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Moisture Intrusion Inspections of Stadiums through the use of Thermal Imagery

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ABSTRACT

Most everyone has visited a stadium in this day and age. We live and work in order to enjoy life and our leisure activities. A lot of our leisure time is spent following our favorite teams at stadiums and arenas around the country. Stadiums are susceptible to the elements. Moisture intrusion into these stadiums can cause havoc on the maintenance personnel and tenants of these structures.

This paper will explore the possibility of testing these stadiums through the nondestructive use of infrared (IR) thermal imagery. We will discuss detection and evaluation of moisture's effect on not only the stadium seating but also offices and vendor sites beneath the seating. Cost avoidance and cost saving measures that can be implemented within a budget as to save the stadium owners large maintenance charges will be discussed. Waterproofing agents and sealers that can enhance the life of these stadiums and thermal imagery has proven to be one of the most reliable and cost effective testing applications in the moisture intrusion arena.

Keywords: Stadium, thermal imaging, infrared thermography, moisture intrusion, maintenance, waterproofing, infrared, camera

INTRODUCTION

Infrared (IR) thermal imaging was found to be an effective way of inspecting, detecting and evaluating moisture intrusion in all types of building envelope systems. The types of structures that we will discuss in this paper are stadiums. These large complexes are susceptible to environmental factors such as solar heating and inclement weather conditions. The largest difference between standard buildings and these stadiums is that standard buildings have roofing systems and insulation where as stadiums are mostly concrete structures left to the elements.

The subject stadium of this work is the United States Olympic Baseball stadium training facility in Durham, North Carolina. The owners of this facility requested a thermal survey in order to determine the extent of the moisture intrusion from the stadium seating to the offices and vendor sites below the mezzanine. A detailed description of the fault and cause was followed by a recommendation to prevent this type of moisture intrusion in the future

MOISTURE INTRUSION INSPECTIONS OF STADIUMS BY THERMAL IMAGERY

Stadiums by definition are sports arenas, usually oval or horseshoe shaped, with tiers of seats for spectators. Most all stadiums are subjected to abuse whether by the patrons or by the elements. These structures hold up reasonably well under these conditions and the life expectancy for all these facilities is fairly long.

The stadium that was chosen as the subject of this paper is in its early teens and it has numerous moisture intrusion problems that are correctable with the proper care. Thermal imagery can help identify these problems and also act as a guide to the contractors in the repair process.

The use of infrared thermal imagery during the evaluation process is an integral tool for this type of investigation. The value of being able to see into a problem allows everyone involved to have much needed information in order to make intelligent decisions. The United States Olympic Baseball Team training facility in Durham, North Carolina needed to solve their moisture intrusion problems without

wasting time and money because of budget constraints. The stadiums condition (see in figures 1 and 1a) was in need of an upgrade. An architect hired to solve this problem used this information to effect repairs.

Figure 1.The efflorescence on the exterior walls illustrates the amount of damage that can occur when a problem is left unchecked

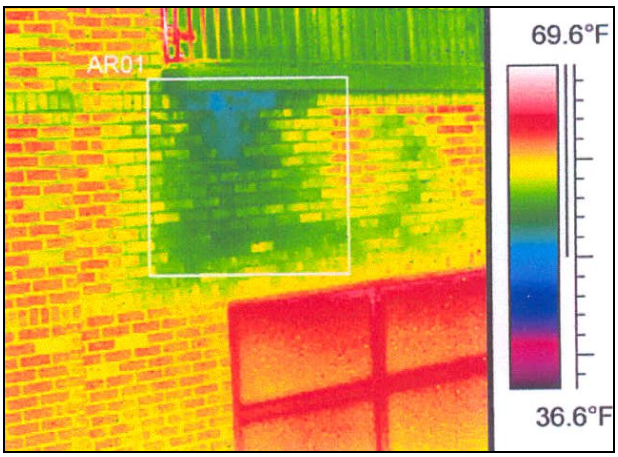

Figure 1a. The thermal scan displays the extent of the moisture intrusion.

An initial walkthrough inspection revealed areas that were leaking into the offices below the stadium mezzanine. The architect and the technician developed a scope of work in order to track the moisture to it's origin. The development of an interior and exterior thermal survey was the result of this walkthrough. The stadium seating was scanned first, followed by the underside of the mezzanine, the concourse, the exterior of the offices and finally the interior of the offices. The interior of the offices, where the moisture was prevalent, needed to have the repairs completed before USA Baseball could move in and begin operations.

The city of Durham, which owns the stadium, needed to ascertain the extent of the problem, as quickly as possible. The architect suggested that a thermal survey be completed before the turn over of the stadium to USA Baseball.

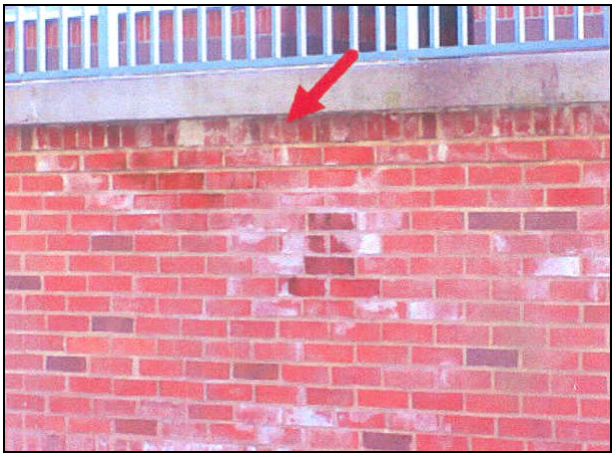

Figure 2. Another example of the moisture..

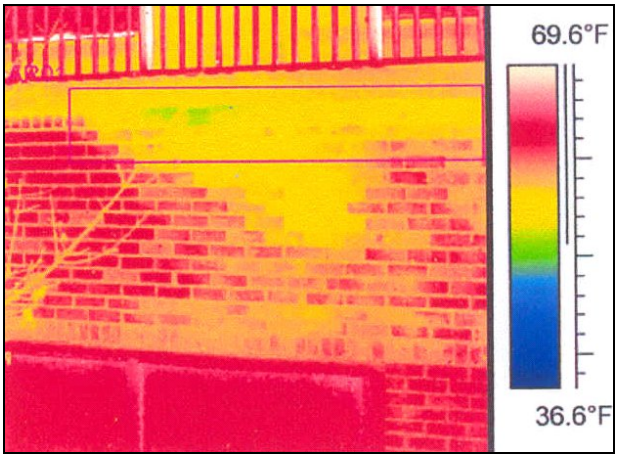

Figure 2a. A good example of the depth of the problem

The city of Durham and USA Baseball both saw the value in this thermal imaging camera survey and brokered a deal in order to solve the problem and complete the repairs in a timely fashion. The thermal survey was conducted over a three-day period in various conditions in order to collate the best possible information. The outside air temperature was around 36 degrees F while the interior offices were regulated by the thermostat and heating elements to around 75 degrees F on average. The scan was done on one sunny day, one overcast day, and one rainy day. A temperature differential of at least 20

degrees F was maintained on all three days. The investigation revealed interesting results on the underside of the mezzanine where the moisture seeped into the walls. The thermal survey tracked the moisture in the walls to the office ceilings below. These are shown in Figure 3 and Figure 3a. It is imperative to know the type of material in which the moisture is tracked in order to calculate the emissivity value of the material which in this case is cinder block and concrete. An emissivity value of 0.87 was the standard used for this investigation. The humidity, the atmospheric temperature and the background temperature were all programmed into the onboard computer of the ThermaCAM PM290 cooled infrared camera that was used.

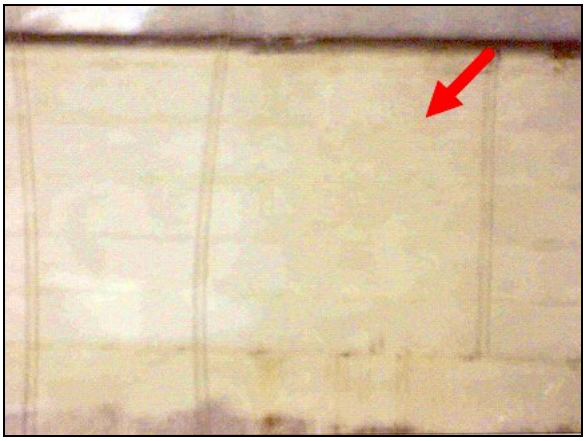

Figure 3. Digital picture of the knee wall that skirts the mezzanine. One cannot really see what is going on in this photo.

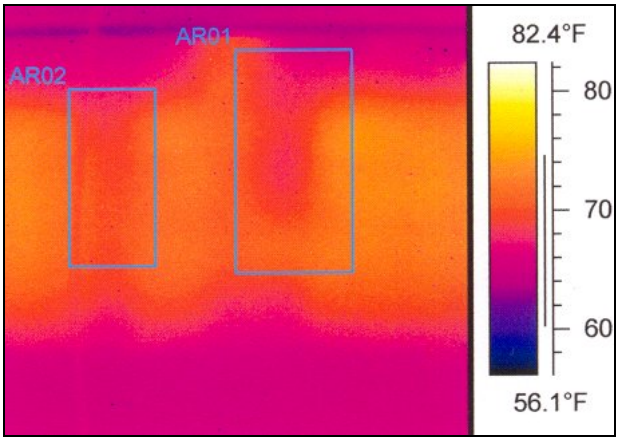

Figure 3a. The thermal image does in fact show the course the moisture is tracking. A core sample of the area confirmed the suspected path.

The inspection of the stadium showed numerous intrusion points by using the thermal imaging camera. The differences in the thermal conductivity of the moisture allowed us to determine the presence of the water. It also allowed us to show the client where moisture had accumulated and provided them with a very good condition assessment. These visual symptoms let us ascertain the extent of each problem as well as the characteristics of the stadium envelope. The rubber membranes of the expansion joints were a large part of the problem in that they were not sealed against the elements. The expansion joints and the coping stones not being waterproofed with a proper waterproofing agent allowed for this seepage to infiltrate the walls of the stadium, thus causing a number of other problems.

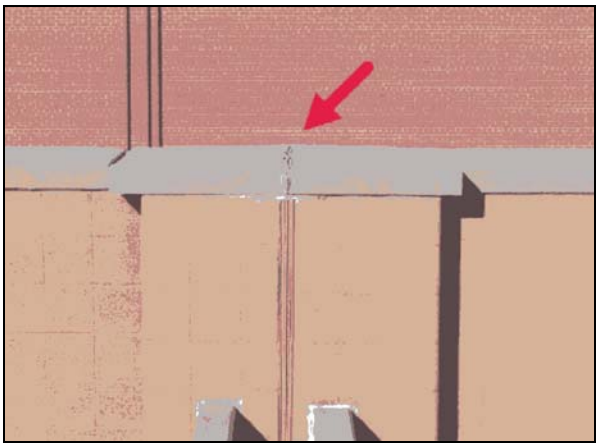

Figure 4. Coping stones that have no waterproofing agent or sealant. These were found to be major intrusion points into the offices.

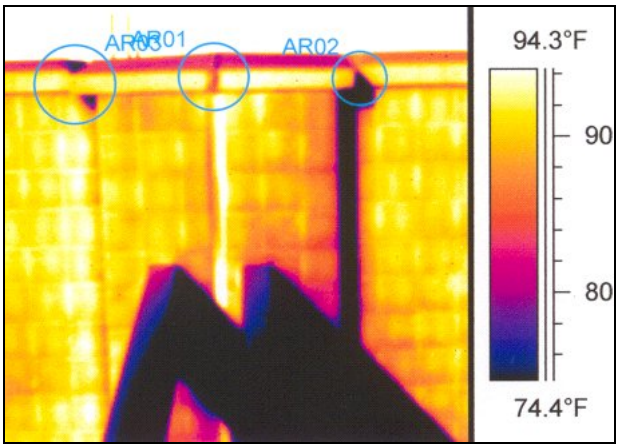

Figure 4a. Infrared thermogram displaying the origin of the moisture from the inclement weathe. Sealing these coping stones will go a long way towards preventing intrusion in the future.

The water in some cases will eventually find its way down the interior of the wall and stop because of a concrete barrier. The result is an efflorescent problem, which is unsightly as well as degrading to the structure. The recommendation of the results of our survey is to pressure wash and clean the stadium followed by the application of a good waterproofing agent, one that will soak into the concrete and provide a barrier against the elements. A sealant is also required for the coping stones.

SUMMARY

Infrared thermal imagery is an excellent way of determining the moisture intrusion into these types of structures. There are other less effective ways to uncover water in facilities such as these, but if you weigh the information IR thermal imaging can provide to the client as well as the cost effective nature of this information, it is difficult to argue the overall value of this technology.

Both the city of Durham and USA Baseball are pleased with the findings that thermal imaging provided. The problem with the moisture is in the process of being resolved and should be completed in time for the international competition. The architect and the contractors are also pleased because the information essentially defines their scope of work.

The use of infrared thermal imaging in this application is here to stay and all the parties involved could not be happier. IR thermography helped solve the moisture intrusion problem at this stadium and it will continue as a valuable tool in the fight against the effects of moisture on these structures for years to come.

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