

An aerial photograph of a large, multi-story building with a flat roof, surrounded by trees and other structures. The image is used as a background for the title slide.

ROOF DECK CONSIDERATIONS AND CASE STUDIES

Vancouver, May, 11, 2018

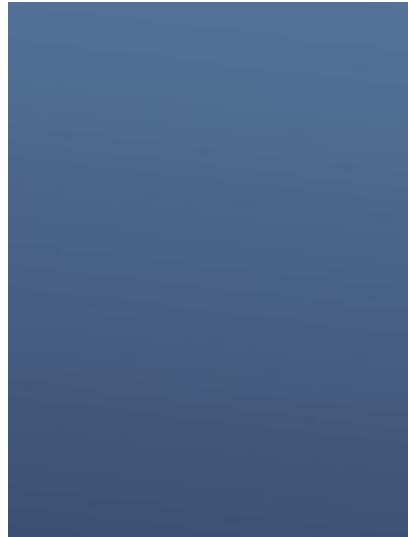
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315 Berry Rd

Roof Deck Discussion
Related Case Studies

OVERVIEW

A series of white lines of varying lengths and orientations are positioned in the bottom right corner of the slide, creating a modern, abstract graphic element.



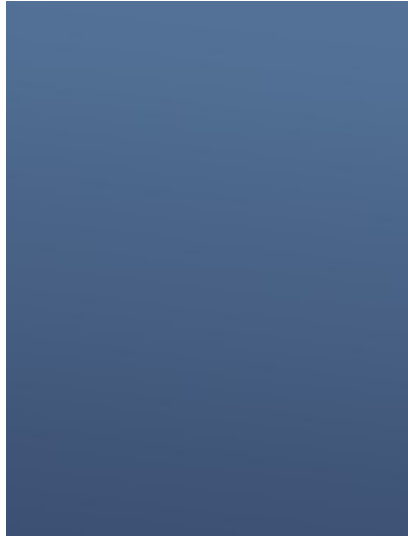
OVERVIEW

Roof Decks
Related Case Studies

Roof Decks

- Lightweight Insulating Concrete And Fills
- Structural Concrete
- Steel
- Poured Gypsum Concrete
- Thermosetting Insulating Fills
- Precast Gypsum Panel
- Wood Plank





ROOF DECKS LIGHTWEIGHT CONCRETE

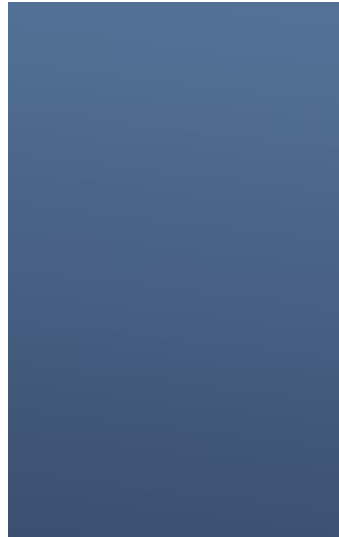
ROOF DECKS LIGHTWEIGHT CONCRETE

- ▶ 40 psi minimum pull out values required for most roof manufacturer wind ratings.
- ▶ Newer energy codes require additional insulation.
- ▶ Proper curing of the concrete, cracking, and related problems can occur during construction.
- ▶ Wimberley School District example
- ▶ School reroof example



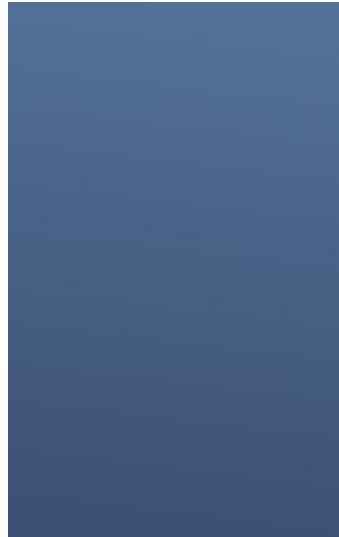
- ▶ Constructed 1951
- ▶ Coal Tar Pitch roof systems – 30-35 years old
- ▶ Poor or nonexistent maintenance
- ▶ School district had to decide whether to demolish and rebuild or renovate the school

SCHOOL REROOF CASE STUDY



- ▶ Deteriorated brick parapet walls
- ▶ Open expansion joints
- ▶ Deteriorated roof top equipment that had to be replaced

SCHOOL REROOF CASE STUDY



- ▶ Poured-in-place lightweight concrete deck
- ▶ Gypsum plank deck
- ▶ Tectum plank deck

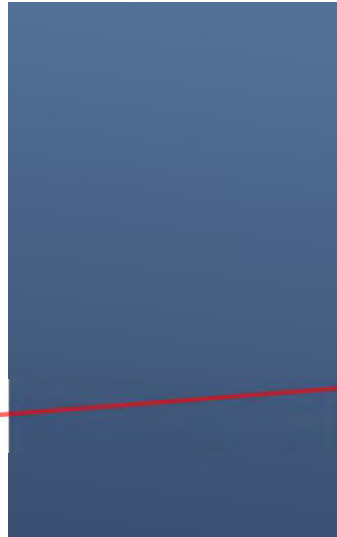
SCHOOL ROOF CASE STUDY

SCHOOL REROOF CASE STUDY

- ▶ A structural engineer was engaged to prepare repair protocols for the various roof decks.
- ▶ A procedure was set in place for the General Contractors and Subcontractors to contact the structural engineer during demolition activities to answer specific questions during roof tear-off operations.
- ▶ All other questions were to be directed to the Architect-of-Record

SCHOOL REROOF CASE STUDY

- ▶ Actual slide taken from pre-bid meeting with all roofing subcontractors
- ▶ Safety
- ▶ The existing roof decks are extremely deteriorated and pose a fall risk for all workers. The general contractor and roofing subcontractor will provide full time tie-offs at all roof areas, at all times.
- ▶ At various roof areas, scaffolding will have to be constructed under the roof deck. The minimum distance between the roof deck and scaffolding shall be 12 inches.
- ▶ Safety is the sole responsibility of the General Contractor and their subcontractors. The General Contractor and Subcontractors shall prepare and execute a safety plan during roof demolition to protect workers and the contents of the building.

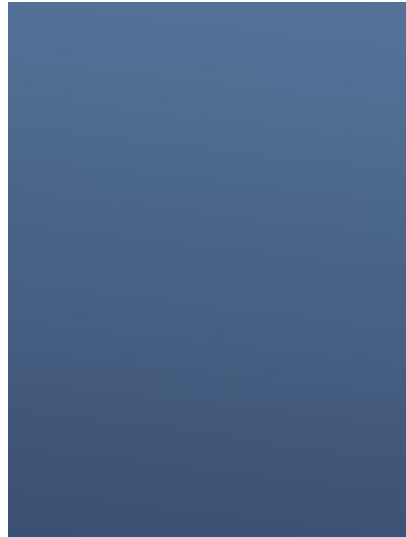
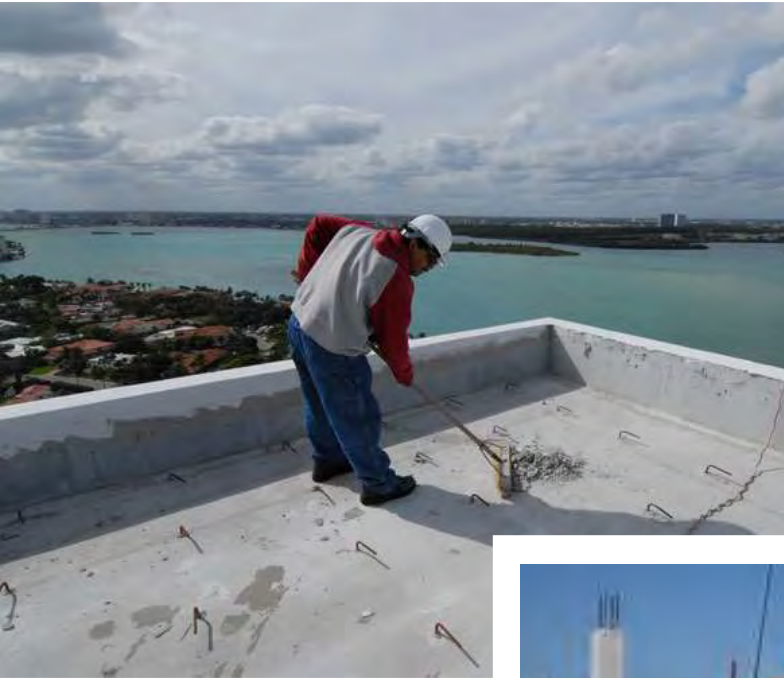


- ▶ On the first several decks, the workers were protected properly.
- ▶ On the gymnasium roof deck, a “soft area” was discovered, marked, and covered with plywood.
- ▶ The plywood was moved during demolition and the area was exposed.
- ▶ One of the workers fell through the “soft area” and was badly injured.

SCHOOL REROOF CASE STUDY

SCHOOL REROOF CASE STUDY LESSONS LEARNED

- ▶ Safety is always the responsibility of the General Contractor and subcontractors. Safety can and must be included in the project documents, however, specific issues should not be addressed by the Architect/Engineer/Consultant.
- ▶ Just as the school had to decide whether to demolish the school and rebuild, or to renovate, the Architect/Engineer/Consultant team had to make that same decision for deteriorated roof decks.
- ▶ All of the roof decks should have been completely removed and replaced.



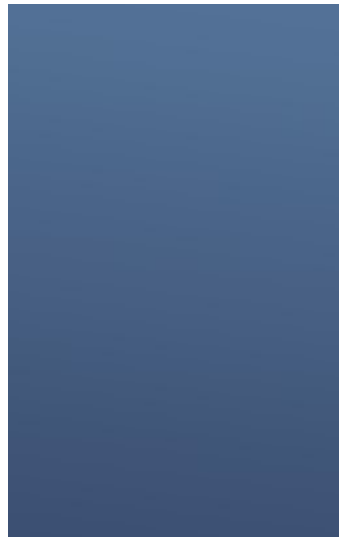
ROOF DECK –
CONCRETE

POURED-IN-PLACE
CONCRETE

CONCRETE PLANKS

ROOF DECK – CONCRETE

- ▶ Typically 28 days is the minimum cure time.
- ▶ Moisture content can be a problem for the roof systems.
- ▶ Moisture vapor testing – various methods can be utilized to determine moisture in the concrete roof deck.
- ▶ Questions arise as the effectiveness of moisture testing
 - ▶ How reliable are the tests?
 - ▶ What are the limitations and expectations of the tests?
 - ▶ Who bears the ultimate responsibility?



ROOF DECK -
CONCRETE





- ▶ ASTM F 1869 – 04 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride 1 (Flooring)
- ▶ ASTM F 2170 – Standard Test method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
- ▶ ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method1

MOISTURE TESTING

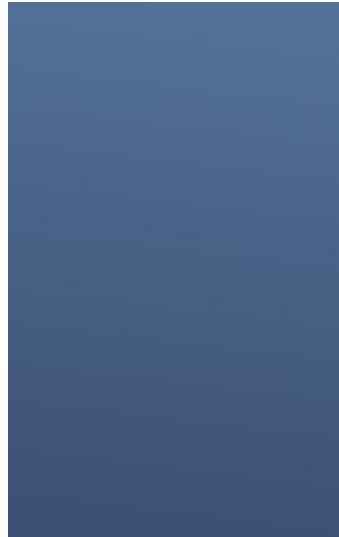
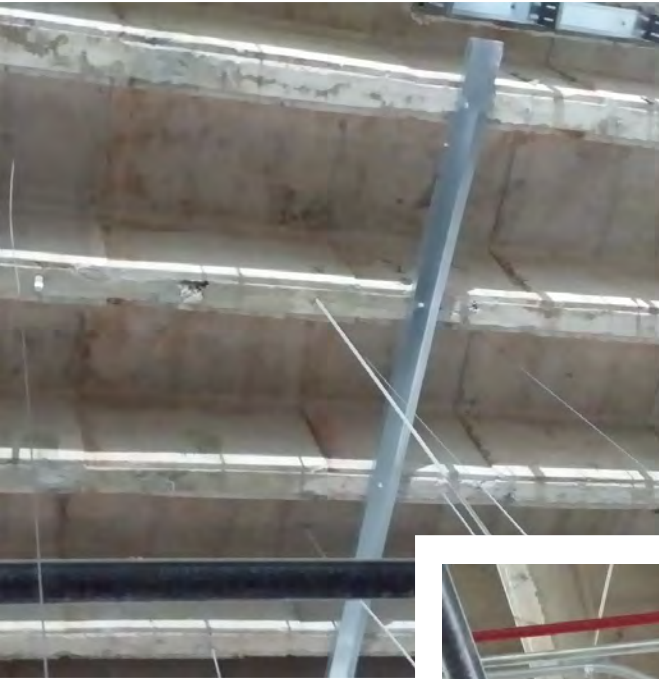


Building left vacant for a number of years without conditioned air

Concrete (poured-in-place) and beam deck

Original roof well beyond useful life; numerous leaks were observed before the start of renovation

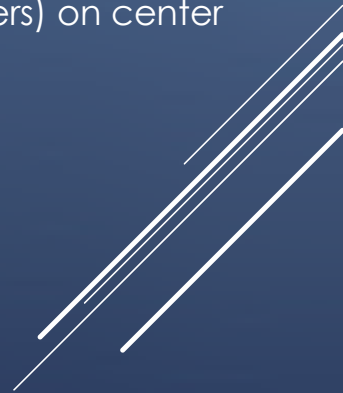
GOVERNMENT BUILDING CASE STUDY

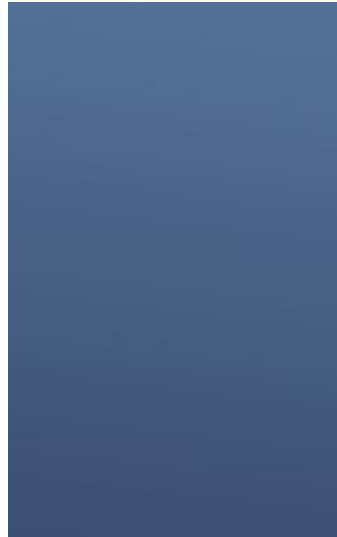


► Roof Deck Factors

- 2" (5.08 centimeters) concrete roof deck
- 36" (.91 meters) x 6" (15.24 centimeters) concrete beams 48" (1.22 meters) on center

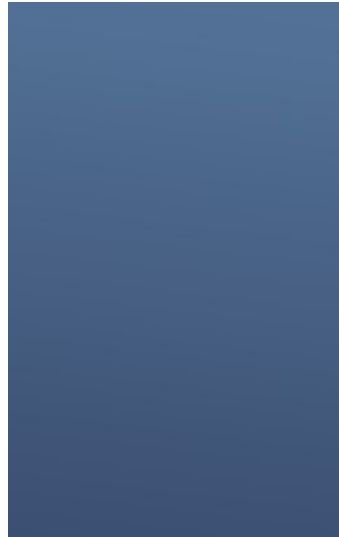
GOVERNMENT BUILDING CASE STUDY





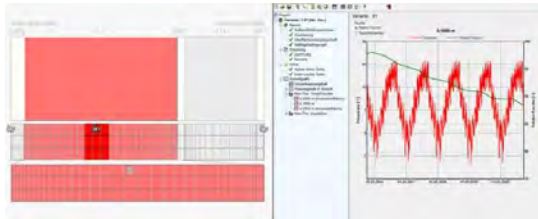
- Test cuts revealed condensation between the concrete roof deck and the first layer of insulation.

GOVERNMENT BUILDING CASE STUDY



- Gravimetric testing was employed to evaluate before and after moisture content by weight

GOVERNMENT BUILDING CASE STUDY



- ▶ The contract documents required enclosing and conditioning the building prior to removal and replacement of the roof system.
- ▶ A full-time roof consultant had been retained by the government during installation of the roof system.
- ▶ Detection of moisture within the roof system required a review of the consultants' documents.
- ▶ Periodic consultant site visit reports were issued indicating the roofing contractor had performed the plastic sheet method test during installation. All results were negative.
- ▶ The WUFI analysis indicated that after enclosure of the building, and conditioning of the interior space, the moisture would dissipate.

GOVERNMENT BUILDING CASE STUDY

GOVERNMENT BUILDING CASE STUDY

- ▶ BES reiterates its recommendation to install in the roof membrane metal one-way roof vents at intervals of one roof vent per 500 square feet to assist in the removal of water vapor from the roof system. In addition to roof vents, BES recommends that additional test cuts are conducted in the late winter as the WUFI models predict that at this time, the potential for condensation at the concrete deck surface will be the least and the water that is potentially from condensation in the roofing assembly will have had the more time to be removed from the system via vapor drive and the relative humidity of the concrete (adsorbed water content) will be at the lowest level of the yearly cycle.

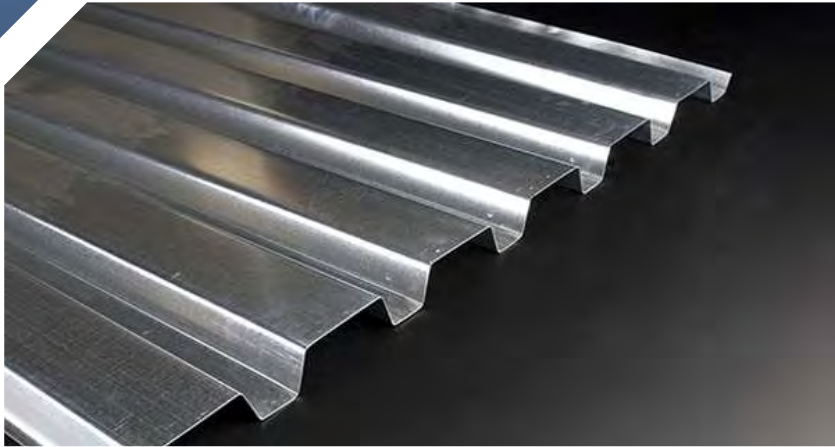
GOVERNMENT BUILDING CASE STUDY

► Lessons Learned

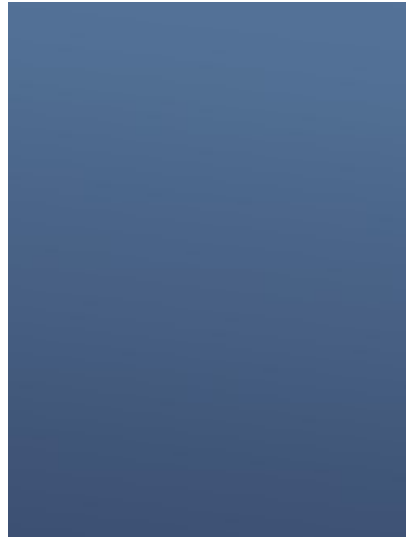
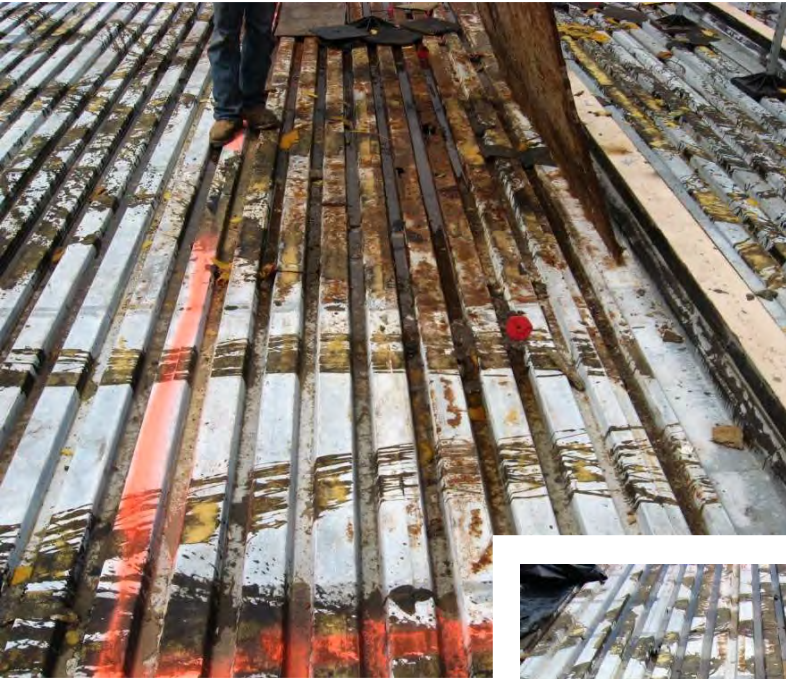
- Thinner concrete decks can readily allow the passage of moisture through the concrete deck material.
- The newly installed roof system provided a dry magnet for the humid air from underneath the roof deck.
- During installation of the roof system, consistent rain events caused delays during construction.
- Concrete roof decks in humid areas (all thickness) can retain water and high humidity.

ROOF DECKS - METAL

- ▶ Typical steel roof deck is approximately 40 ksi
- ▶ FM requires 80 ksi
- ▶ If a true FM assembly is required, the steel deck, structure and attachments must meet FM standards

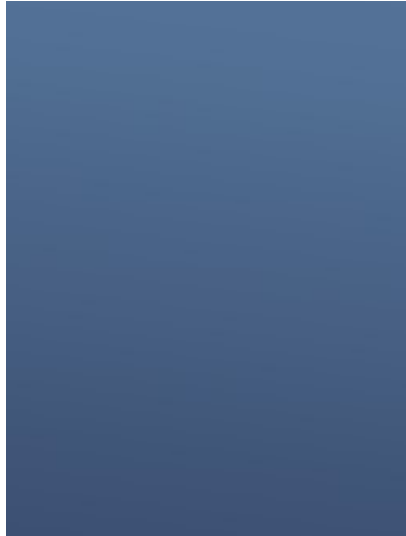


ROOF DECKS - METAL



ROOF DECKS – METAL

CORROSION PROBLEMS



DECK INSPECTIONS

DECK INSPECTIONS





- ▶ Constructed 2014
- ▶ Modified Bitumen Roof System
- ▶ Acoustical deck, lightweight insulating concrete
- ▶ Condensation on the gymnasium floor began occurring two years after installation

NEW SCHOOL ROOF CASE STUDY



- ▶ During the summer, buckets were placed under leaks from roof deck.
- ▶ Testing of the modified bitumen roof system indicated that the roof system did not leak in any of the areas.



NEW SCHOOL ROOF CASE STUDY



- ▶ Acoustical deck with infill insulation
- ▶ Leaks were occurring randomly through the deck

NEW SCHOOL ROOF CASE STUDY



- ▶ Test cuts indicated discoloration of the lightweight insulating concrete.
- ▶ Fasteners for the modified bitumen roof system were placed properly and did not show advanced signs of dislodging or rusting.

NEW SCHOOL ROOF CASE STUDY



- Moisture accumulation was evident at the interface of the deck and the insulating concrete.

NEW SCHOOL ROOF CASE STUDY

- ▶ A consultant had recommended adding one-way roof vents during the previous year.
- ▶ The following year, in June, July and August, the leaking reoccurred.
- ▶ Interviews were conducted with maintenance personnel and it was discovered that the air conditioning in the gymnasium was turned completely off after school let out in the spring.
- ▶ The humidity in the room rose to as high as 70% on some days.
- ▶ The roof system had not been designed for the constant additional humidity.

NEW SCHOOL ROOF CASE STUDY

► Lessons Learned

- Designers and consultants must consider usage of facilities after construction
- The newly installed roof system was designed to vent moisture into the conditioned air below the deck. This process was halted during the summer months.
- The problems were not corrected by just adding conditioned air. The roof system still contained anomalies of water in the system.

NEW SCHOOL ROOF CASE STUDY

► Lessons Learned

- No one wants to “throw new materials in landfills for our kids.”
- The roof system at this school is still under evaluation.
- The problem has lessened after adding year-round conditioned air, but it has not been completely eliminated.

NEW SCHOOL ROOF CASE STUDY

▶ Deck Case Study Examples

- ▶ Verbiage is important and safety must always be directed by the Contractor.
- ▶ Thin decks can translate moisture easily. A venting base sheet or vapor-mitigating system should be installed to control vapor drive.
- ▶ The design of lightweight insulating concrete/acoustical metal should include a drying mechanism.

ROOF DECK - CONCERNS

THANK YOU FOR YOUR
TIME!

QUESTIONS?



Knowledge Experience Solutions

BUILDING EXTERIOR SOLUTIONS