CONCRETE/VAPOR EMISSIONS/RESILIENT FLOOR COVERINGS

Background Information

Moisture related failures of resilient floor coverings installed over concrete have focused unfairly over the years on the premise that the flooring product itself is at fault or the flooring contractor, perhaps, did not install the product correctly. In reality, the vast majority of flooring failures result directly from high emissions of moisture (moisture vapor, if you will) from the concrete slab over which the floor covering has been installed. When discussing these issues, people in the trade may refer to this as a water problem, hydrostatic pressure, capillary action, or moisture migration.

Concrete is porous by its very nature, and the degree of porosity has to do with its design recipe, placement, and cure method. Moisture vapor emission is a function of that porosity, combined with environmental factors that influence and drive it. The greater the porosity, the greater the potential for moisture vapor to move at a volume intolerable to the floor covering. The problem is further exacerbated when high levels of alkalinity move with the vapor emissions and attack the adhesive that bonds the flooring to the concrete.

Moisture related failures in flooring applications is not a human error phenomena, with the exception of the unwillingness of people to accept that nature is indifferent to their contract specifications, construction requirements and schedules. Environmental conditions (temperature, humidity and dewpoint, for example) and the chemistry of concrete will, by and large, determine moisture and alkalinity emission rates that will have a direct bearing on the success or failure of any flooring installation.

Recommendations for Architects in Preparing Contract Specifications

A. GEO-TECHNICAL SURVEY

l. Before commencing design of a building, obtain a soils report from a reputable geo-technical engineer to determine underground moisture conditions.

2. If the soils report identifies a high ground water condition, it may be necessary to include an interior drainage system. There are exceptions to always needing a vapor barrier. Consider building sites with low water tables and sandy soil conditions as not needing vapor barriers.

B. SUBSTRATE DESIGN

1. From geo-technical report, design substrate to meet reports criteria.

2. After substrate is compacted, specify if base is not completely smooth; place a rolled light sand fill to smooth out imperfections.

C. VAPOR BARRIER/RETARDER

1. Specify vapor barrier (barrier is preferred due to perm rating) installation in Section 03l00 Concrete Forms. If only one concrete specification is shown, specify in Section 03300 Cast-in-Place Concrete.

D. CONCRETE

1. Never specify light wire mesh (6x6–l0/l0). If reinforcement is needed, specify #4, #5 or larger, if design conditions require. Space rebars at l2", l5" or l8" on center depending on design consideration of anticipated loads, distance between slab edges and thickness of concrete slab. Isolate concrete slabs from fixed objects. As square footage of reinforced slab increases, a greater amount of reinforcement is required. Place rebars in upper half of concrete slab (l-l/2 to 2" from top surface or l/3 below top surface. It is recommended that concrete slab reinforcement run continuously across the full length and width of the building floor area. Concrete slabs reinforced continuously are found to minimize curling and large cracks. Specify construction joints with lapped rebars. Space construction joints around the largest area that concrete can be placed and finished in a single day's work period.

2. Concrete Finishes: Interior concrete slabs on grade evenness tolerance not to exceed l/8" in l0 feet verified by a ten foot steel straightedge.

3. Many concrete slabs on grade end up being 3 l/2" thick or less. If possible, specify 5" or thicker slabs and in no case less than 4". Specify only concrete brick as supports under the rebars. Regular metal chairs can puncture certain vapor barriers.

4. Never specify sand or granular fill between the bottom of concrete slab and the vapor barrier. (Note: ASTM and ACI standards no longer call for a 2" sand fill over a vapor barrier on interior concrete slabs that are scheduled to receive floor coverings.)

5. Specify that penetrations of the vapor barrier will **not** be allowed for purposes of placing the concrete. This can be done without screed pins puncturing the vapor barrier. One method is employing procedures used with multiple tilt-up concrete slabs. There are other methods available. One example is to place adjustable screed pins with welded 3/8" or l/2"X5"X5" steel bottom plates over the vapor barrier and remove them as soon as the concrete has been poured and the top grade is established prior to the final concrete finishing. In areas where rain is a common occurrence, it becomes necessary to remove water accumulated just prior to pouring the concrete. This can be accomplished

employing commercial air blowers. This method removes most of the accumulated water.

6. Specify a water reducing agent (plasticizer) in the concrete to achieve a 0.42 water/cement ratio. Do not specify air entrainment. Air entrainment is not needed for interior concrete. Use of air entrainment tends to slow down moisture release. There are three different ranges of water reducers on the market. Specify not less than a mid-range reducer that meets ASTM C494 Type A that reduces water content up to 20 percent.

7. Interior Slabs on Grade with Vapor Barrier: Specify single finish steel troweling. Curing/sealing compounds are prohibited (double steel troweling and curing/sealing compounds can retard the release of moisture in the slab). Normally, moist curing is not required unless conditions involve high temperatures, wind or both, then moist curing is most important for a period not less than 48 hours. (Note: Minor cracking should not be a problem for concrete surfaces that will be covered with floor coverings.)

8. Place the concrete with a concrete pump. Concrete strength to be not less than 3,500 PSI and not less than 564 lbs. of cement per cubic yard (consider stronger strengths if usage and load factors indicate) with not more than a 5" slump with plasticizer. With the proper water-reducing additive in the mix, no appreciable surface water should appear and the concrete finishers can start sooner. Specify that concrete not be poured until an architect has inspected the vapor barrier installation just prior to the pour. Continuous inspection of the concrete placing is strongly recommended.

9. Specify methods acceptable for testing of moisture vapor emissions in accordance with flooring manufacturer's requirements. Presently, most will require that testing be conducted in accordance with ASTM F l869-98, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride. Calcium chloride tests are the only practical, well-established and acceptable tests of dynamic moisture. They produce quantified results to which specifications from manufacturers are directly applicable. While maximum acceptable moisture emission levels for commercial installations may vary amongst the various manufacturers, most require 3.0 pounds per l,000 sq. ft. per 24 hours for sheet flooring and 5.0 pounds per l,000 sq. ft. per 24 hours for vinyl composition tile. Remember, calcium chloride testing measures vapor emissions only at the time of the testing. As the environmental conditions within the building envelope change, moisture vapor emission levels may increase or decrease. **Specify that tests be conducted by an independent firm and paid for by the Owner.**

10. Specify a pre-construction conference held at regular project meeting prior to and after placement of vapor barrier.

11. If the above recommendations are followed, the concrete slab moisture content is normally acceptable within 60 days.

We thank the below individuals for assisting in the development of the recommendations and the suggested specification language.

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