C35 Analysis of the Parking Garage Vehicular Protection System in a Vehicular Crash Investigation

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The goal of this presentation is to present a case where a vehicle traveling down an exit ramp of a parking garage exited the side of the building and landed top down in an adjacent alley. The investigation into a lack of proper and adequate perimeter safety protection will be described.

This presentation will impact the forensic science community by illustrating the relationship between strength values used in design as compared to the strength at catastrophic failure as well as emphasizing the necessity to properly apply the requirements of adopted building and maintenance codes.

Design load values are based upon the probability that the structural elements will remain in an undeformed condition as a result of an imposed load. Building codes require that the structural attachments of a vehicle barrier system be able to transfer the load to the building's structural elements.

This recent vehicle crash incident occurred on the third level of a parking garage located in a downtown metropolitan area. For unknown reasons, a driver and car traveled down the exit ramp, jumped a concrete curb, and impacted a precast concrete wall panel, thereby knocking the panel into an alley. As a result of the vehicle loss of control within the garage and the lack of proper and adequate perimeter safety protection, the car exited the side of the building and landed upside down in the adjacent alley.

The original restraint/protective system previously located along the sides of the garage was subsequently removed at the time of an architectural facade renovation in the late 1960s. The existing perimeter system in the garage at the time of the incident was limited to two main components: architectural precast concrete panels attached to the floor slabs and concrete curbing and wheel stops. The combination of the concrete curbing element and the architectural precast wall panel was not able to resist the lateral impact loading of a vehicle traveling at less than fifteen miles per hour, as required by the building code. The architectural facade support system was not a vehicular restraint system. The absence of an additional proper and adequate code-compliant vehicle restraint system allowed the in-place architectural facade support system to fail locally under direct vehicular impact loading.

Multiple field reviews of the existing parking garage building conditions had been performed by various engineering/consulting firms over the course of an approximate thirty-year span beginning in 1978 through the time of the incident. These reviews noted the absence of adequate vehicular protection for the architectural facade system. The building owner, the parking garage management firm, and a construction administration firm were all aware that the exterior precast wall panels were potentially unable to resist vehicular impact loading prior to the incident.

The parking garage management firm and the construction administration firm suggested that the architectural precast concrete panel system was "grandfathered" into the current building code. This "grandfather" description was not correct, given that the current building code specifically stated that existing structures and building elements were not "grandfathered" with regard to general safety and welfare of the occupants and the public. The structural inability of the existing architectural facade panels and/or their connections to adequately support and transfer the code-required vehicular loading posed a threat to the general safety of the parking garage patrons and public use of adjacent surrounding areas at grade.

Structural and civil engineering practice involves the inclusion of normal factors of safety as part of a proper and thorough design process for new and existing building systems and related components. These factors are the relationship between strength values used in a design as compared to the strength at ultimate or catastrophic failure. A properly designed vehicle restraint system would take into consideration load combinations for extraordinary events as well as factors of safety. The calculated catastrophic failure point of the mechanical anchors supporting the architectural panel was significantly less than even the unfactored design values for a vehicle restraint system. Given the use of factors of safety, a vehicle restraint system properly designed would not have had a catastrophic failure until it was subjected to an excessive force.

A proper and adequate code-compliant vehicle barrier restraint system was required to be designed, installed, and maintained in order to properly resist vehicular impact loading by the building code in existence at the time of the original construction of the garage, the building code in existence at the time of the addition of the building atop the garage, and the building code in existence at the time of the preliminary condition appraisal report, as well as the recent and current editions of the property maintenance codes.

Vehicular Impact, Design Load Values, Catastrophic Failure

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