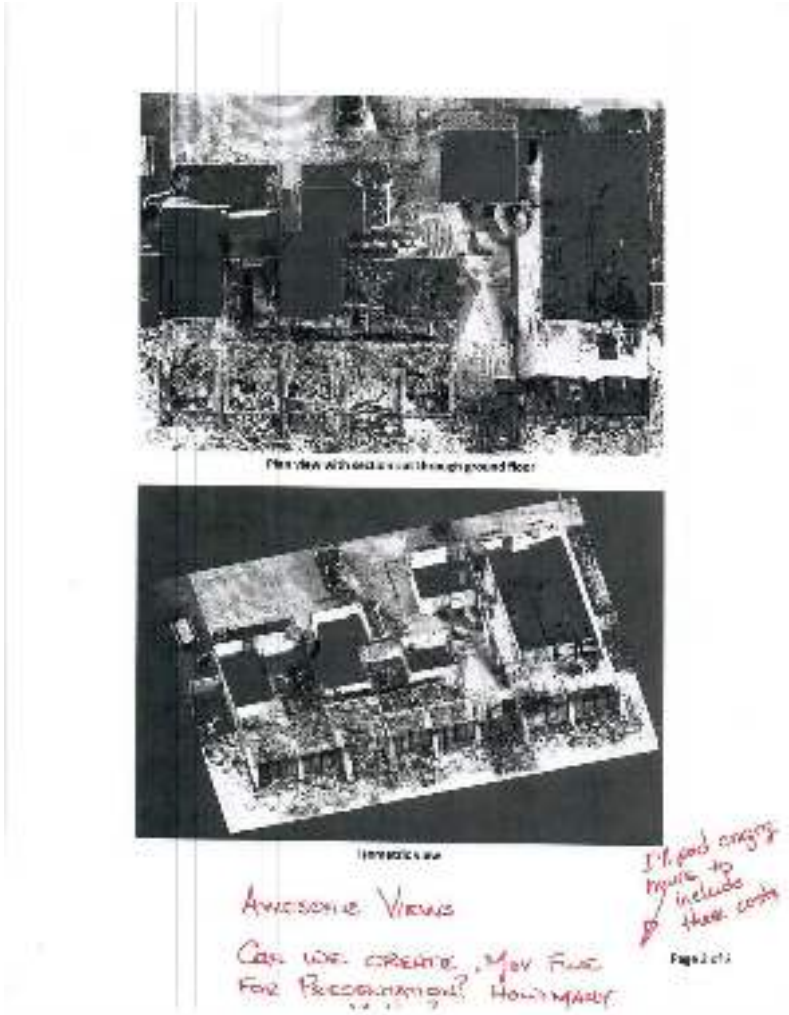


Composite LiDAR scan of West Beach Grand Condominium

- Deflections were noted by hand and transferred to an AutoCAD template of the condominium elevation views
- Deflections were compared against applicable construction and operability tolerances per ASCE, ACI, and IBC Codes

Condemnation, or the Wrath of the Gulf of Mexico



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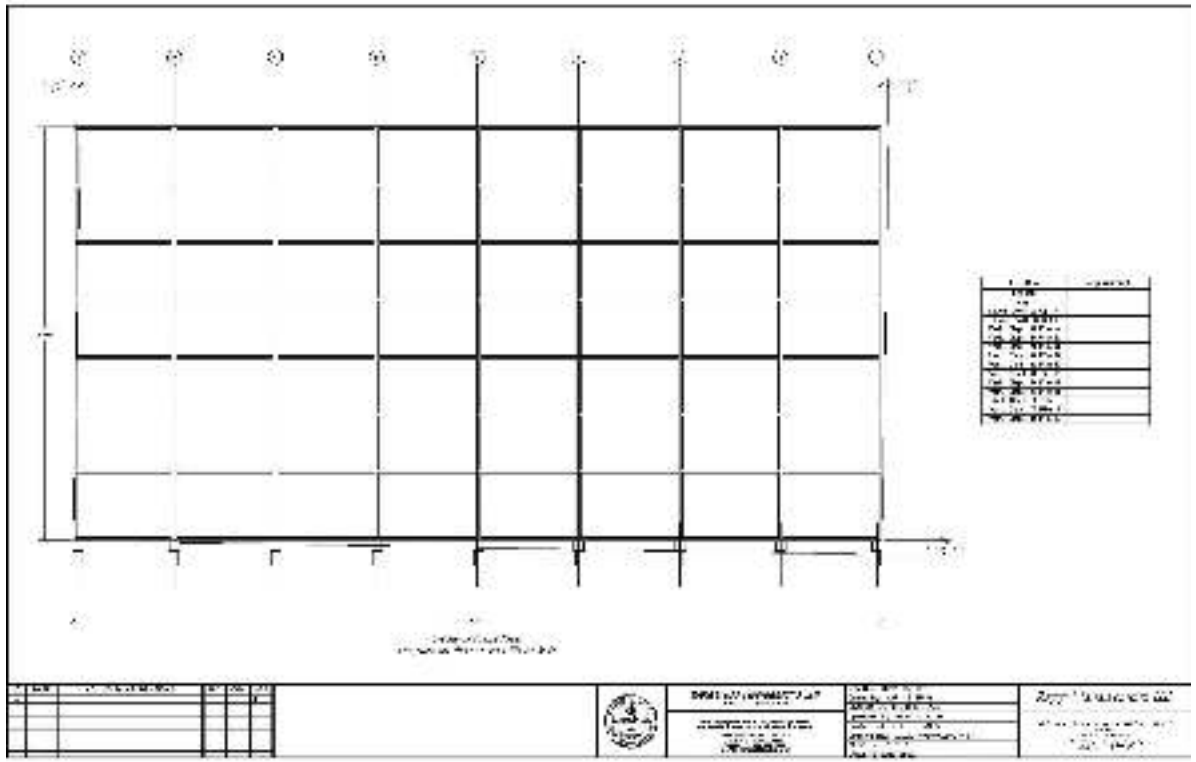
Condemnation, or the Wrath of the Gulf of Mexico



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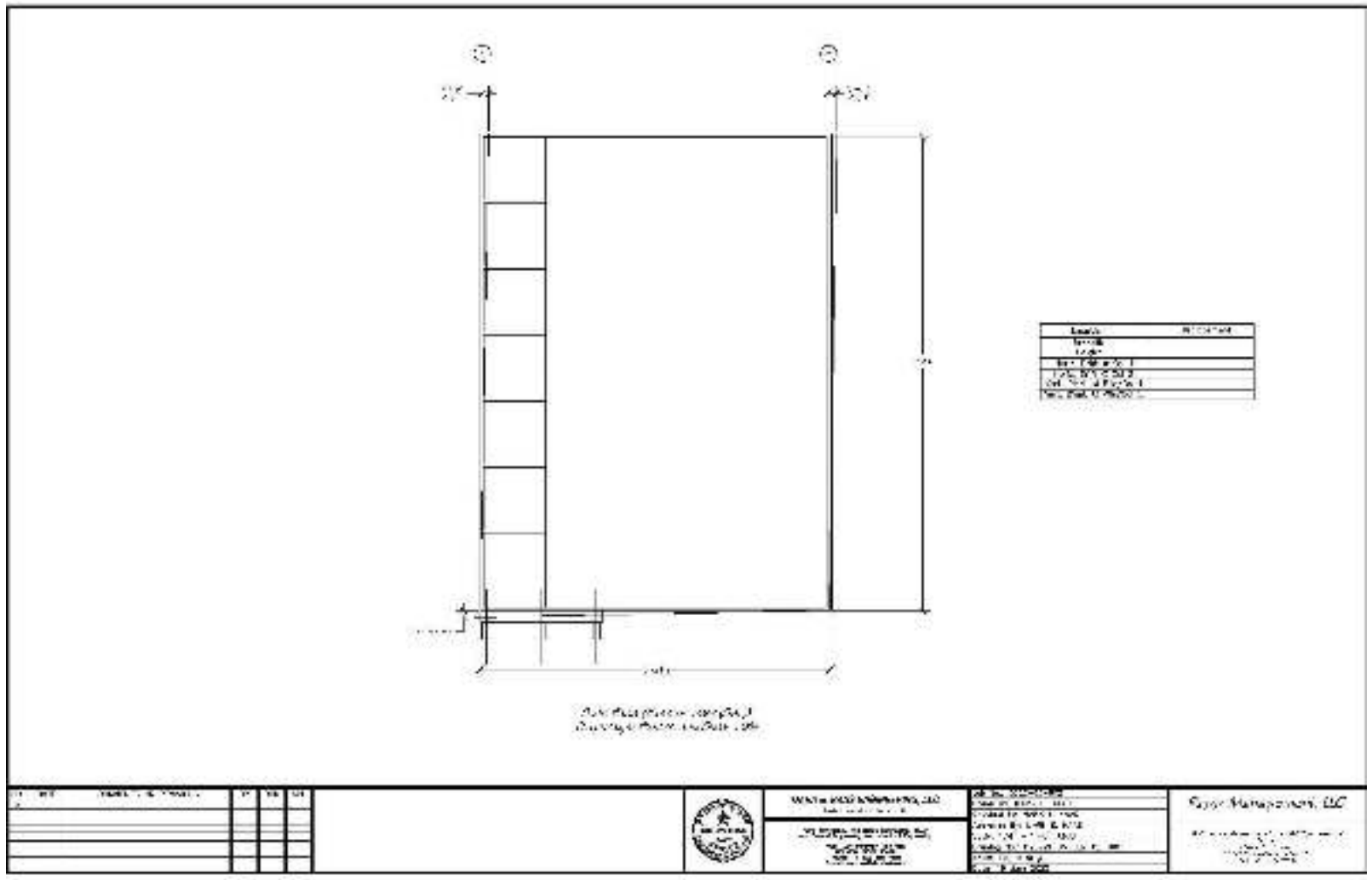
Condemnation, or the Wrath of the Gulf of Mexico



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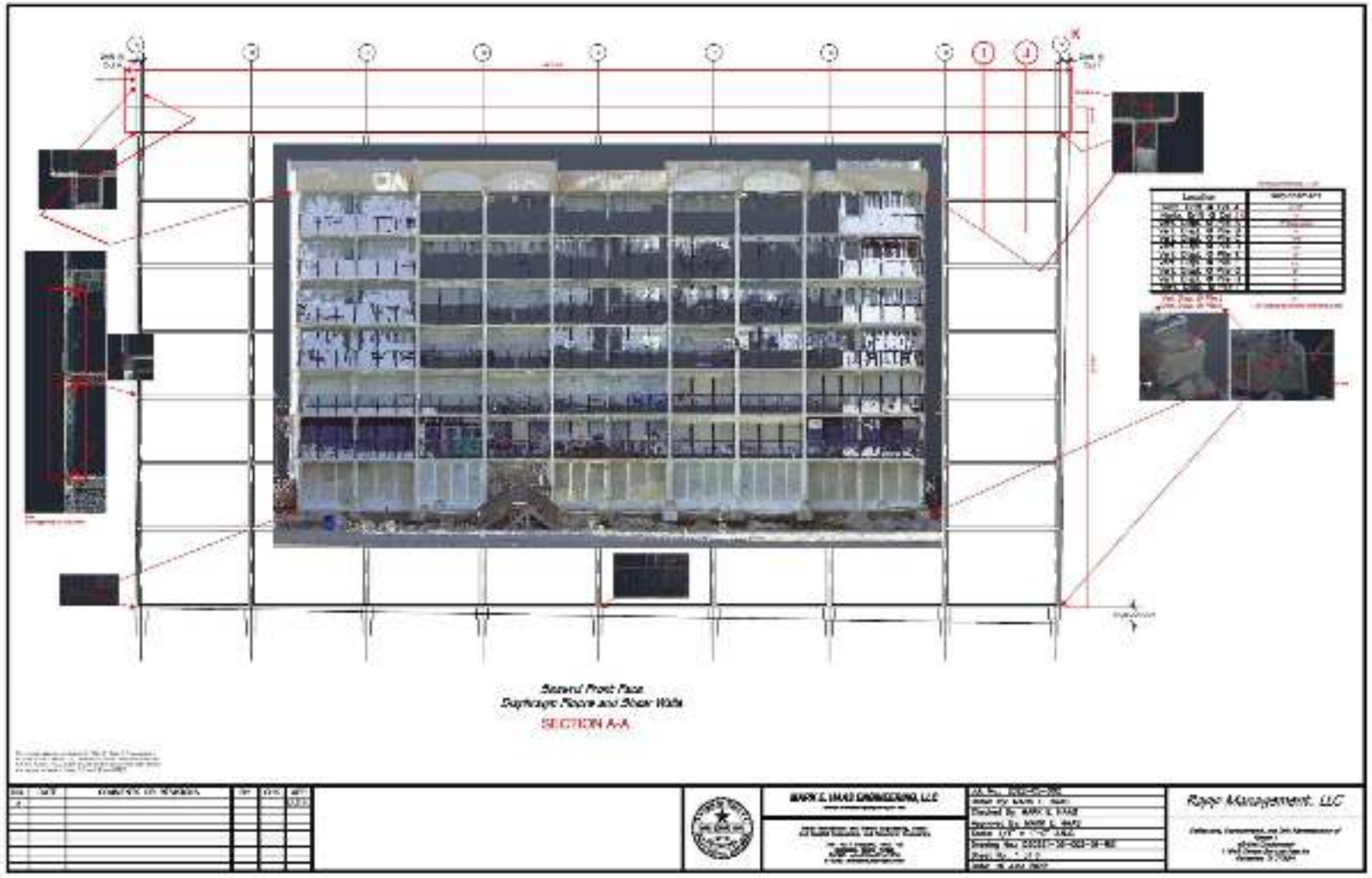

Riviera II - Plotting of Deflections

- Deflections were noted by hand and transferred to an AutoCAD template of the condominium elevation views
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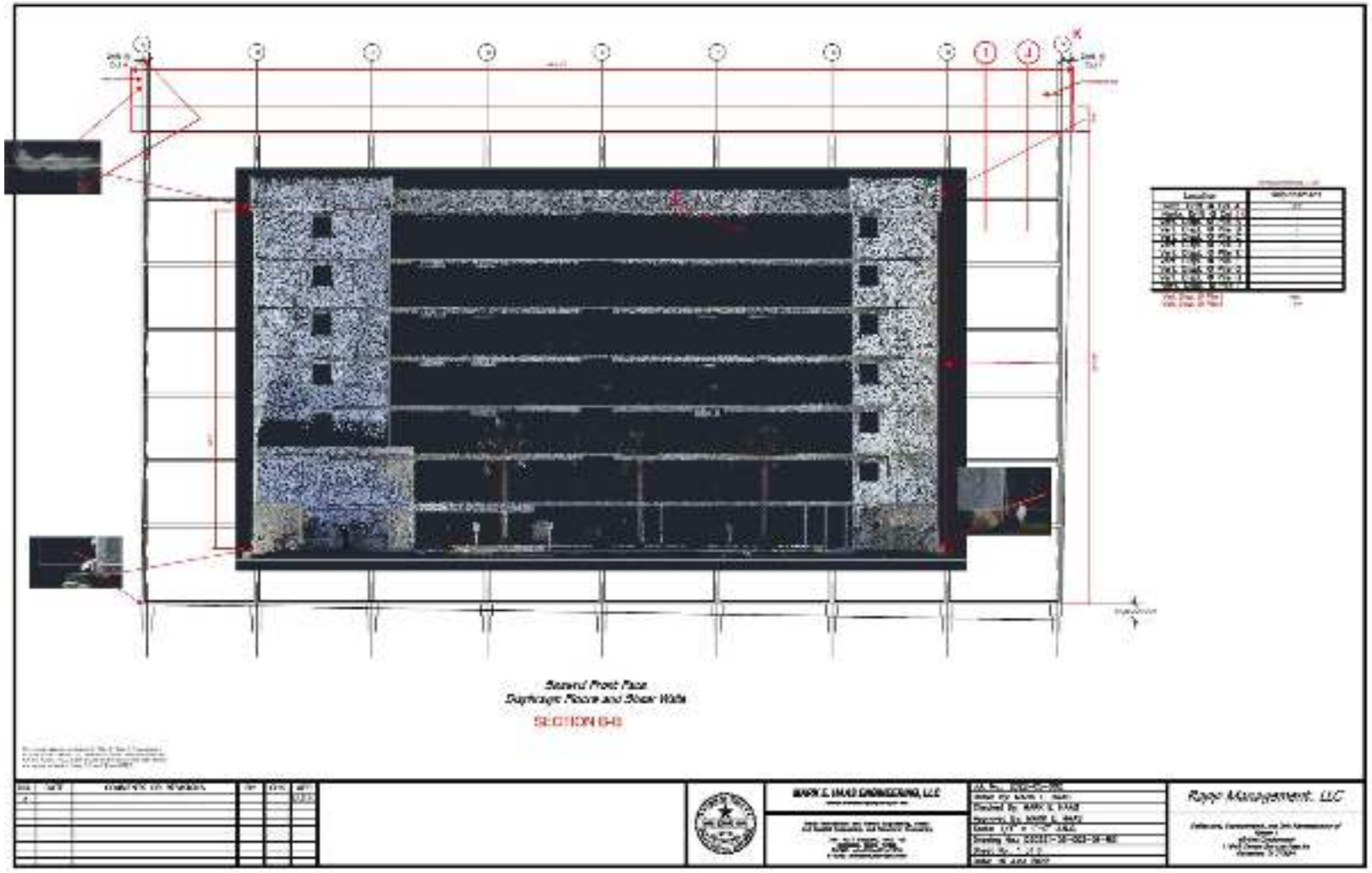
Condemnation, or the Wrath of the Gulf of Mexico



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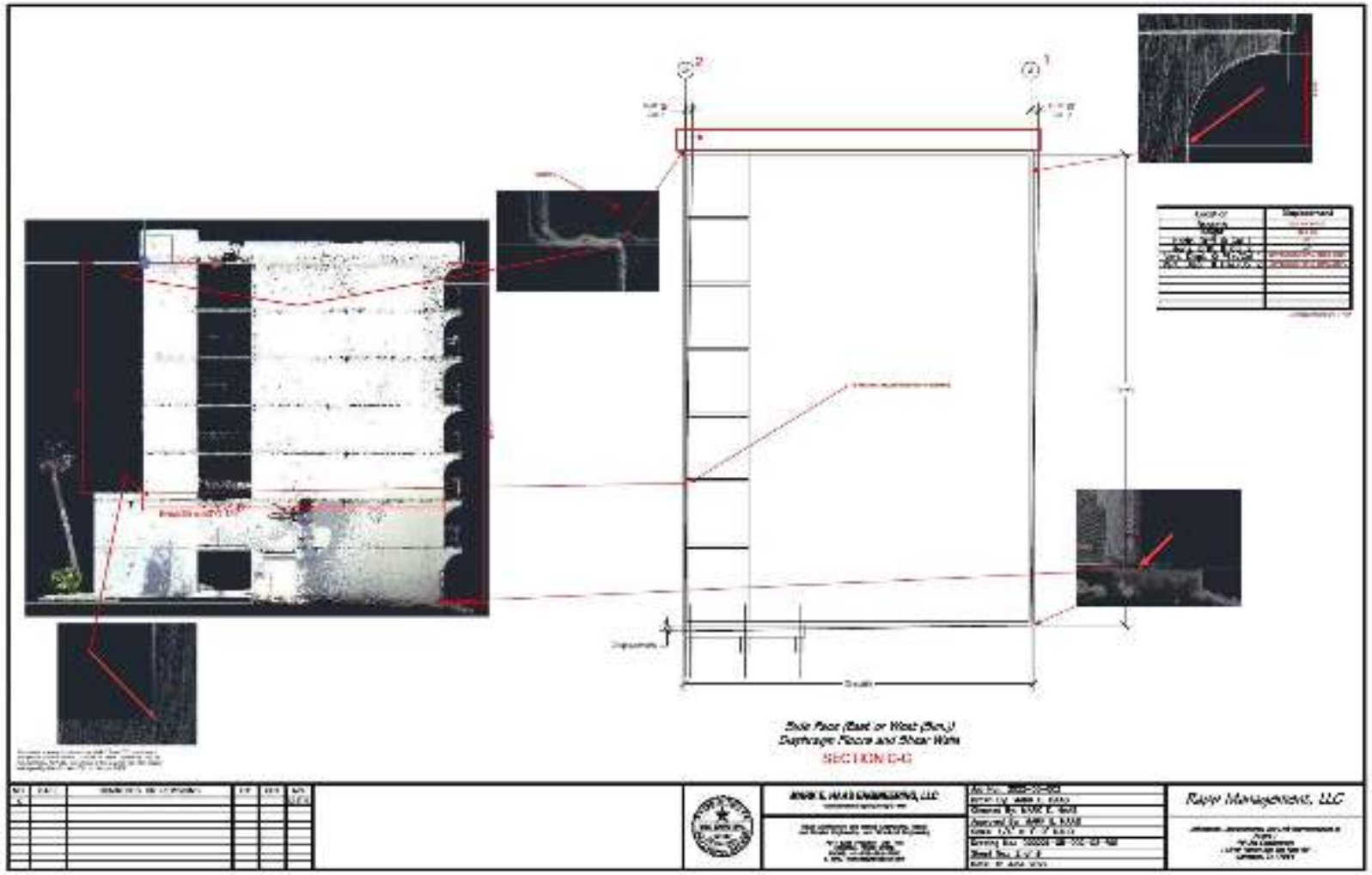
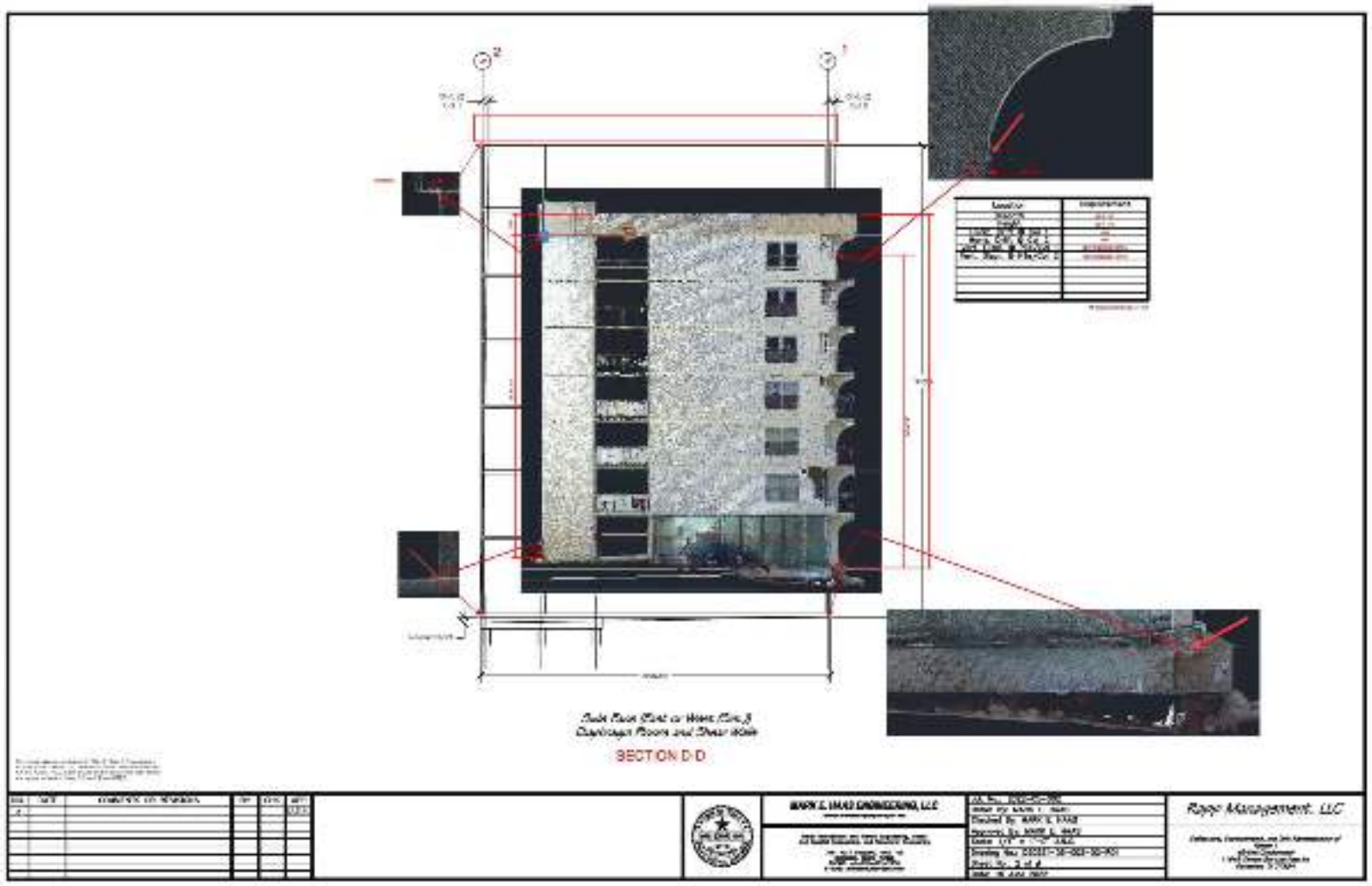


Riviera II - Plotting of Deflections

- All deflections were well within tolerances and guidelines per the applicable tolerances per ASCE, ACI, and IBC Codes
- As deflections and displacements were small and within tolerances, no distinguishable pattern emerged
- Could not distinguish between construction, operability, settling, or soil subsidence

Condemnation, or the Wrath of the Gulf of Mexico



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Condemnation, or the Wrath of the Gulf of Mexico

Shallow Foundation Washed Away to Expose Deep-Piled Foundation
Riviera I Shown (Typical at the Three Condominiums)

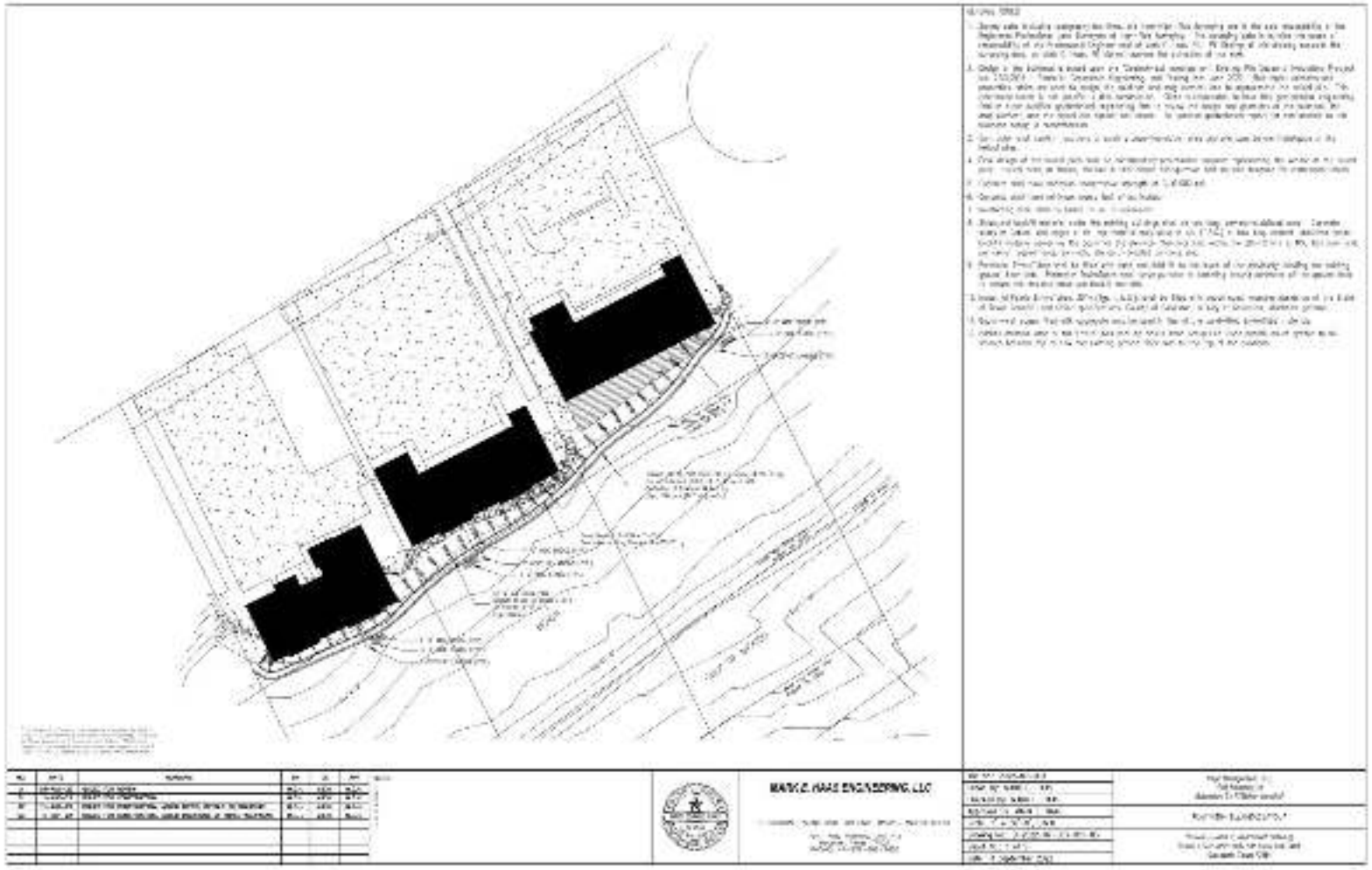
- As the deflections and displacements were small, the City of Galveston, granted a reprieve against condemnation.
- State of Texas GLO concurred with the reprieve, pending a detailed engineering analysis of each condominium.
- To protect the exposed deep-piled foundations against further weathering or damage, a two-step program was initiated.

Condemnation, or the Wrath of the Gulf of Mexico

Shallow Foundation Washed Away to Expose Deep-Piled Foundation
Riviera II Shown (Typical at the Three Condominiums)

- The Condominium HOA's and the HOA of the Sands of Kahala commissioned Mark E Haas Engineering to design a bulkhead to front the properties.

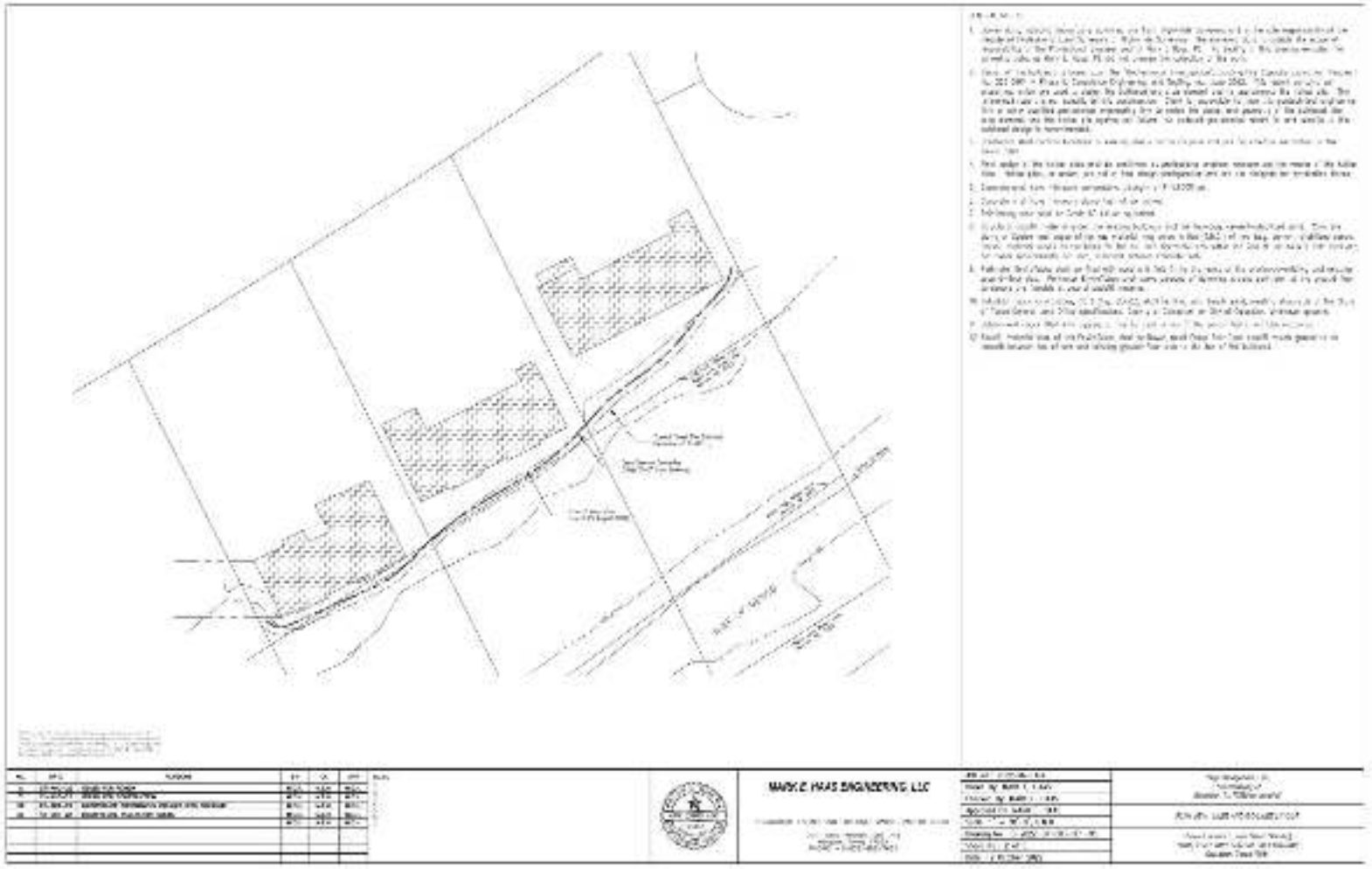
Condemnation, or the Wrath of the Gulf of Mexico



Planning of Proposed Bulkhead

- The plan view for a proposed bulkhead was developed.
- The plan view shows lines of vegetation, of Mean Low Water, of 200-ft offset, of current and original property lines, and of the deadman and of the bulkhead.
- A “random” serpentine pattern was drawn to mitigate rip currents and minimize scouring

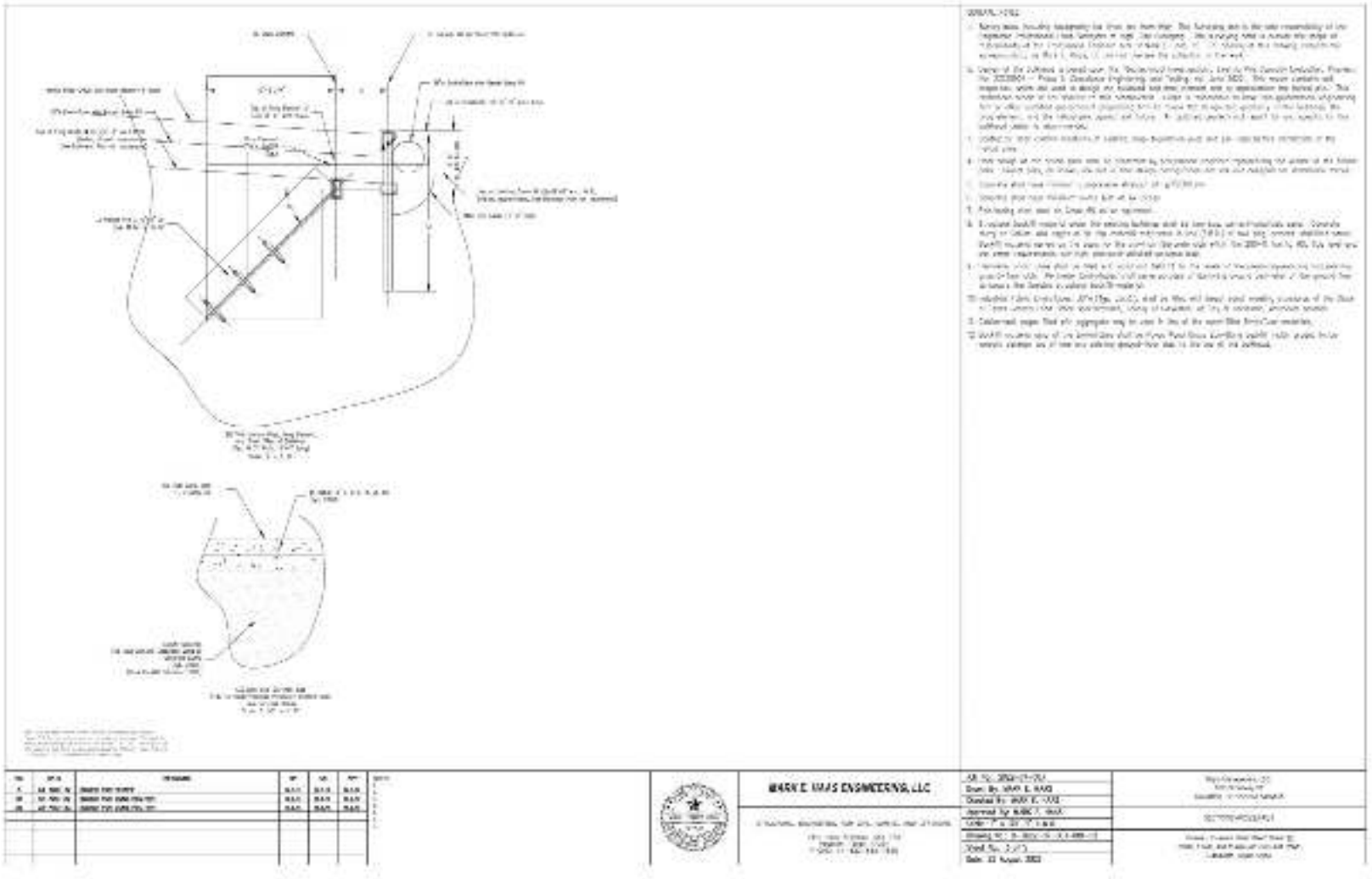
Condemnation, or the Wrath of the Gulf of Mexico



Planning of Proposed Bulkhead

- Another plan view of the proposed bulkhead was developed.
- The plan view shows lines of of current and original property lines, and of the deadman and of the bulkhead.
- Other elevation lines are shown in plan.
- A “random” serpentine patten was drawn to mitigate rip currents and minimize scouring

Condemnation, or the Wrath of the Gulf of Mexico



Planning of Proposed Bulkhead – Elevation View

- Permitting of bulkhead follows two independent paths.
- Work with the City of Galveston and General Land Office to meet GLO requirements and permit construction of the bulkhead on state's lands (within 200-ft offset line)
- Pursue new legislation with the backing of Land Commissioner Dawn Buckingham, State Senator Mayes Middleton, and State Rep. Terri Leo-Wilson.
- These bulkhead drawings are in different committees of the Texas House and Senate for the pending legislation.

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Planning of Proposed Bulkhead

- Five borehole locations were selected to straddle the locations of the proposed bulkhead.
- Geotech Engineering and Testing was selected to perform the borehole sampling and testing.
- Geotech Engineering and Testing performed the sampling and prepared the soils report, tailored to the specific bulkhead design.
- Bulkhead design for the condominiums and the houses was refined and improved for the final IFC drawings.
- The four HOA's are waiting for either the legislation to move forward or the GLO permitting to be approved, so that the bulkhead can be installed.

Condemnation, or the Wrath of the Gulf of Mexico

Prepping Areas for the Backfill of Cement-Stabilized Sand Riviera I Shown (Typical at the Three Condominiums)

- The areas were cleared of debris from Hurricanes Ike, Harvey, Laura, and Delta. Other debris had accumulated from 2020 winter storms.

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Formwork for the Backfill of Cement-Stabilized Sand
@ Riviera I, Riviera I Shown in Background (Typical at the Three Condominiums)

- The areas were cleared of debris from Hurricanes Ike, Harvey, Laura, and Delta. Other debris had accumulated from 2020 winter storms.

Condemnation, or the Wrath of the Gulf of Mexico

Backfill with Cement-Stabilized Sand from Inside Riviera II.
(Typical at the Three Condominiums)

- The areas were cleared of debris from Hurricanes Ike, Harvey, Laura, and Delta. Other debris had accumulated from 2020 winter storms.
- After the areas were cleared of debris and detritus, then the shallow foundation was backfilled with Cement-Stabilized Sand, frequently, with wheelbarrow loads dumped inside the storage areas.

Condemnation, or the Wrath of the Gulf of Mexico

Formwork for the Backfill of Cement-Stabilized Sand
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Condemnation, or the Wrath of the Gulf of Mexico

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Condemnation, or the Wrath of the Gulf of Mexico

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Condemnation, or the Wrath of the Gulf of Mexico

Dune grasses have taken hold at the rebuilt dunes fronting the condominiums. Riviera I shown in foreground (Typical at the Three Condominiums)

- Native grasses are returning to the dunes that front the condominiums and the rebuilt shallow foundation of Cement-Stabilized Sand.

Condemnation, or the Wrath of the Gulf of Mexico

Mott-McDonald prepared a Meteorological/Oceanographic Report for the Site

- Process of re-analysis of the three condominiums starts with assessment of the hurricane loads.
- ASCE 7-16 stipulates 150-mph wind gusts for design.
- FEMA stipulates varied or multistage Baseline Flood Elevations (BFE).
- For flooding from seaward side, minimum BFE is 19 feet above MSL.
- For flooding from landward side, minimum BFE is 16 feet above MSL.
- For flooding from NE or SW, then minimum BFE is 17 feet above MSL.
- Hurricane Ike flooded Galveston Island from the landward side, approximate BFE was 15’ above MSL.

Condemnation, or the Wrath of the Gulf of Mexico

Mott-McDonald prepared a Meteorological/Oceanographic Report for the Site

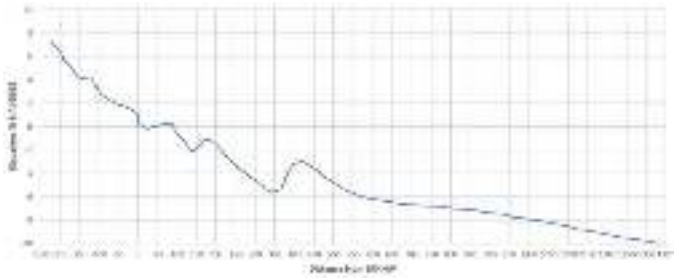
- ASCE 7-16 stipulates the wind speeds.
- FEMA stipulates the Baseline Flood Elevations (BFE).
- Only leeway is assessment of the wave heights, breaking waves, and lateral hydrodynamic and hydrostatic pressures.
- Mott-McDonald and MEH Engineering agreed on the process to assess the wave heights and wave pressures.
- As the Ground Floor was open, hydrostatic pressures were self-canceling, negated, and ignored.
- Wave heights were assessed based upon the constant wind speeds and constant BFE for flood levels

Condemnation, or the Wrath of the Gulf of Mexico

Site Map for the Three Condominiums

- Water levels for the site were predicted from NOAA gauges at Pier 21 and at the entrance to Galveston Bay and the Houston Ship Channel.
- MHHW for both gauges are consistent at 1.1 feet (NAVD88).
- MSL for both gauges are consistent at 0.50 feet (NAVD88).
- MLLW at Pier 21 is -0.31 feet, at Galveston Bay entrance, -0.56 feet.

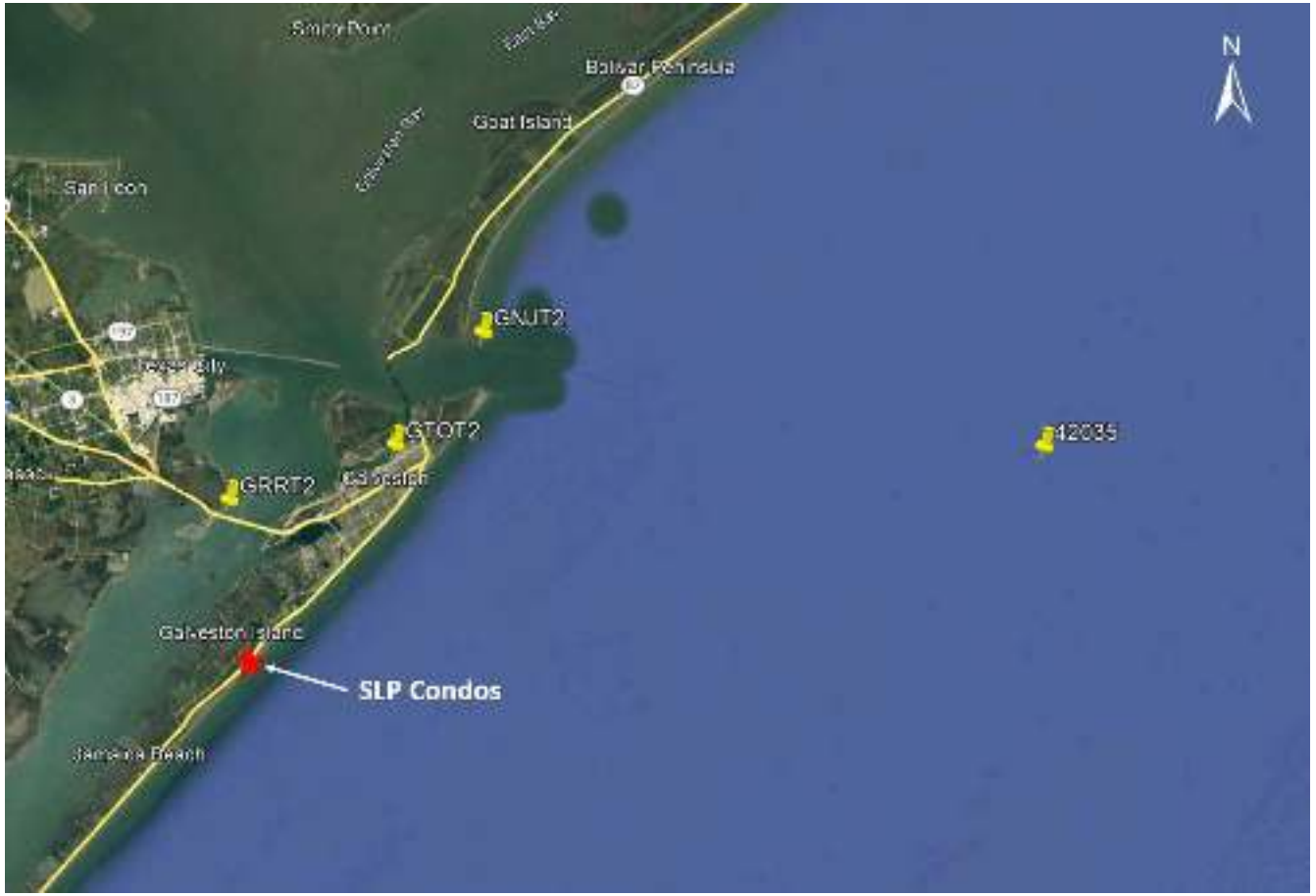
Condemnation, or the Wrath of the Gulf of Mexico



- Beach profiles were developed for the site, so that the modeled storm surges could be assessed and developed.
- Several sections were developed, with one sample shown.

Site Map for the Three Condominiums

Condemnation, or the Wrath of the Gulf of Mexico



Site Map for the Three Condominiums

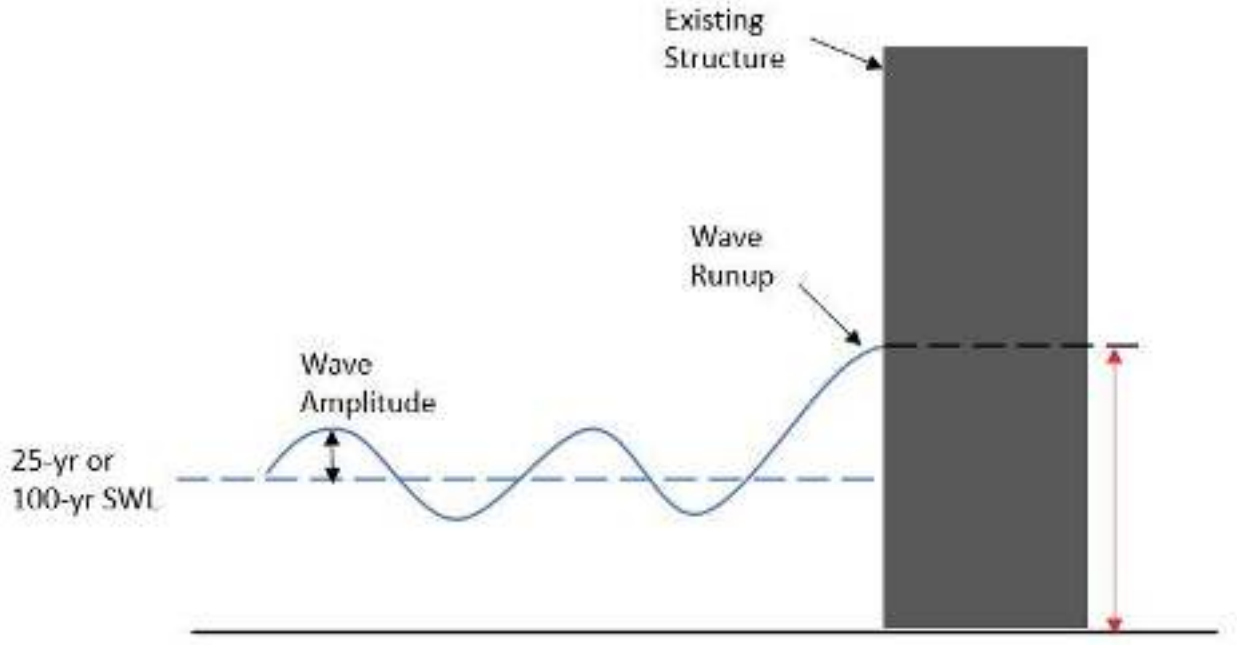
- Similar to the water and wave gauges, various NOAA wind gauges were used to hindcast the data to develop the representative design storm.
- Wind models were developed from the wind gauges.
- From the wave gauges and the wind gauges, the representative design storm was developed for the site.
- The developed wind speeds, the flood elevations, and the wave heights were developed for storms with MRI of 1-yr, 2-yr, 5-yr, 10-yr, 15-yr, 20-yr, 25-yr, 50-yr, and 100-yr storms.
- From this data, 2008 Hurricane Ike, A Category 2 storm at landfall, best fits a 25-yr MRI.

Condemnation, or the Wrath of the Gulf of Mexico

Site Map for the Three Condominiums

- The representative storm for the design would follow a path similar to 2008 Hurricane Ike.
- A direct hit on the condominiums would be with eye of a hurricane approximately 20 miles on either side of the condominium.
- 2008 Hurricane is near-enough a direct hit on the condominiums, but on the dry side of the hurricane.
- The design-level hurricane from the Metocean study is a strong Category 4 hurricane hitting landfall approximately 20 to 25 miles to the southwest of the condominiums.

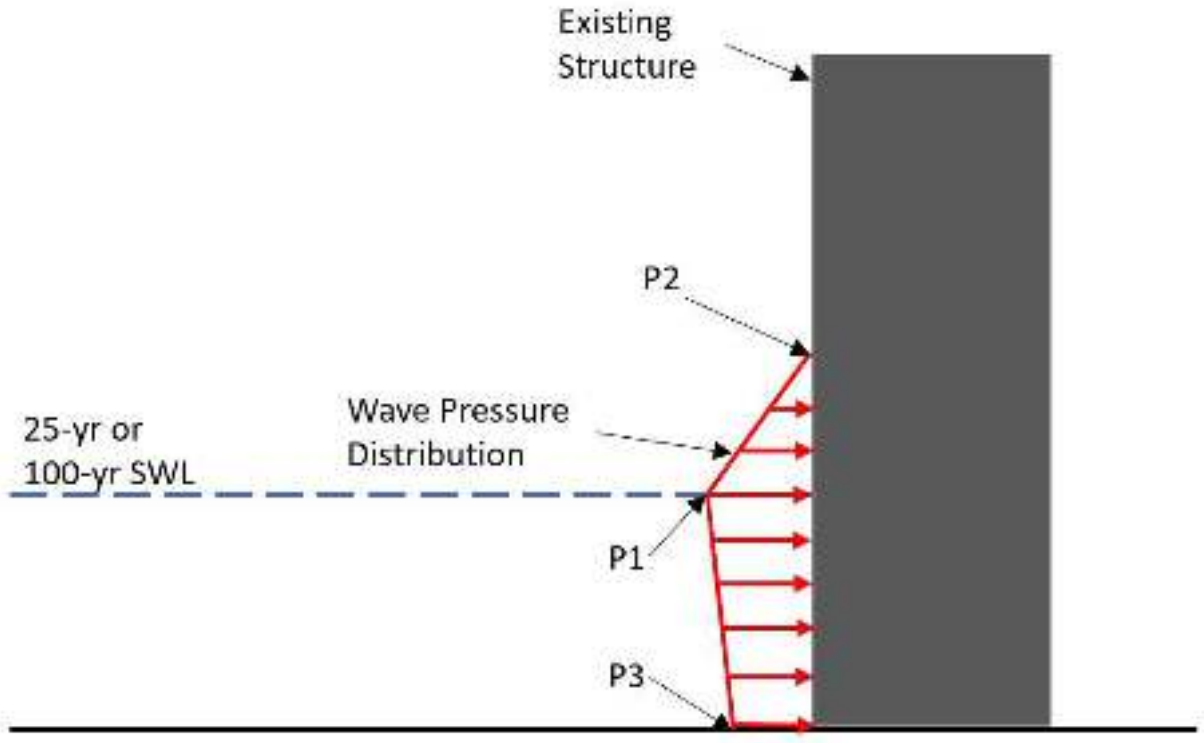
Condemnation, or the Wrath of the Gulf of Mexico



- Maximum wave heights for the 25-yr and the 100-yr storms were developed with respect to the BFE, the maximum sustained wind speed, and the maximum effective fetch.
- Breaking wave heights were developed from the local topography and the maximum normal wave heights.

Site Map for the Three Condominiums

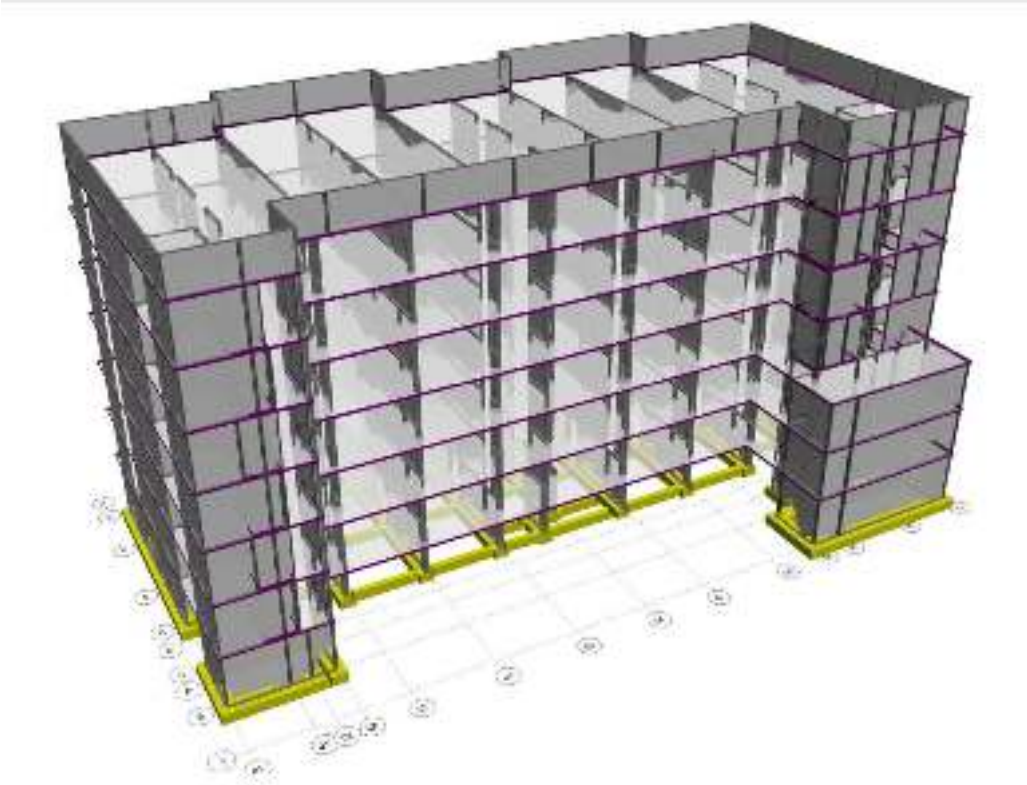
Condemnation, or the Wrath of the Gulf of Mexico



Site Map for the Three Condominiums

- Wave pressures representing the breaking waves for a 25-yr MRI storm and a 100-yr MRI storm.
- These wave pressures are approximately 40% lower than the wave pressures recommended per the ASCE 7-16 standards.
- As the buildings have shear walls on the Ground Floor that are perpendicular to the isolines of the topography, the maximum wave pressures and forces can only occur with the waves parallel to the beach and perpendicular into the sides of the buildings.

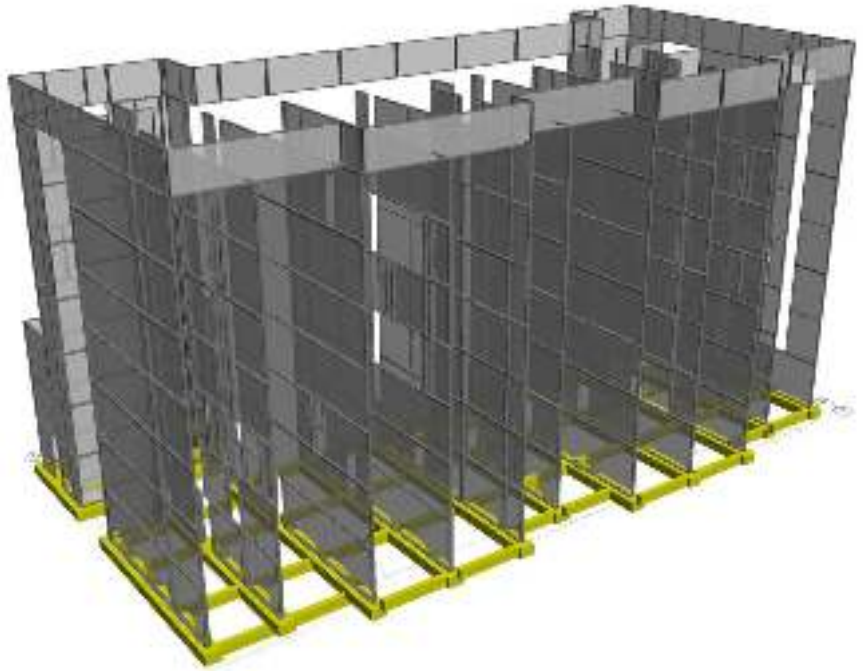
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building NE Corner

- To perform the analysis of the Riviera II condominium, a model for the wind-loading analysis was built in Bentley Software's RAM Structural Systems.

Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building SW Corner
(Floors removed for clarity)

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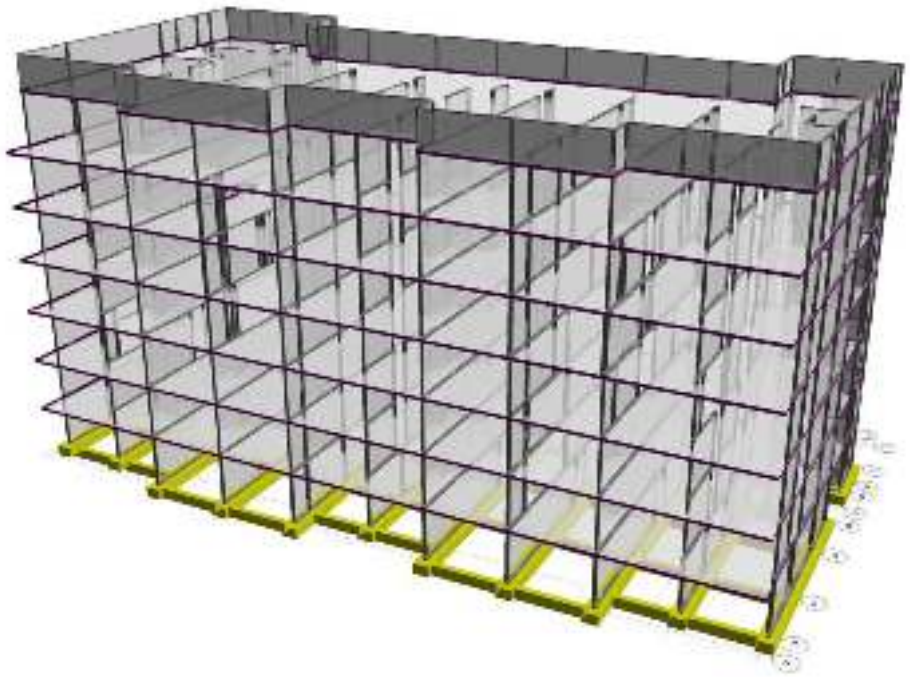
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building SE Corner

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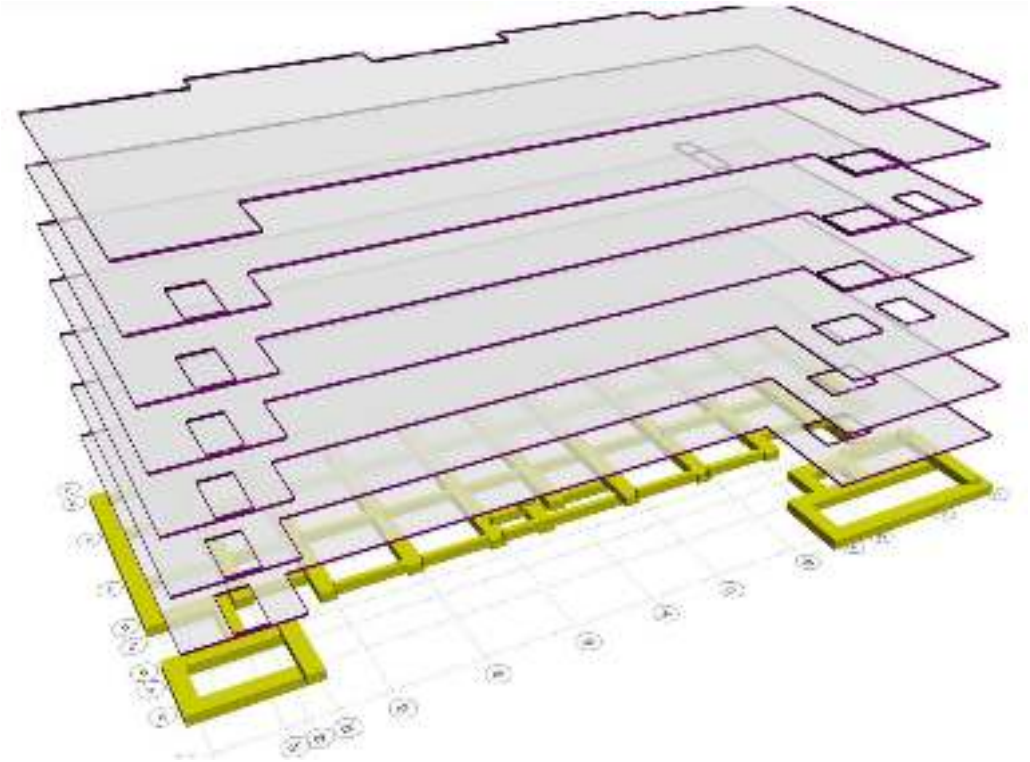
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building NE Corner
(Walls removed for clarity)

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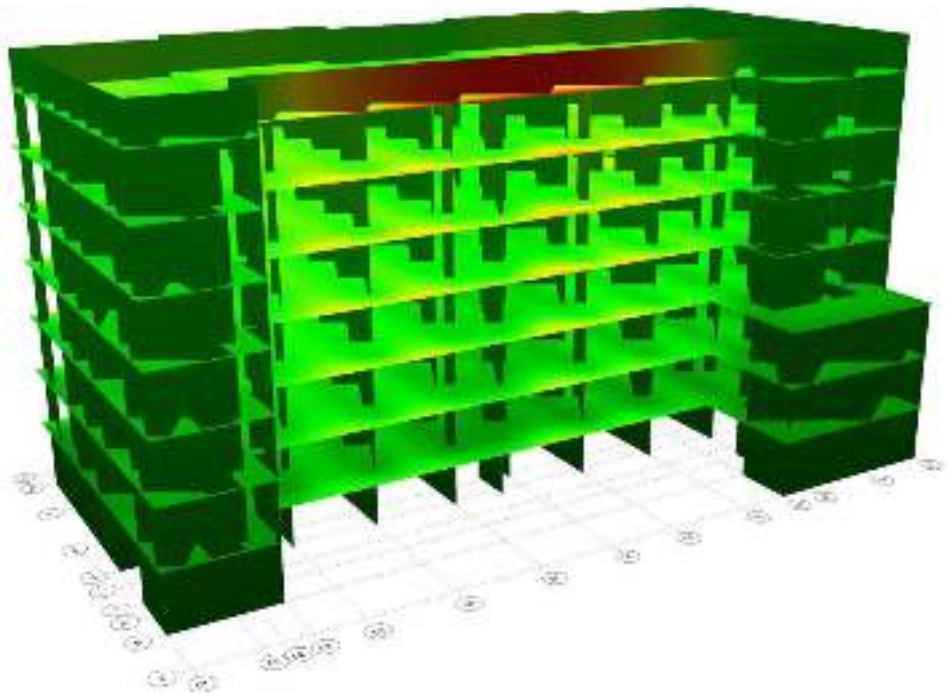
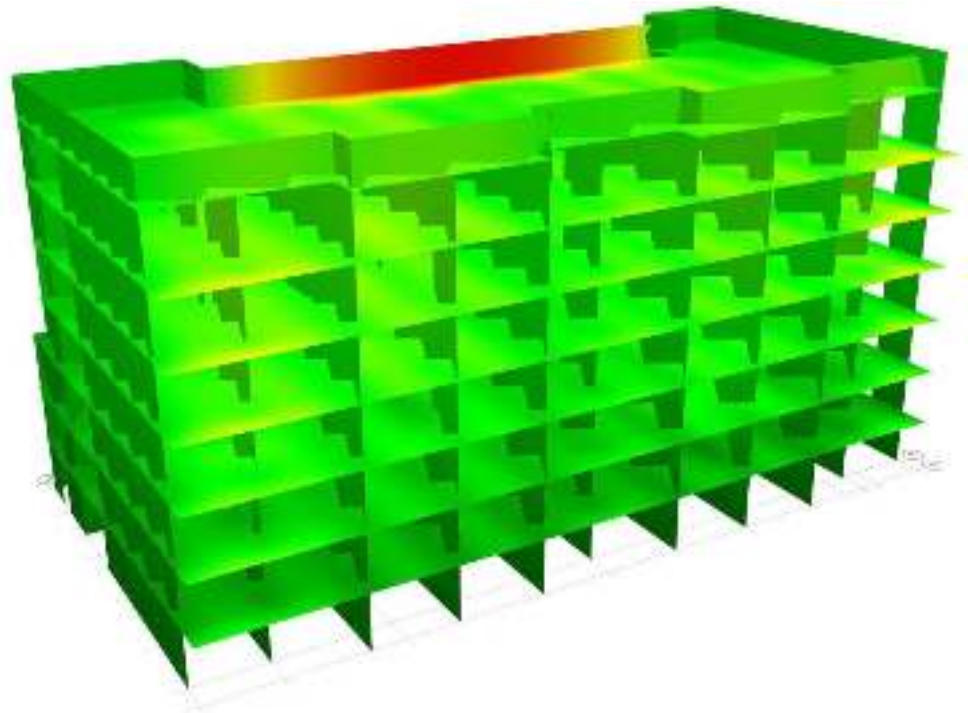
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building NE Corner

- Deflections due to Dead Loads only.
- Maximum deflections due DL less than ¼”, well within Code.

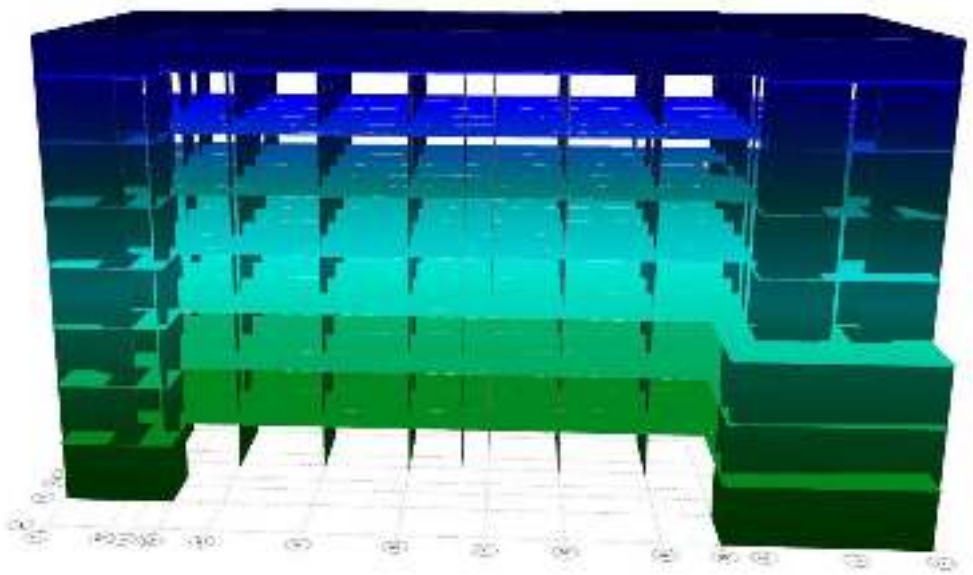
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building SW Corner

- Deflections due to Dead Loads only.
- Maximum deflections due DL less than ¼”, well within Code.

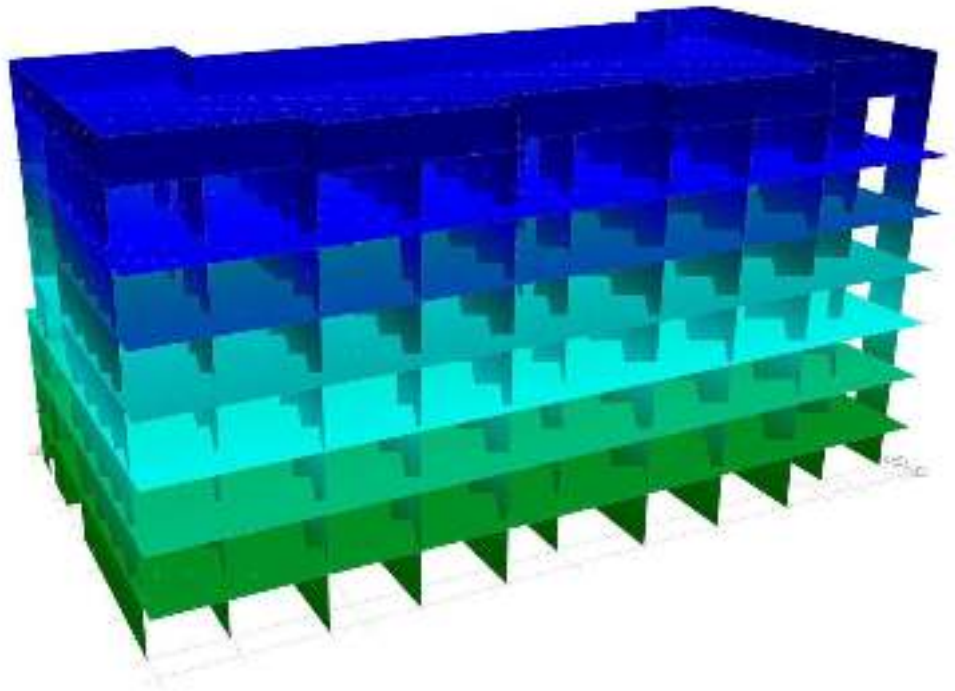
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building North Face

- Deflections due to 150-MPH winds only.
- Wind loads were applied per ASCE/SEI 7-16, including ±e, eccentricities.
- Maximum deflections due Wind Loads less than 3/8”, well within Code.

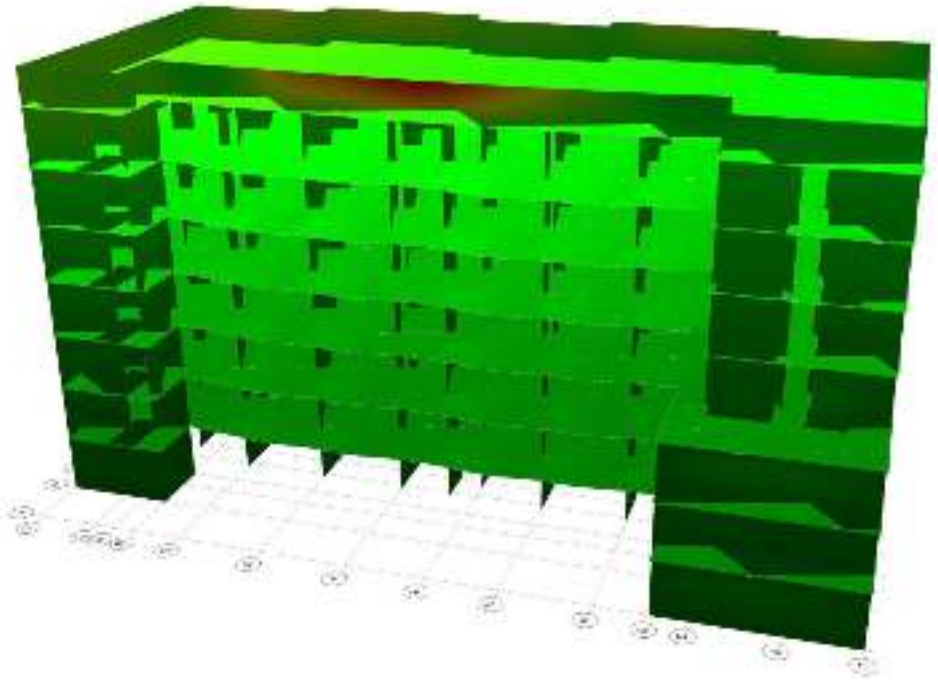
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building SW Corner

- Deflections due to 150-MPH winds only.
- Wind loads were applied per ASCE/SEI 7-16, including ±e, eccentricities.
- Maximum deflections due Wind Loads less than 3/8”, well within Code.

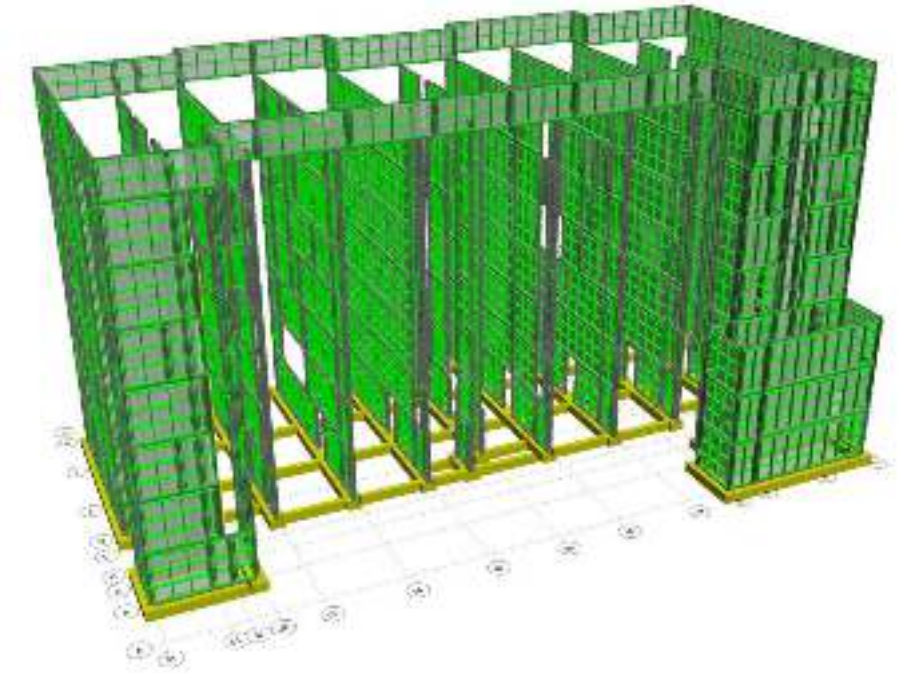
Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building NW Corner

- Deflections due to 150-MPH winds only.
- Wind loads were applied per ASCE/SEI 7-16, including ±e, eccentricities.
- Maximum deflections due Wind Loads less than 3/8”, well within Code.

Condemnation, or the Wrath of the Gulf of Mexico



View of Riviera II from its Building NE Corner

- Code Check of the various sections across the walls.
- Riviera II was well-designed, well-built.
- All sections were passed for geometric considerations and Unity Checks at the concrete sections for forces and moments.

Condemnation, or the Wrath of the Gulf of Mexico

View of Riviera II from its Building SE Corner

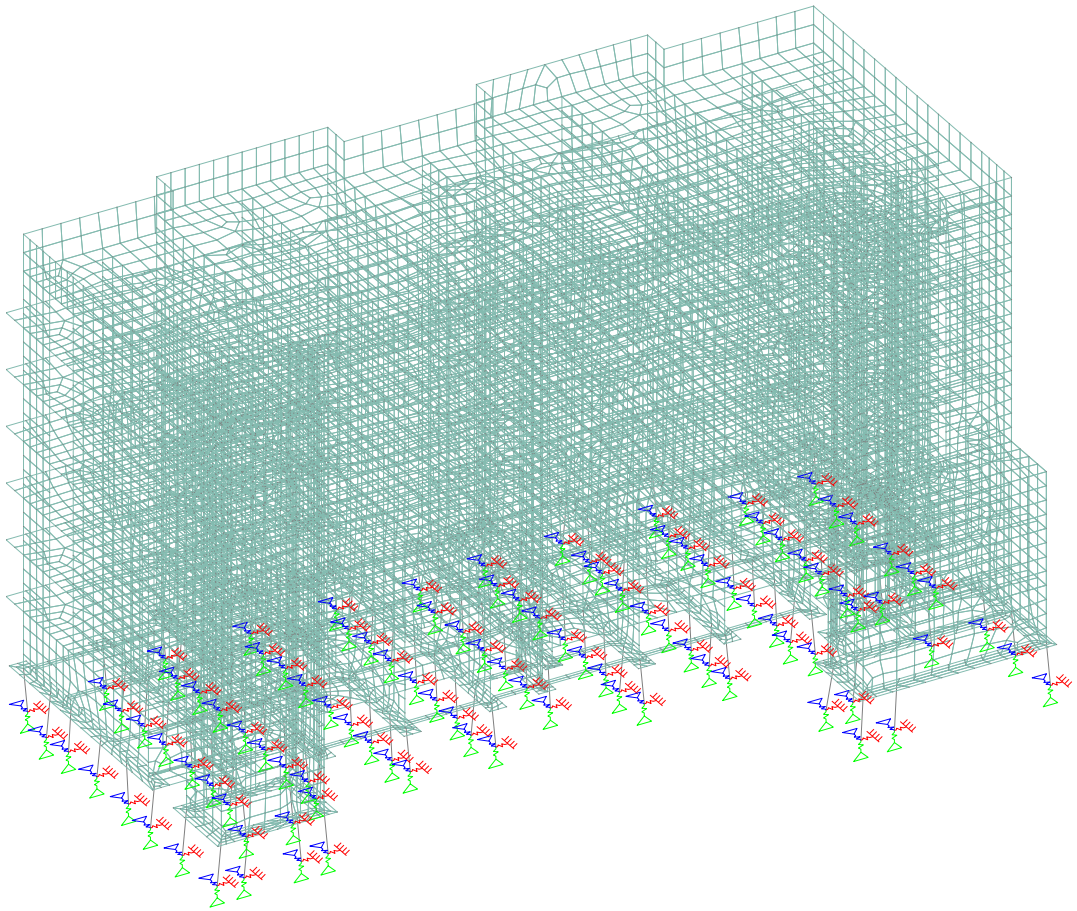
- Code Check of the various sections across the walls.
- Riviera II was well-designed, well-built.
- All sections were passed for geometric considerations and Unity Checks at the concrete sections for forces and moments.

Condemnation, or the Wrath of the Gulf of Mexico

View of Riviera II from its Building SE Corner

- Code Check of the various sections across the walls.
- Riviera II was well-designed, well-built.
- All sections were passed for geometric considerations and Unity Checks at the concrete sections for forces and moments.

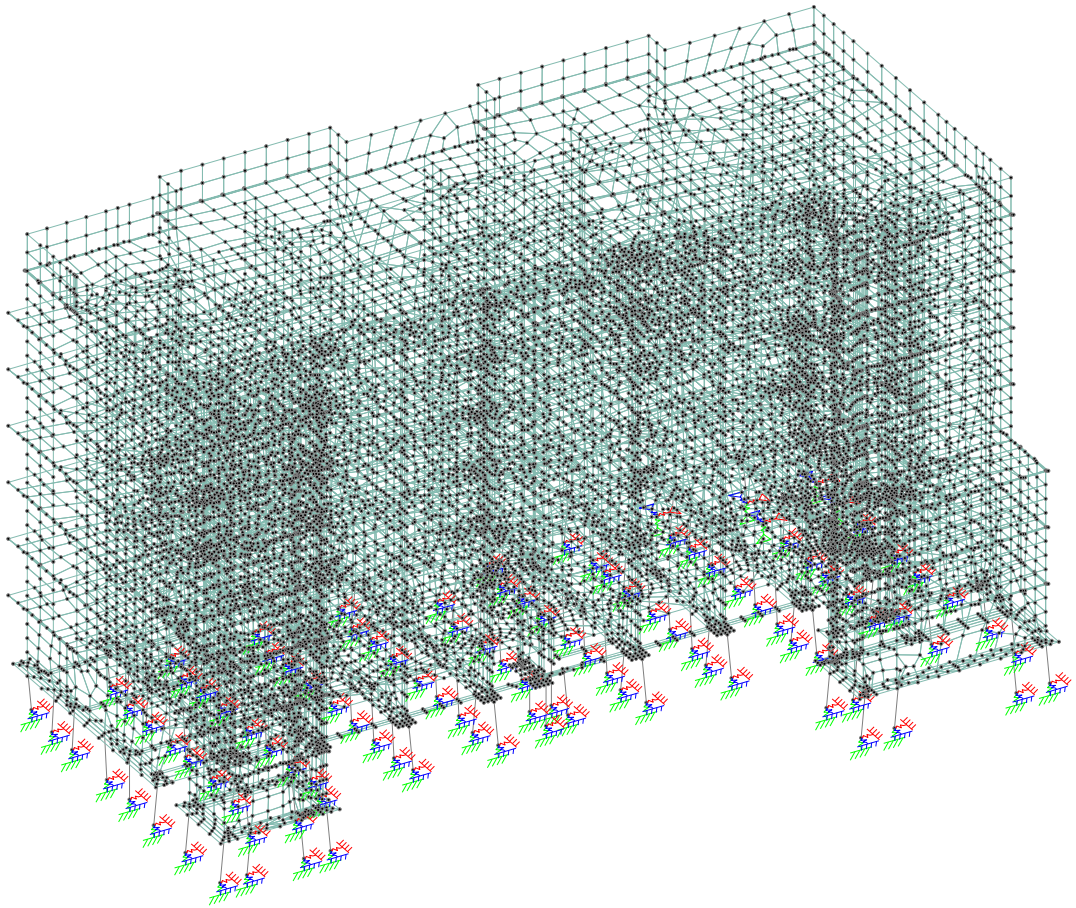
Condemnation, or the Wrath of the Gulf of Mexico



STAAD.Pro Model of Riviera II from its Building NE Corner

- RAM Structural Systems was converted via Bentley iTwins converter into a STAAD.Pro model.
- Linearized flexible foundation was added with pile stubs and piles springs.
- Pile springs were linearized via Tangential method from the P-Y and T-Z curves for the 16-inch piles.
- Quasi-static wave pressures from the 25-yr MRI storm and the 100-yr MRI storm were modeled at lateral pressure loads in the X direction (long'l)
- Quasi-static wave pressures from the said storms were modeled as applied points parallel to the shear walls, based upon the breakaway pressures for the non-loading bearings walls at the Ground Floor and the First Floor.

Condemnation, or the Wrath of the Gulf of Mexico



STAAD.Pro Model of Riviera II from its Building NE Corner

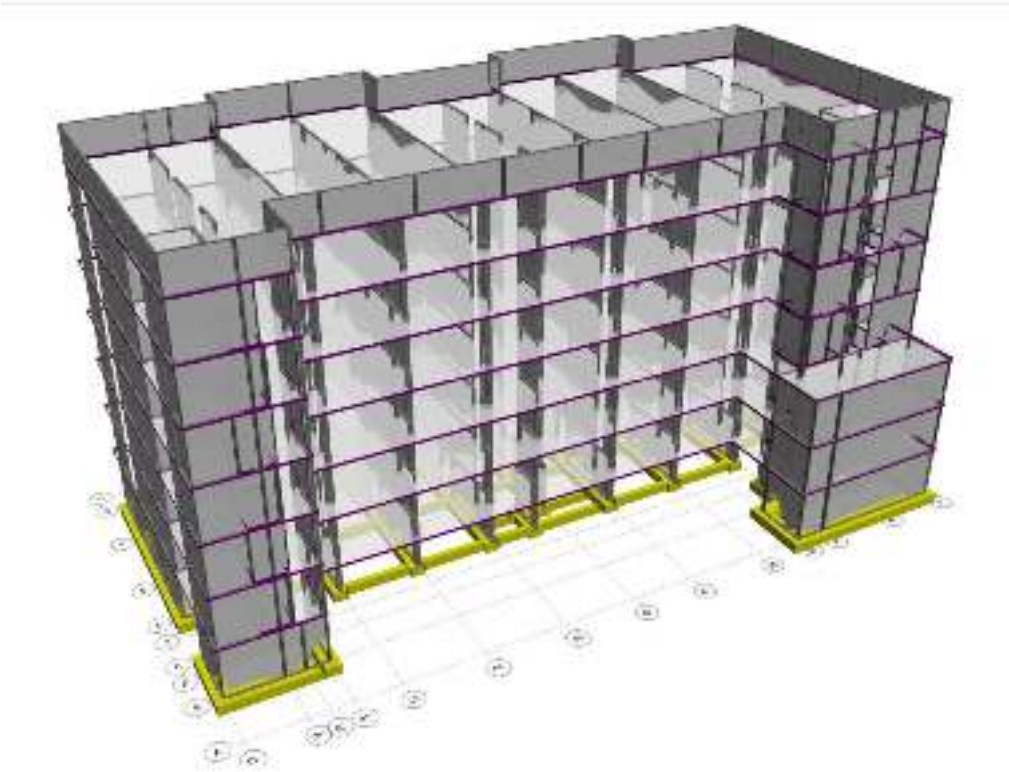
- Wind loads were copied from RAM and applied with STAAD.Pro.
- Code checks were run, similar to the process in RAM Structural Systems.
- All sections were passed with similar results for wave loadings as for the wind loadings.
- Riviera II was deemed intrinsically SAFE for a direct hit from an equivalent Category 4 hurricane, the 100-year MRI design storm.

Condemnation, or the Wrath of the Gulf of Mexico

West Beach Grand condominium looking north at the seaward-facing side

- After completing Riviera II condominium analyses, West Beach Grand condominium is next.
- Whereas Riviera II had a complete set of drawings, albeit with water damage from flooding associated with Hurricane Ike, West Beach Grand structural drawings were lost.
- With existing Architectural drawings, WBG structural drawings were recreated as “IFC” drawings.
- Post-recreating the drawings, the dimensions were checked against the existing building.
- GPR was used to locate and identify pile caps and the piles.
- GPR was used to locate and to identify cover, layers of rebar, and rebar sizes.

Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand condominium looking north at the seaward-facing side

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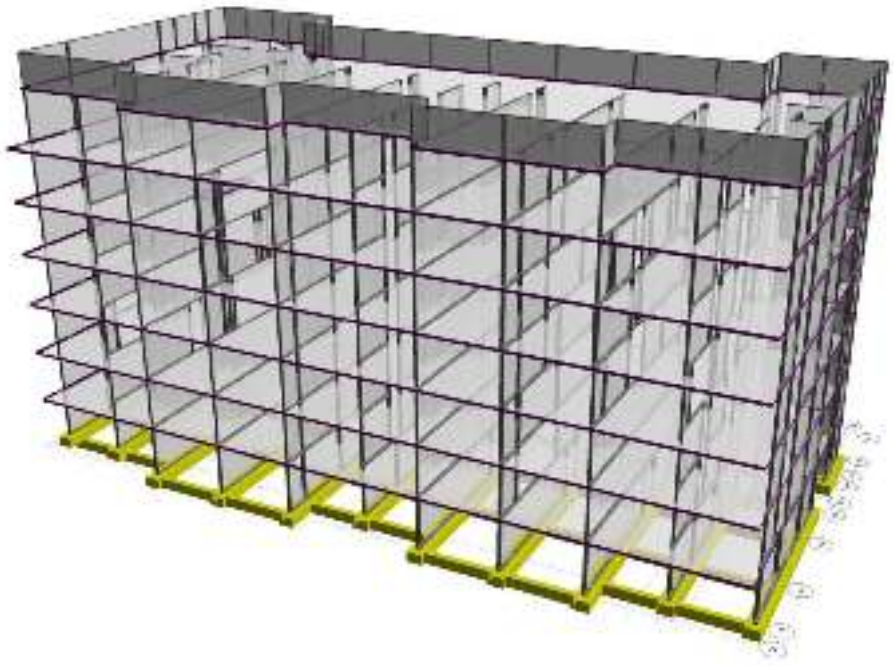
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand condominium looking north at the seaward-facing side

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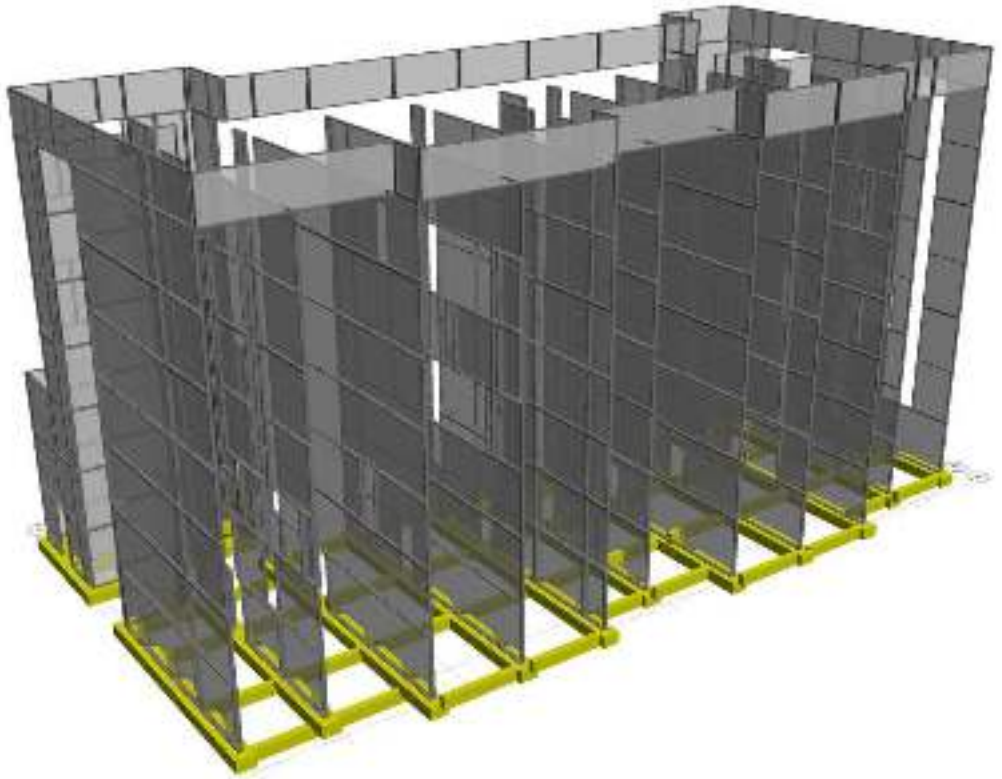
- With existing Architectural drawings, WBG structural drawings were recreated as “IFC” drawings.
- Post-recreating the drawings, the dimensions were checked against the existing building.
- GPR was used to locate and identify pile caps and the piles.
- GPR was used to locate and to identify cover, layers of rebar, and rebar sizes.

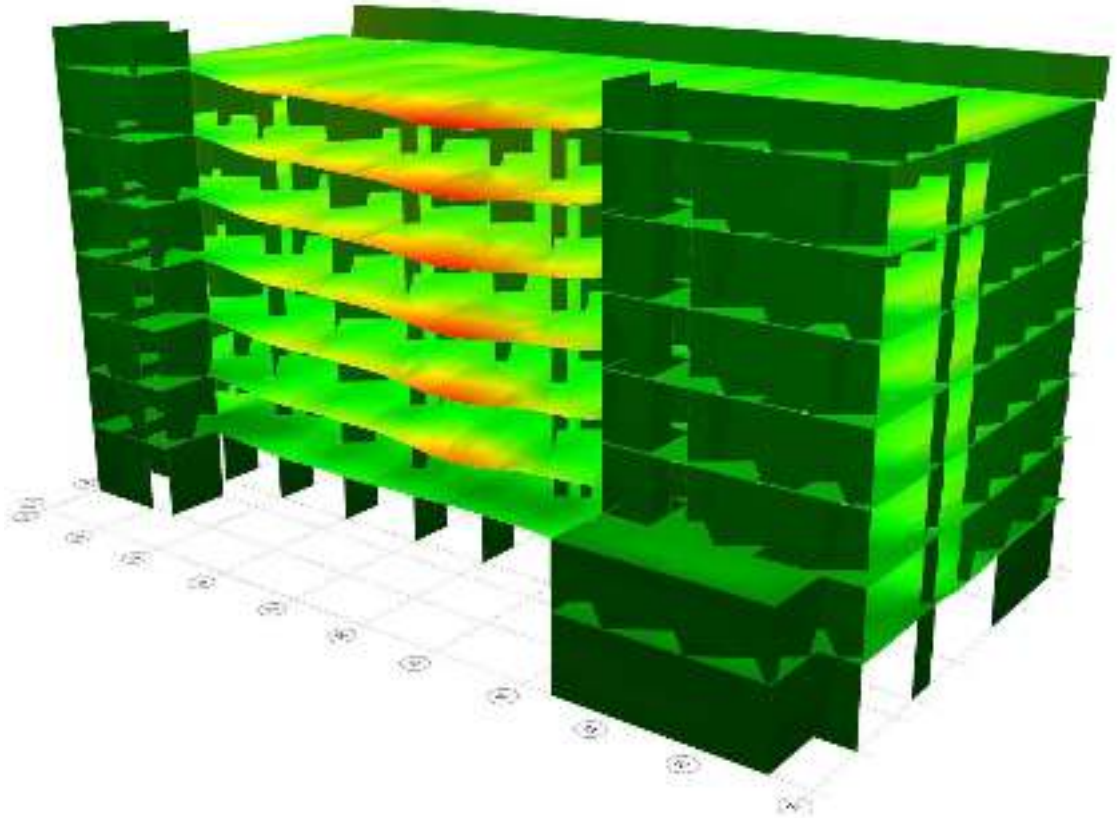
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand condominium looking northeast at the seaward-facing side

- After completing Riviera II condominium analyses, West Beach Grand condominium is next.
- Whereas Riviera II had a complete set of drawings, albeit with water damage from flooding associated with Hurricane Ike, West Beach Grand structural drawings were lost.
- With existing Architectural drawings, WBG structural drawings were recreated as “IFC” drawings.
- Post-recreating the drawings, the dimensions were checked against the existing building.
- GPR was used to locate and identify pile caps and the piles.
- GPR was used to locate and to identify cover, layers of rebar, and rebar sizes.

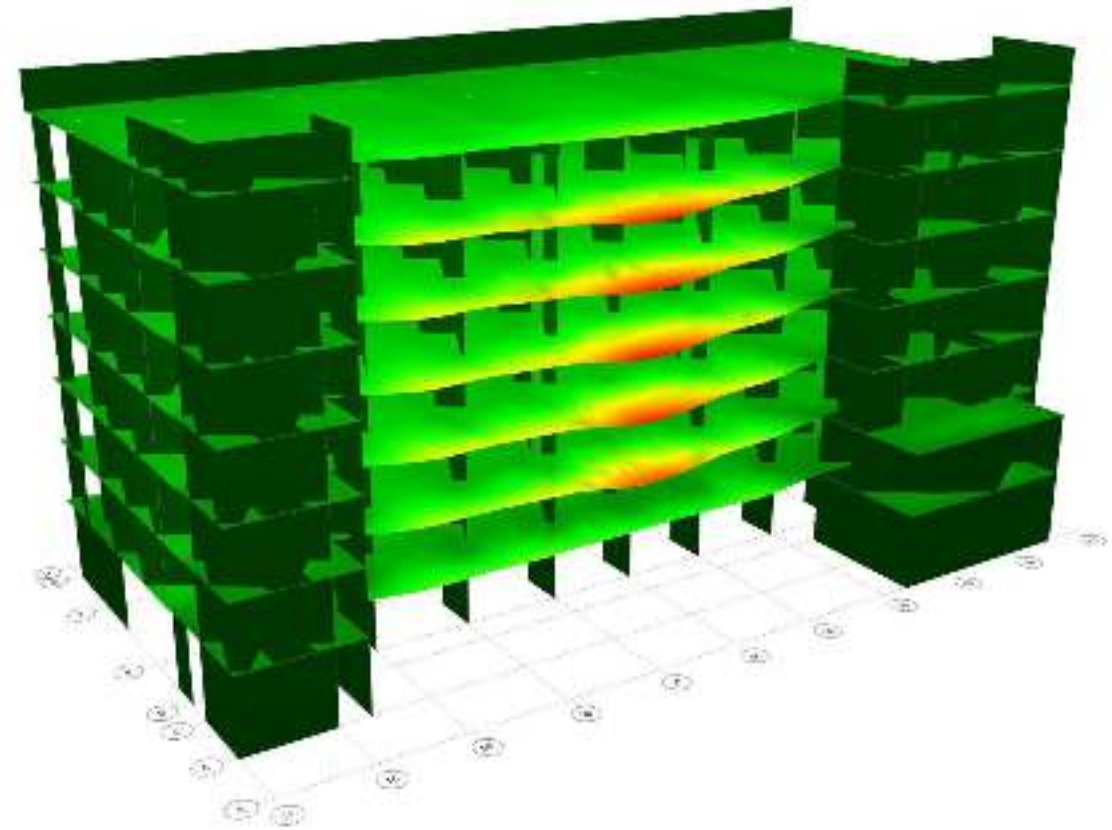
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand deflections from Dead Loads viewed from NW Corner of the Building

- The West Beach Grand condominium was analyzed per ASCE/SEI 7-16 load cases and load combinations.
- Dead Loads were modeled from Self-Weight plus another 10-psf area load for mechanical/electrical/ plumbing loads.
- Deflections from the individual load cases and the integrated load combinations
- All deflections were within constructability and operability Codes and Standards.

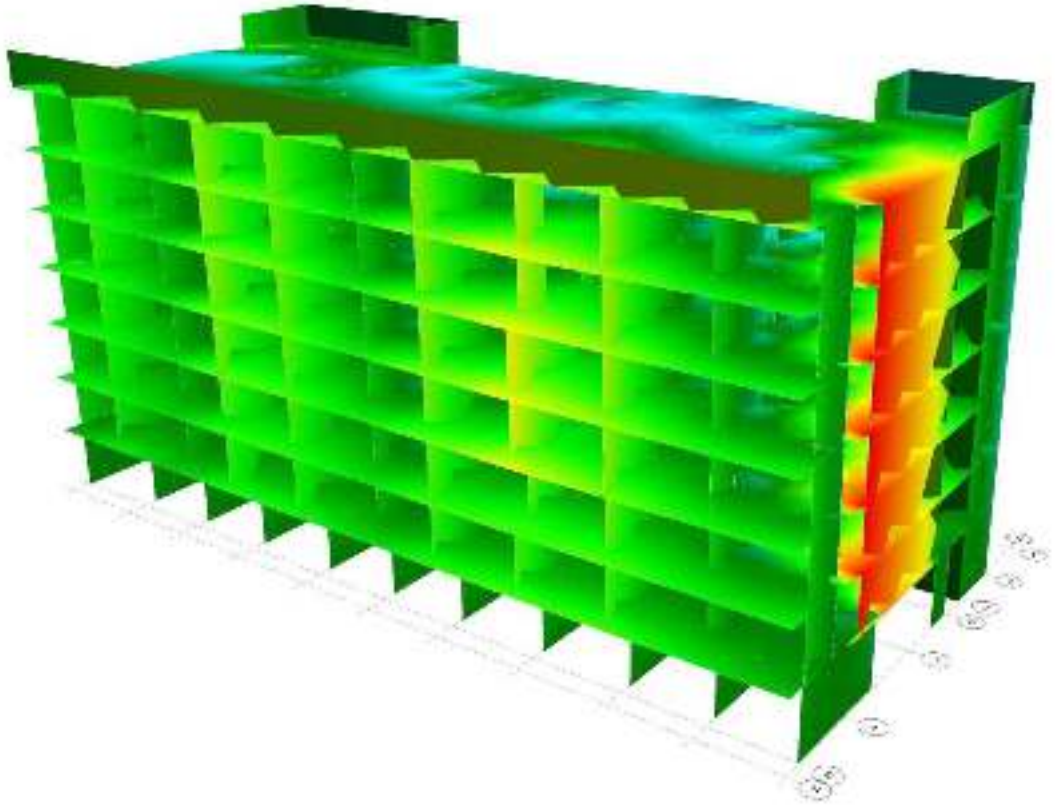
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand deflections from Live Loads viewed from NW Corner of the Building

- The West Beach Grand condominium was analyzed per ASCE/SEI 7-16 load cases and load combinations.
- Live Loads were modeled with 40-psf area loads without reduction factors in the residences and with 100-psf area loads with reduction factors in public areas.
- Deflections from the individual load cases and the integrated load combinations
- All deflections were within constructability and operability Codes and Standards.

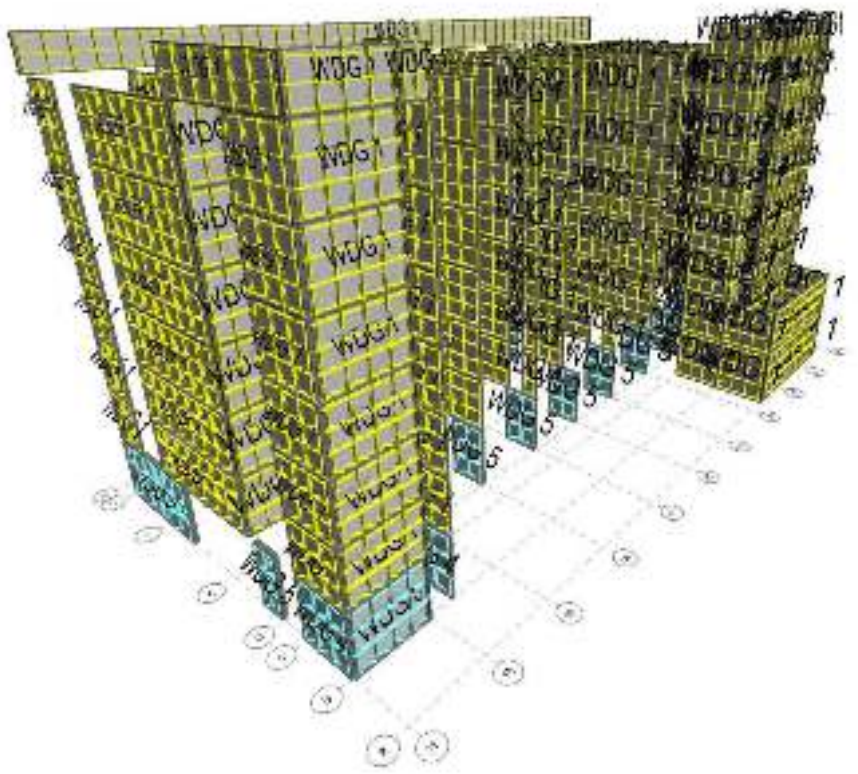
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand deflections from Southerly 150-mph Wind Loads

- The West Beach Grand condominium was analyzed per ASCE/SEI 7-16 load cases and load combinations.
- Wind loads were the result of 150-mph winds applied to the individual floors and applied at the center of the floor diaphragm.
- Deflections from the individual load cases and the integrated load combinations.
- All deflections were within constructability and operability Codes and Standards.

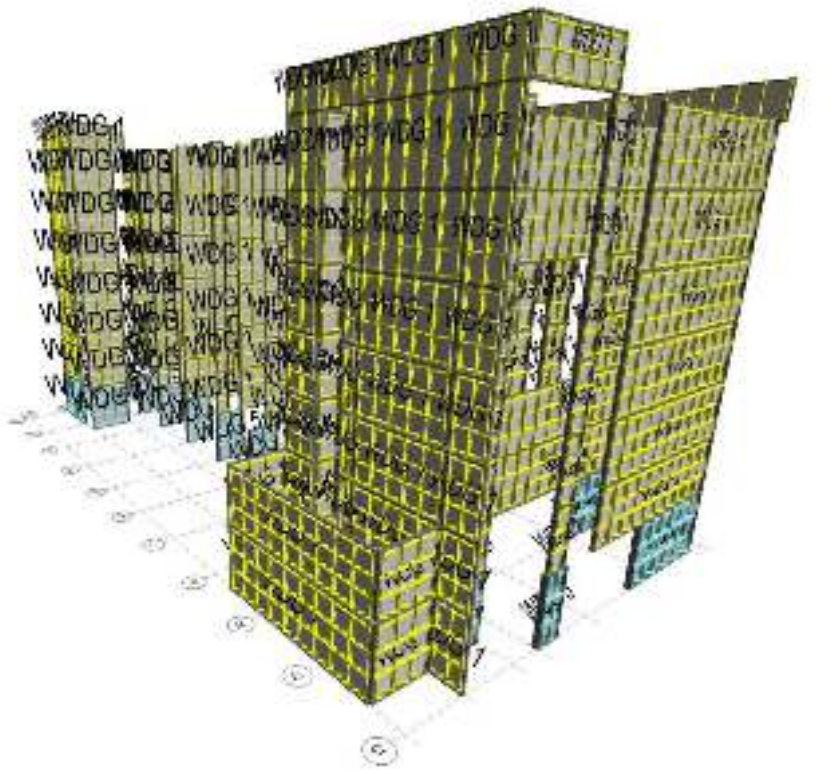
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand condominium Code Check results, shown from the Northeast view

- The West Beach Grand condominium was analyzed per ASCE/SEI 7-16 load cases and load combinations.
- Code checks were performed across the Condominium at the shown section cuts.
- Across all sections, the concrete sections were adequate for strength, with Unity Checks typically between 0.2 to 0.3.
- Unlike Riviera II, where the section cuts were shown in Green, these section cuts are shown in Yellow.
- Across nearly all sections for the walls, but not for the floor sections, the sections did not, met, or just barely passed minimum rebar requirements or minimum concrete cover requirements.

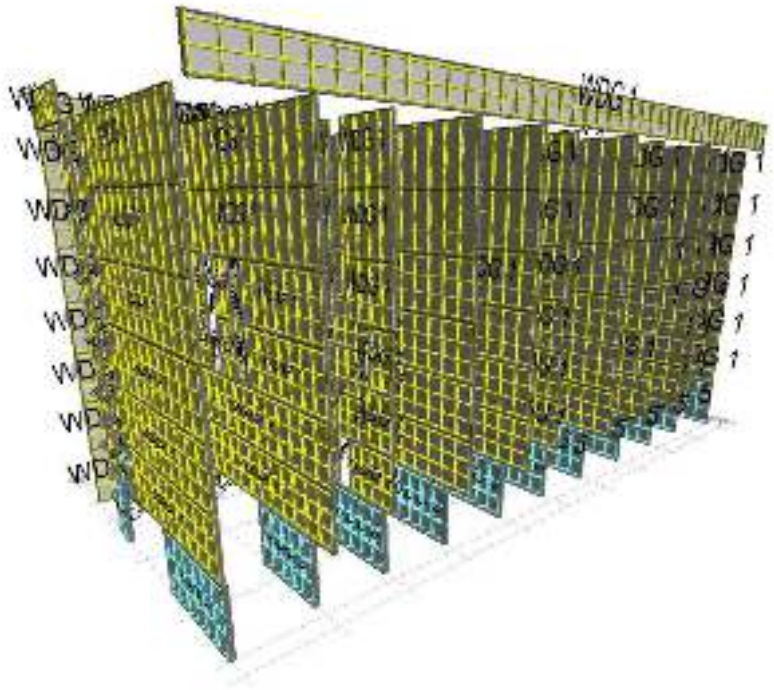
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand condominium Code Check results, shown from the Northwest view

- The West Beach Grand condominium was analyzed per ASCE/SEI 7-16 load cases and load combinations.
- Code checks were performed across the Condominium at the shown section cuts.
- Across all sections, the concrete sections were adequate for strength, with Unity Checks typically between 0.2 to 0.3.
- Unlike Riviera II, where the section cuts were shown in Green, these section cuts are shown in Yellow.
- Across nearly all sections for the walls, but not for the floor sections, the sections did not, met, or just barely passed minimum rebar requirements or minimum concrete cover requirements.

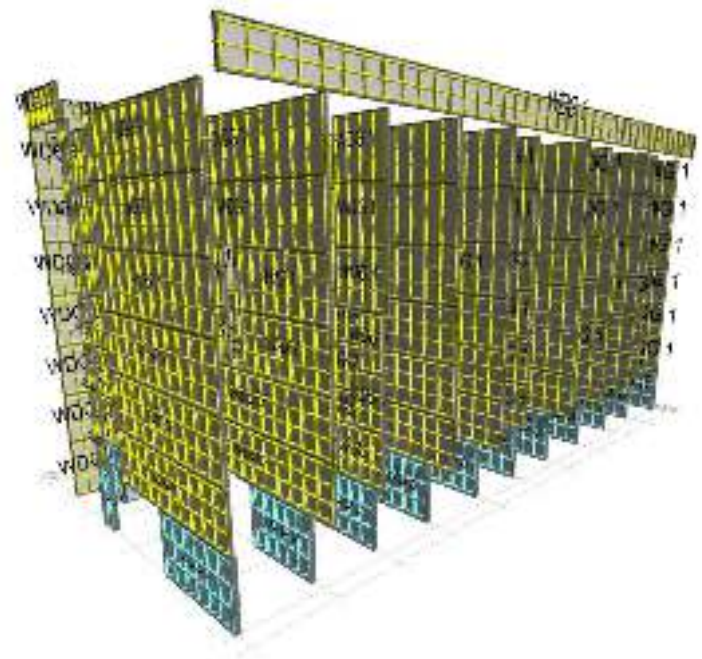
Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand condominium Code Check results, shown from the southwest view, sans floors for clarity

- The West Beach Grand condominium was analyzed per ASCE/SEI 7-16 load cases and load combinations.
- Code checks were performed across the Condominium at the shown section cuts.
- Across all sections, the concrete sections were adequate for strength, with Unity Checks typically between 0.2 to 0.3.
- Unlike Riviera II, where the section cuts were shown in Green, these section cuts are shown in Yellow.
- Across nearly all sections for the walls, but not for the floor sections, the sections did not, met, or just barely passed minimum rebar requirements or minimum concrete cover requirements.

Condemnation, or the Wrath of the Gulf of Mexico



West Beach Grand condominium Code Check results, shown from the southwest view, sans floors for clarity

- As the section barely met or did not meet minimum rebar requirements, the Bentley software concealed the effective Unity Checks.
- The Architectural, Mechanical, Electrical, and Plumbing were drawn in CAD software, probably AutoCAD.
- Riviera II drawings were board drawn in 1985.
- Riviera II drawings were clearly damaged by water flooding.
- Due to the near-perfect minimum amount of rebar in the wall sections, suspicions and a hypothesis are formed that the condominium may have been deliberately shorted of its rebar during construction.
- Due to the rebar and cover issues, an enhanced inspection program is being developed for the HOA.

Condemnation, or the Wrath of the Gulf of Mexico

Riviera I, Riviera II, and West Beach Grand condominiums shown

Future Works:

- Finish the in-progress wave-loading model and analysis of the West Beach Grand condominium.
- Perform remedial engineering for West Beach Grand, as necessary.
- Develop an enhanced inspection program to negate effects of the minimal cover and minimal rebar
- Riviera I drawings were board drawn in 1985.
- Riviera I drawings were destroyed by water flooding from Hurricane Ike, and no drawings exist.
- Recreate structural drawings for Riviera I with LiDAR measurements of the dimensions and GPR scanning for piles, pile caps, and rebar content.
- Build the RAM and STAAD.Pro models of Riviera I for the wind and wave analyses.
- Analyze the models and report results to the HOA, City of Galveston, and the Texas GLO.

Condemnation, or the Wrath of the Gulf of Mexico

Riviera I, Riviera II, and West Beach Grand condominiums shown

Future Works:

- Support HOA's for the bulkhead permitting, development, and installation.
- Support the Legislature and Executive Branch, as requested, with documentation and other information.
- Rep. Terri Leo-Wilson, State Sen. Mayes Middleton, and Texas Land Commissioner Dawn Buckingham are supporting the engineering efforts to save these condominiums and to get permitting or legislation to allow the bulkhead to front the HOA's.
- Provide engineering support to the HOA's as the USACE begins its planned beach replenishment, currently scheduled to begin in 2025