

October 2, 2018

Cracked Glass Unit 36B Investigation



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ALLANA BUICK & BERS

Making Buildings Perform Better

Millennium Tower San Francisco, CA

Prepared for:
The Millennium Tower Association
301 Mission Street
San Francisco, CA 94105

Job # 16-4094.01

GBC California - B – 935970
GBC California - C17 – 862689



Executive Summary

Allana Buick and Bers (ABBAE) is pleased to present our findings for the Millennium Tower Association (MTA) regarding a cracked insulating glass unit (IGU) in unit 36B at the Millennium Tower, San Francisco. At the request of the Miller Law Firm (ML) ABBAE performed an investigation of the cracked glass and to determine the condition of the curtainwall assembly as it relates to the ongoing building settlement.

The damaged IGU is located in the master bedroom of unit 36B on the North facing elevation of the large tower. The exterior pane of glass cracked, while the interior pane of glass remained intact. Until recently, the only way to access the glass was from the interior of the unit, due to a malfunctioning swing stage system on the exterior of the building. Below is a list of different investigations that ABBAE performed to assist in determining the cause of the cracked glass:

1. Interview with the homeowner that reported the glass breakage to determine the sounds and immediate observations during the incident.
2. Interior visual observations of the glass and surrounding curtainwall assembly, including the floor slabs.
3. Long distance photography with high powered zoom to observe the glass from an adjacent building.
4. Demolition of interior finishes at unit 36B and 37B to observe the structural slab edge connections for the curtainwall.
5. Interior survey measurements for floor level and floor height differential
6. 3D scanning of the unit were also performed by a 3rd party firm to confirm measurements.
7. Visual observations from the swing stage on the exterior of the cracked glass.

Before this incident of the glass breakage in unit 36B, ABBAE has conducted various curtain wall and glazing observation and investigations starting in October 2016, through February 2018. This report includes a synopsis of the previous investigations as well.

ABBAE has evaluated glass breakage in unit 36B and determined that the cracking is from a source break due to an exterior impact. Observations performed from the interior and exterior of the curtainwall assembly, along with previous investigations at other units show a lack of structural defects that could cause this type of damage. The curtainwall connections also do not show abnormal movement that could cause an IGU to break.

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Previous Investigation

Previous Investigations, October 2016 through February 2018

In October 2016, ABBAE conducted a visual survey of the exterior curtain wall modules, utilizing the house window-washing rig, to observe if the building settlement had any noticeable impact on the system. During these exterior drops, we observed some issues with module offsets as well as the “coating finish” on the aluminum mullions. During these visual surveys, we conducted about a dozen drops with the window-washing rig on various elevations to identify these issues. We observed module offsets and recommended further invasive testing to ascertain the causation of the shifting panels. Prior to the invasive testing, we also augmented our visual investigation by conducting a partial drone survey. The drone was unable to complete a full survey because of technical issues related to surrounding high-rise buildings.

Based our drops as well as the drone survey, we observed that offset panels were isolated on a few stacks, on certain floors only.



TYPICAL PANEL OFFSETS OBSERVED



Following our observations, we conducted invasive testing of five curtain wall units , 40E, 42E, 45E, 47E and 50D by cutting open sections of the slab edge metal panels from the exterior. We investigated the structural connections of the curtain wall panels to the slab edge. Based on investigating all five locations, we concluded that the curtain wall modules had not shifted. Rather, we determined that the modules were installed in this position during the original installation due to slab and other normal construction tolerances



PRE-INVASIVE TESTING OBSERVATION OF SHIFTED PANELS



OBSERVATIONS OF THE CURTAIN WALL STRUCTURAL CONNECTIONS

Our observations of the five invasive testing locations all proved negative for any potential structural issues or the shifting of the curtain wall due to settlement.

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Unit 36B Investigation

Glass Breakage in Unit 36B, September 1, 2018

Homeowner Interview Unit 36B

ABBAAE was informed of a glass break in unit 36B on September 2nd, 2018. We received written accounts of the noises associated with the breakage from 2 homeowners in the B stack. The homeowner of unit 36B described the event as follows:

"We were abruptly awoken by a massive bang at 2:30 am in the morning. This sound was so massive in scale, it sounded like a huge, thick vault door had just slammed shut."

The homeowner also described hearing a sound like the glass cracking for ½ hour following the bang.

Interior Visual Observations

ABBAAE investigated the interior side of the glass several times in the days following the incident. The glass in the unit is "dual paned" and we observed that the crack was in the exterior pane of glass. The cracks in the IGU appeared to initiate from the left side of the lite, approximately mid-span of the left jamb. From the inside we observed that there was an impact like damage and cracks emanating to the left and right of that point. At the time of our initial observation, the cracks had spread throughout the rest of the glass. In the days following our initial site visit, the cracks continued to spread because of the fact that the glass is heat strengthened. We did not rule out building settlement as a potential cause of breakage. Our initial concern was that due to the heat strengthened nature of the glass, the cracks would continue and potentially pieces of broken glass may fall down.

Temporary Safety Measures

We wanted to drop down the face of the building and examine the glass breakage as well as tape up the glass to make it safe, however the house window-washing rig was not working at the time. In order to prevent glass from falling, we hired a local glazing contractor to apply thick (7 mil) security film over the glass. The glazer was able to reach out from an adjacent operating window opening to apply the film.

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Long Distance Photography

The first look ABBAE obtained from the exterior side of the glass was from a building across the street. ABBAE was able to gain access to the building on the 28th floor to photograph the cracked glass from a level vantage point. These photographs showed that the point where the cracks appear to initiate from is beyond the vertical mullion and is visible from the interior side of the building, but the edge of the glass where the break radiates to is not visible from the interior.



CLOSE-UP OF THE GLAZING CRACK AND SECURITY FILM INSTALLED

Interior Observations of Curtainwall Connections, 36B and 37B

In order to investigate potential building movement as a cause of the broken glass, ABBAE conducted invasive testing, visual observations and laser scans of unit 36B and 37B. With 3D laser scanning and with conventional methods, we measured the floor to ceiling height at several locations within both units. Laser measurements were taken at each mullion to determine the relative distances between the vertical mullions and the slab. Measured slopes on the floor slabs and curtain wall horizontal mullions were level (zero inches per foot). The slight variances in floor levels were due to concrete tolerances.

3D scanning was performed inside the unit to capture dimensions of slabs and walls to confirm our measurements. With the assistance of a contractor, ABBAE removed the interior finishes and fire safing to examine the structural connections of the curtain wall modules to the slab edge. We examined the curtainwall slab edge connections once interior finishes at the window sills were removed in units 36B and 37B. The curtainwall connections did not appear to be permanently stressed or displaced. In some of the connections there were signs of scratches that we



determined occurred during the initial installation. There was no deformation or signs of stress or recent movement in the structural connections.

UNIT 36B, STRUCTURAL CONNECTIONS EXPOSED AT SLAB EDGE



CLOSE UP OF CURTAIN WALL CONNECTION AT SLAB EDGE

Exterior Observations from the Swing Stage

The swing stage repairs were completed to allow for a September 25th inspection from the exterior of the building. ABBAE dropped the North elevation of the building to observe the cracked glass in 36B up close. The observations showed the “source break” a point where the cracking starts and the resulting cracks throughout the IGU. The source break was a single round point of impact from which the rest of the cracking emanated. This confirmed the observations from previous investigation.

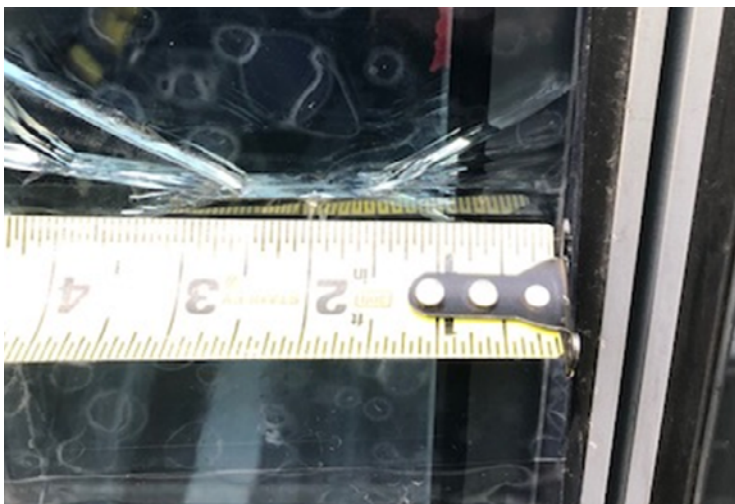
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VIEW FROM THE INSIDE OF UNIT 36B



VIEW FROM EXTERIOR, AT SOURCE BREAK



SOURCE BREAK IS 2" FROM EDGE OF GLASS



**PERIMETER GASKETS AROUND EDGES OF GLASS HAVE UNIFORM SPACING AND
HAVE NO EVIDENCE OF ANY CONTACT WITH ALUMINUM FRAME**

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Conclusion

ABBAE has looked at this damage and determined that the cracking is from a source break due to an exterior impact. The homeowner corroborates this damage observation with the report of a loud noise that awakened them, followed by continued noises as the glass breakage grew. Additionally, the slabs and ceilings in the unit do not show signs of movement capable of causing this type of damage. The curtainwall connections also do not show any abnormal movements that could in any way cause an IGU to break. The exterior observation shows there is uniform margins between the glass and curtainwall frame. From the exterior, there is no evidence that the glass made contact with any other curtainwall elements. Replacement glass has been ordered and we can further analyze the glass after removal. ABBAE does not recommend further action at this time for the glass in unit 36B.

Based on our extensive investigation in Unit 36B, 37B and the previous units, 40E, 42E, 45E, 47E and 50D, it is ABBAE's opinion that further structural investigation of the curtainwall assembly is not warranted. It is not uncommon to have some glass breakage in all high-rise buildings due to impact. We have conclusively determined that the breakage in unit 36B is unrelated to building movement and settlement. We also recommend that the pedestrian protection be removed now that the broken glass has been secured with heavy security film.

Let us know if you have any questions.

Sincerely,

Allana Buick & Bers, Inc.

Karim Allana, PE, RRC, RWC
Senior Principal, Chief Executive Officer
PE California - C 41693
GBC California - B - 935970

Ray Mohun
Senior **Glazing** Consultant
GBC California - 862689

ABBAE is an Architectural Engineering firm specializing in forensic investigation and engineering of curtainwalls, exterior façade and other building envelope assemblies. ABBAE is a licensed engineering and architectural firm; a licensed general contractor and a licensed glazing contractor in California.

KARIM ALLANA, PE, RRC, RWC



President / Founding Principal

Mr. Allana is the founder and Chief Executive Officer of Allana Buick & Bers (ABBAE). He has been in the construction field for over 38 years and specializes in forensic analysis, sustainable design, and construction management of building envelope, roofing, and waterproofing systems.

Mr. Allana is one of the foremost building envelope defect expert in the Western United States. He has acted as a consultant or expert witness in over 600 construction defect projects and specializes in system failure and standard of care issues. Of those 600+ forensic projects, over 50 are Bay Area projects involving complex glazing.

Mr. Allana has worked with many attorneys and has represented all types of clients on a wide range of projects. He has acted as lead plaintiff expert, lead defense expert, or subject matter expert on behalf of Owners, Property Managers, Developers, General Contractors, Subcontractors, and material Manufacturers. His litigation experience includes single-family and multi-family residential buildings, commercial office buildings, industrial structures, public building buildings, and educational facilities.

As a consultant and expert witness, Mr. Allana has worked on many aspects of building envelope construction. His trade-level expertise include most types of roofing systems, EIFS, cement plaster, windows and fenestration systems, façade systems, metal panels, masonry, hardboard siding, pre-cast and formed concrete, masonry, metal panels, windows, doors, storefronts and curtain wall systems, flooring, ceramic tile, stone veneer assembly, dimension stone, and general exterior construction.

Mr. Allana is heavily involved in the forensic investigation process. He has personally performed most destructive and non-destructive testing methods and is an expert in all relevant ASTM/AAMA and industry standards. In conjunction with forensic investigation and expert witness testimony, he also assists with preparation of construction documents, cost estimating, bidding, and procurement, and construction phase consulting during defect reconstruction. Mr. Allana has also acts as an expert and mediator to resolve disputes between parties, analyzing claims, and change orders to mitigate the risk of future litigation.

Education

- Santa Clara University, Santa Clara, California
 - B.S., Civil Engineering

Registration

- PE, Civil Engineering:
 - California
 - Hawaii
 - Washington
 - Nevada
 - Oregon

Contractors Registration

- California (935970)
- ABBAE's (814455)

Certifications

- Registered Roof Consultant (RRC) Registered Waterproofing Consultant (RWC)
- General Building Contractors License, California

Representative Experience

- With ABBAE Since: 1987
- With Other Firms: 8 years

Professional Societies and Affiliations

- The Association for Preservation Technology International (APT)
- Coalition for Adequate School Housing (CASH)
- International Facility Management Association (IFMA)
- Roof Consultants Institute (RCI)
- Sealant, Waterproofing and Restoration Institute (SWRI)
- American Architectural Manufactures Association (AAMA)

Office Locations

- Palo Alto (Headquarters)
- Oakland
- Los Angeles
- Irvine
- San Diego
- Sacramento
- Seattle
- Portland
- Las Vegas
- Charlotte
- Honolulu
- Kihei

Sample Litigation and Forensic Experience

- **900 Green Street, San Francisco, California:** EIFS, windows, and balcony defects and damages to a 12 unit luxury condominium project.
- **Fillmore Center, San Francisco, California:** Provide investigation, preliminary design, budgets, design options, plans and specifications and litigation support for defect remediation for a 1,114 unit, multi-story, multi-family apartment home.
- **Infinity HOA, San Francisco, California:** Performed visual investigation, recommended further investigation, and investigated the curtain wall, below grade parking structure, and mechanical investigation of the multi-structure mixed use property located in the South Beach District of San Francisco. The property includes 4 buildings; Building A, Building B, Building C and Building D. Building A consists of 8 floors, Building B consists of 27 floors, Building C consists of 9 floors, and Building D consists of 42 floors.
- **Madrone Homeowners Association, San Francisco, California:** Unit and common area destructive testing.
- **South City Lights Homeowners Association, South San Francisco, California:** ABBAE was retained to provide forensic investigation, limited destructive testing and water testing for this four story residential community built over a podium slab with two levels of garage below. The complex has a total of six buildings with 290 total units and common areas. Our investigation included exterior stucco systems, belowgrade waterproofing systems, structural concrete cracking in the garage, and leaking window systems.
- **631 Folsom Street (Blu), San Francisco, California:** We performed project initiation, visual observations, common area destructive testing to this project.
- **San Francisco International Airport, San Francisco, California:** Multiple large projects for individual buildings to repair and rehabilitate leaks and other water intrusion.
- **San Francisco Examiner, San Francisco, California:** Construction defect litigation assistance regarding the San Francisco Examiner headquarters building. International Gaming Technologies (IGT), San Francisco, California: ABBAE was retained to provide construction defect consulting for a new construction system failure. The building was IGT's new Las Vegas office and manufacturing building. ABBAE was hired to perform forensic investigation and destructive testing to determine causation for the exterior tile façade falling off. ABBAE's scope included oversight of the contractor during the repair construction.
- **Mission Dolores, San Francisco, California:** Investigation, analysis and recommendations of roof improvements for single ply, metal and cool roof. Additional scope included design and construction administration services including public bidding for this 92 unit public housing community.
- **555 Mission Street, San Francisco, California:** Construction Monitoring Services on the Curtain Wall of a 33 story commercial office building in downtown San Francisco. The scope of work included review of the subcontractor shop drawings for conformance to the specifications for curtain wall system components.
- **Chevron Real Estate Management, San Francisco and Dublin, California:** Investigation, leak surveys, analysis, design, water testing, preparing schematic design and construction documents, construction administration and construction monitoring during roof installation, for eight office buildings consisting of single ply, built up roof, metal roof and tile.
- **The Suites at Fisherman's Wharf, San Francisco, California:** Investigation and repair summary report on a four story, 24 unit timeshare condominium property. Provided recommendations for repair and replacement of roof system and components, first level patio waterproofing, roof top deck, and structural waterproofing.



Senior Consultant, Glazing Consultant

Mr. Mohun is a Senior Consultant at Allana Buick & Bers (ABBAE). He has over 35 years of experience working with glass and aluminum systems as a commercial glazing and general contractor. Mr. Mohun has in-depth knowledge of all types of windows and metal panel wall systems including window and curtain walls. In addition, he has extensive experience with sloped glazed systems and applications.

Mr. Mohun provides expertise in both new and remedial glazing selection including specialized applications for high STC/OITC requirements, high performance low "E" insulating glass, fire resistant assemblies, and high-velocity wind design for exterior building cladding. He is routinely asked to provide litigation support forensic expertise for a wide variety of cases. Mr. Mohun has worked on numerous projects out of which 25+ were based out of San Francisco.

Education

University of California, Berkeley, California

- B.A., Political Science, 1976

Licenses

- General Building Contractor (Class B)
- Specialty Contractor (862689) - Glazing (Class C-17)

Professional Societies and Affiliations

- Construction Specifications Institute (CSI)
- Voting Member of ASTM International

Representative Experience

- With ABBAE Since: 2013
- With Other Firms: 30 years

Office Locations

- Palo Alto (Headquarters)
- Oakland
- Los Angeles
- Irvine
- San Diego
- Sacramento
- Seattle
- Portland
- Las Vegas
- Charlotte
- Honolulu
- Kihei

Sample Litigation and Forensic Experience

- **The Infinity Towers, San Francisco, California:** Performed visual investigation, recommended further investigation, and investigated the curtain wall, below grade parking structure, and mechanical investigation of the multi-structure mixed use property located in the South Beach District of San Francisco. The property includes 4 buildings; Building A, Building B, Building C and Building D. Building A consists of 8 floors, Building B consists of 27 floors, Building C consists of 9 floors, and Building D consists of 42 floors.
- **The Radiance, San Francisco, California:** ABBAE performed visual investigation, water testing, destructive testing, building evaluation, leak investigations.
- **Fenton Grant Mayfield Kaneda & Litt, Campana Condominiums, Roseville, California:** ABBAE provided visual observation and destructive testing services.
- **Pinnacle Galleria, Roseville, California:** ABBAE provided leak investigation services. Evaluated the condition of the exterior one coat stucco, balcony waterproofing, roofing and gutters, assist in providing recommendations.
- **BRE Properties, Avenue 64 Apartments, Emeryville, California:** ABBAE provided waterproofing consulting for the design and construction of the roofing and building envelope systems as well as belowgrade waterproofing.



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ABOUT ALLANA BUICK & BERS

Allana Buick & Bers, Inc. (ABBAE) is a leading Architectural Engineering firm with over 31 years of experience specializing in forensic investigation of building assemblies.

Our core expertise and strengths are in building envelope, waterproofing, HVAC, plumbing, construction management, and energy efficiency. We can assist with investigation, testing, engineering design solutions, design consulting, preparation of construction documents, bidding and construction administration and management.

Many of our investigation projects are forensic in nature which include, visual analysis, water testing, destructive and non-destructive testing, and analysis of claims, cost estimating and reporting services. Our forensic experts work on both plaintiff and defense cases and we represent owners, property managers, developers, contractors, sub-contractors and architects. Our forensic experts have been on over 650 cases since early 1990's including arbitrations and jury trials. As a company we have worked on over 5,250 projects.



OUR MISSION

Sustainable and durable buildings with low operating costs have long been integral to Allana Buick & Bers' core values. These beliefs were part of our mission long before it became an industry trend. We strive to reduce the construction community's carbon footprint and environmental impact.

We design building components to last longer, provide alternative energy solutions and decrease building operating costs by reducing the maintenance cycle and energy usage. We've repeatedly proven that integrating sustainable solutions in new construction and building repairs increases longevity, benefits the environment and ultimately improves our clients' financial bottom line.

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CORE SERVICES

INVESTIGATION SOLUTIONS

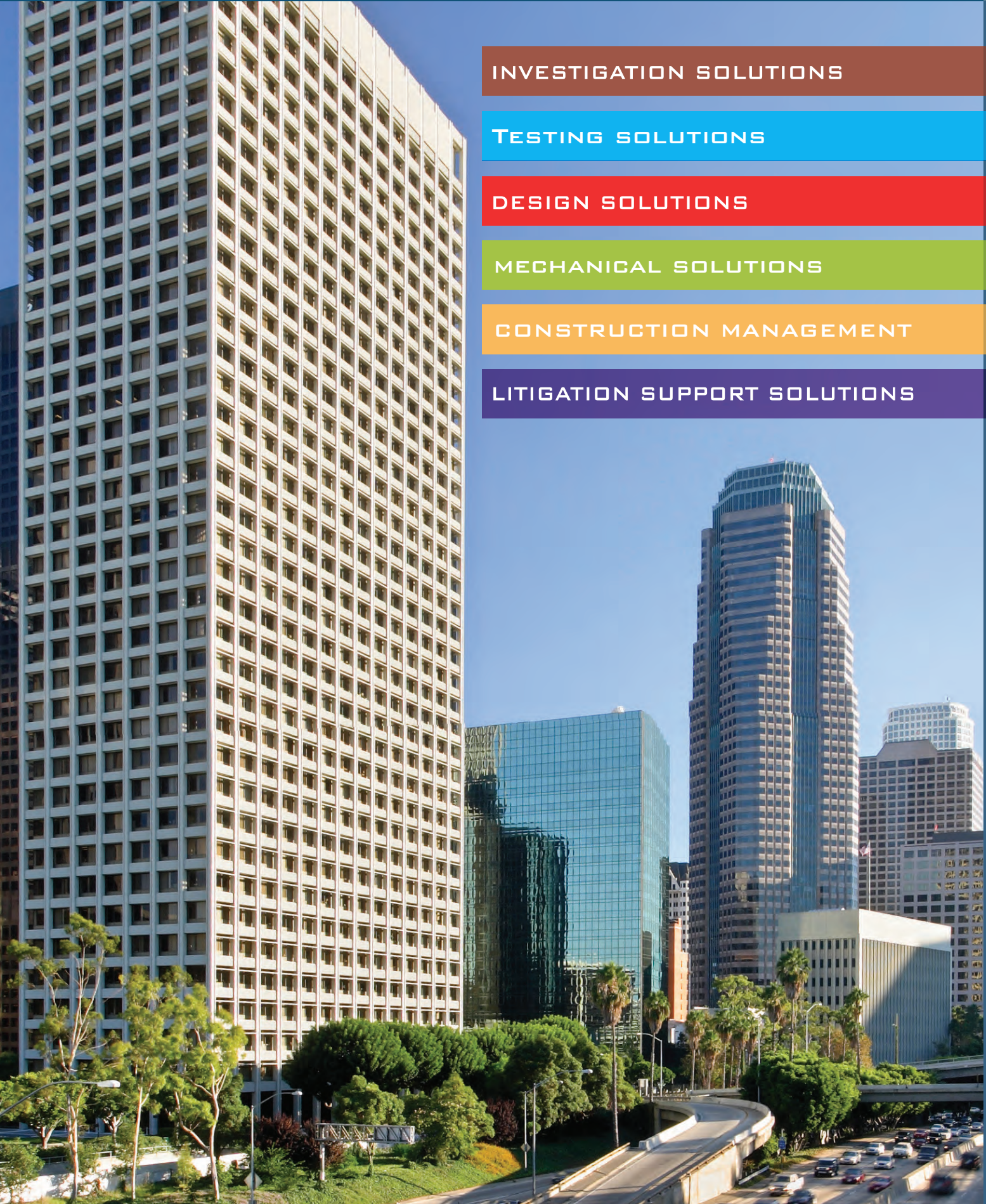
TESTING SOLUTIONS

DESIGN SOLUTIONS

MECHANICAL SOLUTIONS

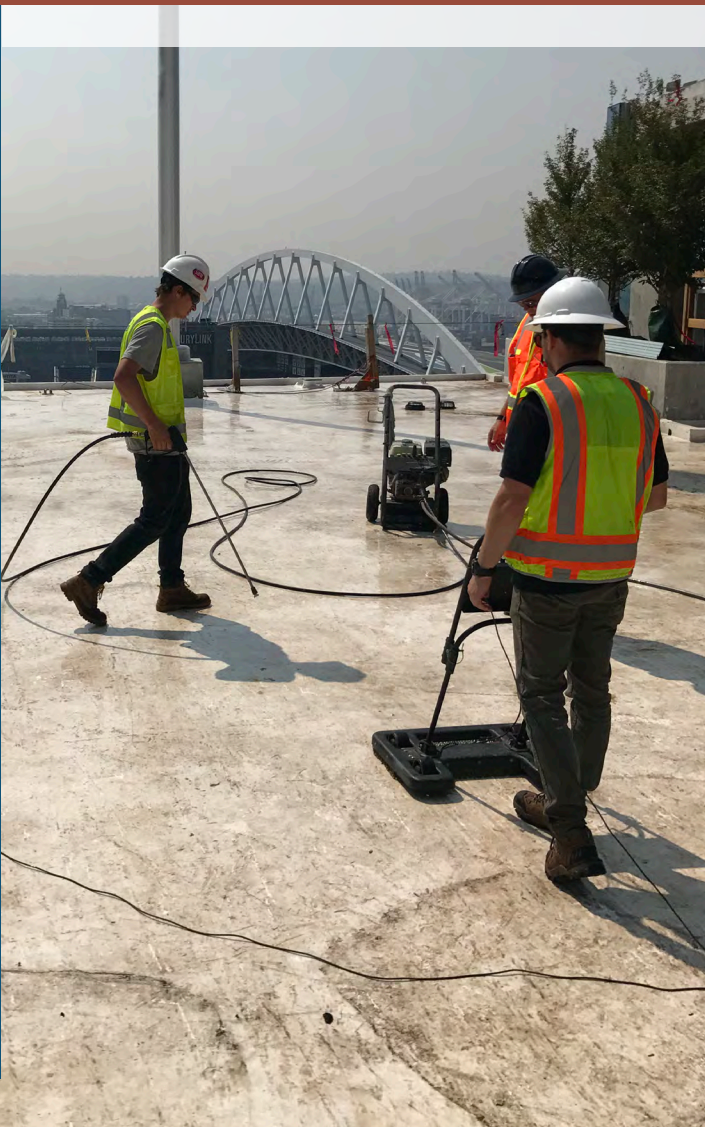
CONSTRUCTION MANAGEMENT

LITIGATION SUPPORT SOLUTIONS





INVESTIGATION SOLUTIONS



- Water Intrusion Investigation
- Forensic Investigation
- Building Envelope Evaluation
- Property Condition Assessment
- Roofing Assessment
- Plumbing Evaluation
- Mechanical System Assessment
- Structural Investigation
- Due Diligence
- Reserve Study Analysis



TESTING SOLUTIONS

- Adherence to ASTM, AAMA, and ASHRAE Protocol
- Water Penetration Testing for Wall Assemblies
- Water, Air, and Structural Performance
- Horizontal, Plaza Deck, and Roof Waterproofing
- Field Testing for Paint Finishes
- Water Delivery System Testing
- Building System Mock-Ups
- Commissioning Verification





DESIGN SOLUTIONS



- **Architectural Engineering**
 - Building Envelope & Air Barriers
 - Roofing & Waterproofing
 - Curtain Wall & Glazing
 - Exterior Façade
 - Energy Efficiency & Generation
- **System and Material Selection**
- **Construction Documents**
 - Design Consultation
 - Peer Review
 - Engineer of Record
 - Value Engineering
 - Unit Pricing
- **Mechanical Retrofit and Improvements**
- **Structural and Seismic Retrofit Design**



MECHANICAL SOLUTIONS

- HVAC Equipment Upgrades
- Chiller Plant Design and Optimization
- Control System Optimization
- Refrigerant Flow System Conversion
- Energy Audits
- Domestic Hot Water Upgrades
- Pressure Booster System Optimization
- Distribution Piping and Balancing





CONSTRUCTION MANAGEMENT

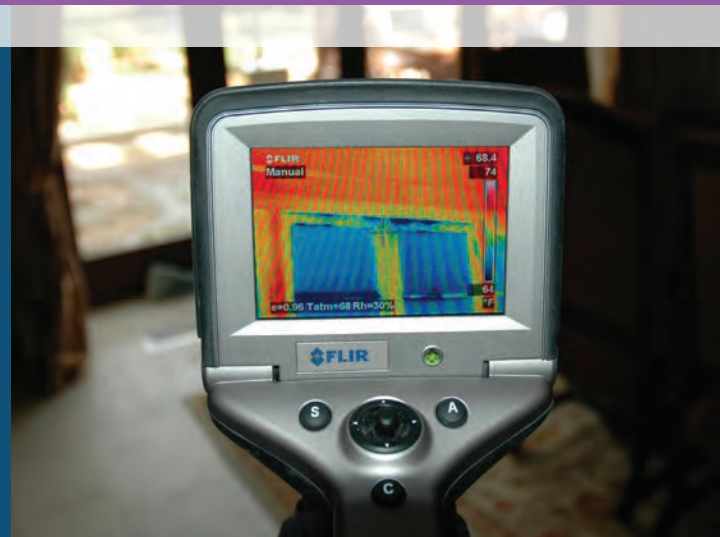


- **Cost Estimating and Value Engineering**
- **Construction Administration**
- **Quality Control and Quality Assurance Monitoring**
- **ICC Required Quality Assurance**
- **Project Management**
- **Construction Management**
 - At Risk
 - Owners' Agent
- **Project Delivery**
 - Design-Build
 - Design-Bid-Build



LITIGATION SUPPORT SOLUTIONS

- Forensic Investigation
- Construction Defect Analysis
- Expert Witness Services
- Cost of Repair Estimates
- Settlement Sufficiency Analysis
- Post Litigation Services





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Allana Buick & Bers is dedicated to providing comprehensive and innovative solutions with award-winning expertise in building envelope design, architectural engineering, energy consulting, and construction management. We have over **130 in-house staff** experienced to meet customer needs, including:

- Licensed Professional Engineers — Civil, Structural, and Mechanical
- Registered Architects
- Registered Roofing Consultants (RRCs)
- Registered Waterproofing Consultants (RWCs)
- Registered Building Envelope Consultant (RBECE)
- Registered Exterior Wall Consultant (REWCEs)
- Registered Roof Observers (RROs)
- Certified Exterior Insulation and Finish System (EIFS) Inspectors
- Curtain Wall Specialists
- Construction Monitors
- DOE/ORNL WUFI Moisture Transport Analysis Instructors
- LEED Accredited Professionals
- ABBAE Contractor License (814455)

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