

Project Report:

Florida International Museum Reroofing – A Decision-making Process

By David H. Siple, RRC, FRCI

In new construction, the roof designer can apply all the best design principles and standards to meet the requirements of the project. In reroofing, the structure is in place and many features cannot economically be changed to meet these same optimum goals. The design process in reroofing is usually more challenging, requiring greater creativity from the design professional.

The design process can be aided by following checklists similar to those proposed by Richard Canon in "Meet the Code, Bear the Load, and Other Guidelines for Roof Projects"¹. The RCI Seminar Sections, "What is the Best Roof?"², and "Roof Systems"³ explore and expand on these same principles. The statement, "Good roofs don't just happen, but bad ones do"⁴ implies that design can prevent "bad roofs." Of equal importance is assuring that the design is indeed installed. "Whatever roof system that is decided upon, the codes, standards, specifications, and installation procedures still must be followed to assure that you really do get that 'best roof.'"⁵

This article will attempt to explain the conditions encountered on a reroofing project, the factors that were considered, the decisions that were made, and why they were made. The rejection of some products or systems may not be discussed because of the lack of information or "track record" in Florida.

Project

- Building:** Florida International Museum, St. Petersburg, Florida
- Roof:** 50-year-old 4-ply coal tar pitch and slag roof membrane, over 2" of foam glass insulation boards, over 3" poured-in-place concrete deck. 46,000 square feet. 2" to 4" of ponding water. The Museum spaces occupy the first floor and part of the second floor. The third floor is vacant space.
- Parking Deck:** 36-year old parking deck, concrete wearing slab over coal tar pitch membrane, over a concrete waffle deck. 34,000 square feet. Slight slope of the

wearing slab to the drains. The museum spaces occupy only the first floor. The second floor is vacant.

History:

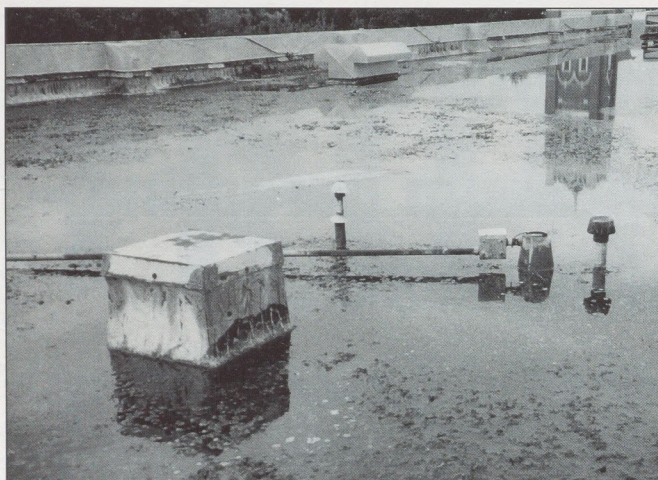
The museum presents a once-a-year show and has no permanent exhibits. The building was purchased from a vacated department store. Interior remodeling was completed to provide gallery space, a theater, administration offices, gift shop and restaurant. The main entrance canopy roof was replaced, but no money was available for a new roof or parking deck water-proofing. (Sound familiar?) Both the roof and deck had leaks. An application had been made for grant money for water-proofing for the next year. \$50,000 was available for repairs.

Initial Contact

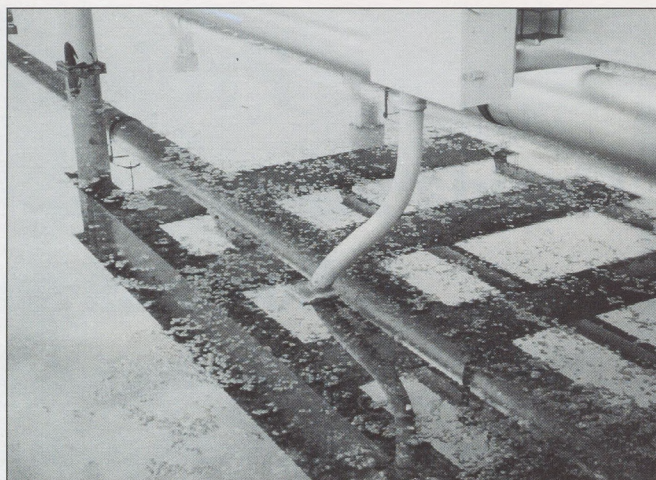
We were contacted to see if we would be interested in bidding on the investigation and design for the roof and deck problems. The "Treasures of the Czars" was just about to close and water had leaked onto several of the display cases and "The Horse." The artifacts on display at that time were estimated to be worth at least \$50 million. We were informed that the roof and deck leaked and that only repairs could be completed because money was not available for reroofing.

We went to the facility the next day during a normal summer rainstorm. We actually went more out of curiosity to see the interior and exterior conditions under which someone would consider placing \$50 million worth of artifacts, knowing that previous leaking had occurred.

We went onto the roof (which was totally ponded with water) during the rain and slogged through water and large clumps of algae. The water was 2" deep in the shallow areas and up to 4" deep in two areas. Even though the water was quite murky, it was evident that blisters were present. On the parking deck, water was up to 1/2" deep in a number of areas.



(Left) Ponding water conditions with colonies of algae floating in the water. (Right) The pitch pan for the new chiller electrical supply was too low and not enough space was allowed from the conduit to the sides of the pan.



We were taken on a tour of the interior of the upper floors above the museum spaces. It was a maze of old beauty shops, fitting and alteration rooms, sales spaces, storage and administration spaces. An appropriate number of barrels, buckets, waste baskets, wheelbarrows, and wading pools were in place to catch water before it entered the newly-constructed museum spaces. There were leaks, many leaks!

Decision #1 - Should we get involved? A quick calculation determined that about 100,000 gallons of water were on the roof during the rain. The roof membrane was 50 years old. The parking deck was only 36 years old but it was leaking at the wearing slab control joints and coming through cracks in the thin portions of the waffle slab. And they don't have the money for a new roof! Think, think, think! Do we really need to get involved? But who is really capable of helping this owner? Should we just let one of our competitors botch up the roof, so we could sit back and feel comfortable that we did not tarnish our reputation? How about returning in a couple of days after the water has had some time to recede? Maybe ... the conditions will not look quite as bleak. We decided to return later, evaluate further, and then make a decision.

I am reminded of Richard Horowitz's statement, "A good general rule of thumb would be to ask yourself (when confronted with any puzzling situation), 'what would a prudent man do in my place?'" When you have thought about it and come to an answer, *be* that prudent man!"⁶ Another rule of thumb might be, "Can you see the end product?" Even though you have not worked out all the details, if you know what you want to accomplish, you can develop how to get to the end product.

Upon returning two days later, we found one area about 20' in diameter that was not under water. We were able to remove a core sample. A small "live" pitch area was observed. It was evident that the walls had been reflashed several times and many surface repairs had been made. We had been assured by the owner's consulting engineer that the building was heavily designed and had withstood

50 years of ponding water with no structural problems. The leaking through the roof was at the penetrations, with the worst conditions in one corner at the curbs and ducts at unused HVAC equipment. A new chiller had been installed but none of the old equipment had been removed. The parking deck leaks were all at the control joints and various repairs had been attempted. We also discovered the other canopy roof had failed and was leaking in many places.

Decision #2 - Should we get involved? The decks were surely adequate. The foam glass insulation was unaffected by any leaking. The flashings were adequate. The pitch was still "live" in the dry area of the roof. Could we find a roofing contractor willing and capable of making repairs on a 50-year-old roof membrane? The drainage was dreadful. Relief drains were needed just to get off as much water as possible, to make the repairs and to minimize the potential for future leaking and its liability. How could we get a relief drain installed in 4" of ponding water, during the rainy season, with 100,000 gallons of water just ready to pour in if any mistakes were made? Could the repairs be completed for \$50,000? It is obvious that not all the problems can be solved at the time the proposal is written. Further study is always needed. If we do everything right, our reputation will just get better. Are we confident in our ability to meet this challenge? Our answer: submit a proposal.

A proposal was written to conduct a complete investigation, give repair recommendations, a cost estimate of the repair work, prepare specifications for the repairs, put the project out for bid, conduct a pre-bid conference, assist in the bid evaluations, monitor the work in progress and provide reroofing recommendations and their cost. The proposal was accepted and we were under way.

The investigation was completed, repair specifications were written and accepted, and the project was put out for bid. But a number of decisions had to be made before the specifications were written. The decisions had to be based upon not only the immediate leak repair solutions but the

long term goal of reroofing and the permanent parking deck waterproofing.

The Repair Project

Decision #3 - How can we solve the ponding water? -

Much of the water needs to be removed just to be able to see the roof membrane to write the repair specifications and for the roofing contractors to not freak out when they look at the project. The roof deck was constructed the same as the lower floors with the apparent thought of eventually adding floors. The roof drains were all at the back of the building at the alley, 200' from the front parapet wall. The original drains were 8" x 14" rectangular welded steel leaders. One was functioning, one was restricted with 3-4" PVC leaders installed inside it because it had rusted out, and the third was blocked off because it was rusted out and was a source of leaking. These original drains were all 2" above the surrounding roof surface. Approximately 3' of attic space was available to install new roof drains and horizontal drain lines. The owner did not want any lines below the existing ceiling because the vacant floors may someday be used. We did not want to have any drain lines dropped down into the occupied museum spaces, especially into the gallery. Any drains installed must be part of the permanent reroofing drainage system. Can we find a roofing contractor willing and capable of installing a single relief drain to get rid of most of the ponding water?

We again slogged through all the water and measured its depth. Of the two places that were 4" deep, one was selected as the best place to install the relief drain and run the horizontal line out through the rear wall and down to the alley. Answer: install one relief drain, ASAP.

Decision #4 - Find the roofing contractor and get the relief drain installed. Calls to several contractors were made and one met us at the museum to discuss the installation. Their proposal was accepted and the date was set; hopefully the rains would not spoil the plan. A coffer dam was planned and coordination with a plumbing contractor was made.

An attempt was made to broom the loose gravel off a



(Left) The rusting supports for the old cooling tower were left on the roof. (Right) Unused HVAC equipment was covered with tarps because leaking occurred through it.

12' x 12' area, with 4" of water resisting. Little success was made with the brooming. A 10' x 10' dam of 2" x 8" wood was set over the area and a Bentonite clay stop-leak powder was poured all around the outside. The water was removed with a sump pump followed by shop vacs. The gravel was spudded back, a hole drilled through the concrete, the drain set and the drain line run. The drain was flashed in with an SBS modified, torched to the existing pitch membrane and followed with a complete troweling of pitch mastic over the tie-in. This whole process took about three hours and then the dam was removed. Within two hours, about 80% of the ponded water was removed from the roof.

Decision #5 - Where did additional relief drains need to be installed? Even after the first drain was installed, several areas still held as much as 2" of water. Two areas were so far away from the alley that no horizontal drain lines could be installed. One area was next to the parking deck, so a line could be directed onto it. Two other areas were selected, one with an independent drain line and the other connected to the original relief drain line. These three additional relief drains would be part of the repair project.

Decision #6 - Which unused HVAC equipment needs to be removed? All of the unused equipment where leaking has occurred must be removed. Some other equipment had not caused a problem. To hold down the repair cost, it could be left in place.

Decision #7 - How are the roof membrane and flashings to be repaired? We first had to identify the problems. Blistering in the roof membrane was the biggest problem. Some splitting at the base of the parapet walls was evident. Some rusting at vent curbs was a problem. Once the roof was dry for a couple of days, the defects to be repaired were all identified and marked with yellow spray paint. This would give the roofing contractors an idea of the amount of the repair work required. The roof repair manuals from several manufacturers and the NRCA were consulted to define the procedures and materials to be used in the repairs. Blisters were to be cut out, the slag spudded back to tight, dry membrane, and then felts and pitch mastic would be used to rebuild the membrane. The areas were to be regravelled with a pitch resaturant. Wall





A coffer dam was built in 4"-deep water. A new relief drain was installed and flashed into the existing pitch roof membrane.

and curb flashings were to be repaired with asphalt mastic and fiberglass mesh. Over 80 blisters were identified for repair.

Decision #8 - Define repairs appropriate to waterproof the parking deck. Because the source of the water appeared to enter at the control joints in the wearing concrete slab, the repairs should be directed at their waterproofing. The cost to remove the concrete wearing slab and the old pitch membrane; install a new membrane, a protection mat, a drainage mat, and deck drains; and then pour a new wearing slab, was way beyond any proposed museum budget. We would have to consider how to best stop most of the water on the deck surface.

Some very crude repairs had been made with the concrete jack-hammered out at selected areas of control joints, the waterproofing membrane repaired and the concrete repoured with packaged mix. Also, various pourings and sealants had been applied over some of the joints. The deck drains did have some small holes at the membrane level but they all were filled with pitch. Some of the wearing slab sections had many small cracks which obviously could allow water to penetrate down to the membrane and migrate to the control joint lines and into the building.

With the limited funds available, the sealing of the control joints was selected as the first waterproofing priority and the coating of the concrete repairs as secondary. Discussions with fellow consultants, a roofing contractor and several manufacturers' representatives were all made in an attempt to identify the materials and procedures to waterproof the joints. Because the joints had been contaminated with several pourings of pitch and asphalt coatings and inappropriate sealants, the preparation of the very uneven control joint gaps could only be sealed with a tape on the surface of the concrete. The answer was to clean the joints' surfaces, prime and install an EPDM tape and then seal with a deck coating. The concrete patches were to be leveled out and coated in three passes.

Decision #9 - What to do with the failed canopy roof?

The canopy wrapped around two sides of the building and was 10' x 350'. It had a steel deck with lightweight concrete fill and a gravel surfaced BUR membrane. Fastener pullout resistance testing was completed with satisfactory

results. The membrane had obviously failed and no repairs should be attempted to get even one more year of service life. A mechanically attached single ply recover system would be quick, easy and economical. The front edge of the canopy was a curved stucco surface with large rounded building corners. Answer: specify a mechanically-attached heat weldable thermoplastic singly-ply membrane.

Decision #10 - What time limits need to be placed in the repair specifications? - The "Treasures of the Czars" exhibit had closed and interior construction had started for the new "Egyptian" show which was to open on Jan. 7, 1996. Repair work, therefore, needed to be completed to protect the new interior finishes and to provide a leak-free roof for the new artifacts. Very specific completion times would be needed. October 30, 1995 was set as the completion date for the roof and parking deck repairs. The canopy roof was not critical, but Dec. 1, 1995 was set as the completion date—one month before the exhibit was to open.

The pre-bid conference was scheduled with an appropriate instruction to bring boots because the surface of the roof might be slippery and have as much as 2" of water in places. The specifications were written for three separate parts: the roof repairs, the parking deck repairs and the canopy roof replacement. The contractors could bid on any or all three. One contractor was selected to do both the roof and deck repairs. Another contractor was selected for the canopy roof replacement.

The roof repairs were the most urgent because the leaking was directly over the gallery. They were started one day after the contract was signed. The most difficulty encountered during the repairs was the rain interrupting the work. Once the additional three drains were installed, most of the ponding was eliminated. But a wet roof still needs to be dried before repairs can be completed. The removal of the unused HVAC equipment and capping off the curbs, all under threat of rain, made that day one to remember by the roofing contractor.

The parking deck repairs were complicated by the previous repair work and coatings, all of which were deemed inappropriate applications or procedures. The only other problem encountered was in getting the control joint surfaces clean and dry enough to install the primer and tape.

The roof and deck repairs were completed by the Oct. 30 time limit. The canopy roof recover was pushed back and then back again because of rain delays but it was completed on Dec. 12, almost two weeks after the deadline.

The Egyptian exhibit did not open on schedule because of a contract dispute with those supplying the artifacts. Another museum supplied Egyptian artifacts and the exhibit opened about two weeks later. The exhibit was open until July 8, 1996 with only a couple of minor leaks through the parking deck. Water was getting through cracks in one concrete wearing slab section and down into the storeroom of the gift shop. A proposal was given for the removal of some concrete, the patching of the deck



The venting base sheet has been fastened with base ply fasteners with 1-90 plates.

waterproofing membrane, repouring of the concrete and the coating of the concrete section. The museum felt the leak was manageable by catching the water on the floor above and saving the repair expense.

So the repair work on the 50-year-old roof membrane and the 36-year-old deck waterproofing did indeed perform for nine months, with one minor leak. The total repair cost was \$40,000—\$10,000 under budget. But the canopy reroofing cost almost \$20,000. So the total expenditure was \$60,000—\$10,000 over budget.

Reroofing Project

We were notified by the consulting engineer in March of 1996 that the museum was getting approval for grant money from the State of Florida for waterproofing of the building. They were not sure when the formal approval would be given but they would like to reroof in the months of August and September, 1996. The engineer wrote a letter suggesting this was the least desirable time of the year to reroof and we also drafted a letter with the same concerns in trying to reroof during the rainy season. In the middle of May we were notified that the state grant had been approved and that we should proceed full speed ahead with the reroofing to start as soon as the exhibit closed on July 8, 1996.

Another investigation was completed and a proposal was written for our services. The proposal was accepted with the provision that if the grant fell through we would not get paid. The grant status was, "Yes we have approved your grant, but you cannot sign any contracts for work until the money is formally approved and in place. And we have up to 90 days to give you the final approval."

This meant we could write the specifications, put it out for bid, and wait until the formal state grant approval was given, then sign the contracts and get all the work done in the allotted time. The new exhibit—"Alexander the Great"—was to open on Oct. 1, 1996, while construction time was really getting squeezed down, with the starting date unknown.

Specifications were written for both the roof replace-

ment and the parking deck coating. A warning cover sheet for the specifications notified of the urgency of the completion of the project by the completion date. The new exhibit was to open Oct. 1 and the "drop-dead" completion date of Sept. 15 was chosen. It had to be set back to Sept. 21 because of the delay in getting the final grant approval. That meant the work could proceed up until just one week before the new exhibit opened. The roofing work did get completed by the Sept. 15 date, but the deck work ran over by four days.

The specifications were written with the thought that construction time was very critical. Summer rains in Florida can cause severe delays, especially on decks that pond water. The decisions that follow explore the reasons why they were made.

Decision #11 - Should the existing roofing be torn off down to the concrete deck so we can start with a good clean deck? The existing roof membrane is coal tar pitch which is more than a mild irritant in the bright Florida sun. The alternative is to remove the old roofing at night and install the new roofing in the day. The other problem was that the existing insulation was foam glass, which fractures upon removal and can become an irritant if it gets into the workers' clothing. Wearing sufficient protective clothing to avoid these two irritants can become deadly in the hot Florida summer heat. It was determined that tearing off was a definite option but the timing and cost could be prohibitive, depending on the bidders.

Decision #12 - Can the existing roof membrane be left in place and a new roof system be installed over it? The foam glass insulation had been unaffected by any leaking and has a high compressive strength. The coal tar pitch membrane was firmly bonded to the foam glass, so delamination was not a problem. A nuclear moisture survey was completed when the roof was dry and the highest moisture content in the foam glass was 5%. Most of the roof membrane was still in good condition and any blisters or deteriorated areas could be removed. Leaving the existing roof membrane in place would keep the building watertight and fosters lower disposal fees. We decided, therefore, to keep the existing insulation and roof membrane in place to provide a stable base for the new roofing.

Decision #13 - Can sufficient slope be provided to meet at least 1/8" per foot slope to the drains? All the drains for the roof were in place and no more could be added. To slope the roof for the 200' run would require insulation 24" thick at the front parapet wall. This would provide an average insulation thickness of 12", which would be very costly, so this was deemed uneconomical.

Decision #14 - Which roof systems will perform well with less than 1/8" per foot slope? The existing coal tar pitch roof system survived for 50 years with as much as 4" of ponding water on it. It was discovered during the removal of the loose slag that extensive reworking had been completed over much of the surface. Extensive wall flashing work had also been completed, so it had not performed for



(Left) The cellular insulating concrete pour is in progress, with filler boards being set in the slurry. (Above) 2" to 3" of cellular concrete are being poured over the stepped insulation boards.

50 years without continued maintenance work. But it did survive for 50 years! This track record would be difficult to meet with any other roof system.

Decision #15 - Which insulation systems will work well with coal tar pitch? Coal tar will work in ponding conditions, so a flat board installation will work. If a tear-off is considered, the nightly tie-off will be relatively easy. A tapered board installation with even a minor slope of 6" from front to back would eliminate some of the worst ponding and the night tie-offs would also be easy, but would require a little more planning. This would be a safe but slow reroofing process.

Also very popular in Florida is the installation of cellular concrete pours. A flat or tapered pour would work very well but it would take four to five days to pour, two days to dry and another four to five days to get the plies mopped down to make the roof watertight. This would require almost two weeks of dry weather in the middle of the summer. And if rains did occur, procedures must be in place to deal with the wet cellular system. This system might be much quicker to install, but rains would cause problems. A structural analysis was performed to verify that the added dead weight load would be within the capacity of the structure. It was determined that both flat and tapered boards and flat and tapered cellular would work well, but they both had disadvantages in the timing of their installations.

Decision #16 - How many options will be allowed for the contractors to bid? The specifications required the installation of a coal tar pitch roof membrane, period. Both tear-off and recover systems were allowed to be bid. Isocyanurate – both 1.5" flat and 6" tapered, from front to back, were allowed. Both 3" flat cellular and 8" tapered cellular were allowed. The time of construction was very critical and the roofing contractors were allowed to bid on one or all of the options they felt they could best install in the limited time given for the project.

All the contractors bid the project with a recover system only. None felt up to the task of tearing off the pitch and foam glass, given the time schedule. The successful bidder wanted to install the cellular system, feeling it was the

quickest method and being familiar with its installation. The tapered cellular was naturally a little more expensive. Our recommendation was to spend the extra money because it would vastly improve the ponding water situation and it might not have to be reroofed for another 50 years.

The project was started the day after the contract was signed. The rest of the unused roof-top equipment, old pipe supports, vents and curbs were removed. All the loose slag was removed. A couple of rains occurred during these days of preparation. The cellular pour was scheduled and was placed out in four days, all without rain. The last day of the pour the roofers were loading the materials on the first section poured. The following day the base sheet was being nailed down and the four plies were being mopped down. In the four days of mopping, no rain fell. The work was scheduled both on Saturday and Sunday with the normal crew size being 16 men. The weather threatened every afternoon and sometimes it stopped just short of the project or it split apart and rained on both sides and behind the project. The cellular pour and the felts were all mopped down without one drop of rain! The day after the roof was watertight, it rained. But the balance of the project was not troubled with the normal summer rains. So the work proceeded without emergencies.

Parking Deck Resurfacing

Decision #17 - How can the parking deck be waterproofed? The original waterproofing for this deck was the coal tar pitch membrane on the structural concrete waffle deck. This membrane had failed and the temporary repairs on the control joints had stopped all but one of the leaks in the last rainy season. The cost to install a new waterproofing membrane under the wearing slab was much too costly for the museum. The waterproofing must be completed on the top of the wearing slab.

Decision #18 - Which coating system performance specifications are to be used? Networking with other consultants and reviewing coating manufacturers' requirements was



The new, completed roof.

the basis for the specifications. The biggest problem to overcome was the presence of the coal tar membrane in the control joints that could eventually migrate into and destroy the new sealant and coating. Even a thorough cleaning or grinding of the control joint sides would not prevent the pitch vapor migration, even being 37 years old (according to most coating manufacturers). After cleaning, the deck was to be primed. Backer rod was to be installed in the control joints and urethane sealant installed. Then a base coat of a urethane coating would be applied. The next urethane coat would have sand broadcast into it for skid resistance. This would be followed with a top coat of urethane coating.

The successful bidder worked with the coating manufacturer, Gaco-Western, on the pitch vapor problem. They required the installation of a 6"-wide rubber tape over the control joints rather than urethane sealant. All the coatings were to be applied over the tape. They also required a two-part urethane coating to be applied. These changes to the specifications were submitted and approved.

Naturally, the concrete first had to be power blasted to get it clean and then they had to get it dry before the primer could be installed. One other problem encountered was the water for the blasting backed up in the control joints and under the wearing slab and threatened to come into the areas being coated. If the deck was cleaned too far ahead of the coating work, wind and rain would get it dirty before the primer could be installed, and the concrete would have to be water blasted for the second time.

One other problem was the rapid curing of the coating once it was applied to the warm concrete deck. Some solvent had to be mixed in so the coating would flow better. There are also definite times before one coating can be applied over the next. There is also a limit of how long one coating can be left before it must be coated or else a coat of primer will have to be applied. The weather condi-

tions caused a few sections to require priming between coatings.

Decision #19 - Are all these changes necessary and how can a consultant cope? The conditions encountered in vehicular parking decks can vary widely. Coatings that work well in milder climates have to go through a learning curve in a hot, humid climate. Job conditions can vary greatly, even on the same deck. Previous repair coatings and sealants can deteriorate the new coatings. Unless the exact conditions have been coated with a particular system beforehand, you have to rely on the coating manufacturer, their reputation and their warranty. Your coping mechanism has to be your experience and the written changes from the manufacturer. Expect changes

for job conditions but require changes be explained in writing.

The final striping of the parking spaces was completed just three days before the new exhibit opened. The coating work will be monitored during the first year for any obvious defects.

Conclusion

The decision-making process on this project was driven by a number of factors. The first was the short construction time during the rainy season. Another was the flexibility to allow the roofing contractors to decide, through their bidding, which system they felt they could get installed easiest in the allotted time. Many of the little decisions made on every project have not been discussed but they may be equally important in the long-term performance of the roof system.

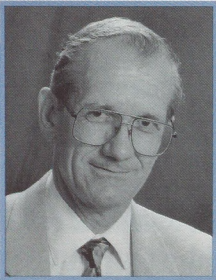
Of equal importance were the decisions by all of the contractors, subcontractors, suppliers, engineers, museum board and personnel, lawyers, and the State of Florida to provide their skills in a spirit of cooperation, for which we are profoundly grateful.

References

- ¹ Canon, R., "Meet the Code, Bear the Load, and Other Guidelines for Roof Projects," *Engineer's Digest*, January 1988, Page 19.
- ² "What is the Best Roof?," *The Basics of Roofing Seminar Textbook*, The Roof Consultants Institute.
- ³ "Roof Systems," *Basic Roof Consulting Seminar Textbook*, The Roof Consultants Institute.
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⁶ Horowitz, R., "The New Order of Liabilities," *Interface*, July 1990, Page 2.



About The Author

Dave Siple is president of Accurate Roof Consultants in Clearwater, Florida. He has been in the construction industry for the

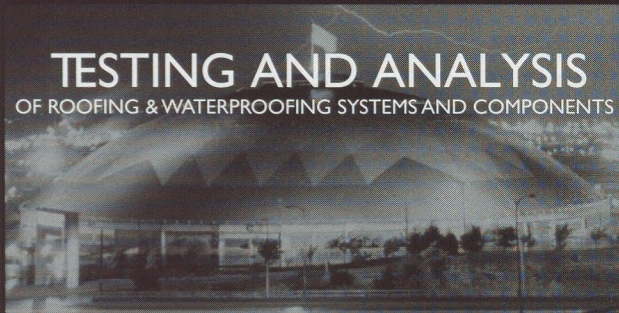
past 29 years with the last 12 in roof consulting. During nine years as an RCI member, he has achieved the RRC and FRCI designations. Siple has helped to develop RCI seminars and been a frequent instructor for the Institute. He is currently on the Education Services and the Nominating Committees. His practice is centered in Florida and specializes in condominiums. Siple has developed and taught courses about roofing to condominium association managers. His articles have been published in Interface, Condo Management, and Condominium Times.

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