



# COMPARISON OF SUBFLOORING INSTALLATIONS USING THE DAP URETHANE ADHESIVE AND CARTRIDGE ADHESIVE

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DAP Products, Inc.

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## EXECUTIVE SUMMARY

DAP Products, Inc. (DAP) developed a new urethane adhesive for subflooring (OSB, plywood) installation on wood floor joists. The adhesive is delivered by a reusable dispensing gun loaded with a pressurized canister of expanding urethane that fills gaps as it bonds. Preliminary evaluations by DAP indicate their adhesive has a much higher coverage rate and takes less time to install than cartridge subfloor adhesive and DAP engaged the NAHB Research Center to validate their findings.

This study was a comparison of construction time and adhesive usage in subflooring installation between: 1) traditional cartridge subfloor adhesive and 2) a new urethane-based adhesive by DAP Products. The Research Center designed and implemented a testing program to compare installation times and application rates of the DAP urethane subfloor adhesive and traditional cartridge subfloor adhesive. The study was conducted on a total of seven (7) identical floors, alternating between the two adhesives, while Research Center staff used the Group Timing Technique (GTT) method of time-and-motion study to observe and record labor time.

The specifications of the floors and installation crew were typical of a residential construction setting—OSB subflooring installed on 2x10 lumber joists with layouts, joist spacing, tools, and a carpentry crew with extensive experience in structural floor framing and subfloor installation. The study data indicated the time to construct the floors using the DAP urethane-based adhesive was less than the floors using cartridge-applied adhesive. The primary reason for labor saving with the DAP product was a reduction in time of handling, refilling, and applying the DAP adhesive compared to the cartridge adhesive due its higher coverage rate and ease of handling the adhesive dispensing gun. A single, 24 ounce canister of the DAP product had the same coverage rate as 4-3/4 cartridges of the traditional subfloor adhesive. Additionally, an inspection of the area below the trial floors revealed there were far fewer drips and spills of the DAP product than cartridge adhesive and the average size of the drips of the DAP adhesive was much smaller.

Upon completion of the installations, two Research Center marketing researchers held a 40-minute, recorded discussion with the installation crew members to discuss their experiences with the new adhesive. Each crew member offered favorable opinions of the new product, citing the following factors: 1) it was less messy than their usual adhesive; 2) the loaded dispenser

was lightweight, well balanced and offered good control in applying the adhesive; 3) they estimated a four-fold increase in coverage rate per canister compared to cartridge adhesive; and, 5) the metal container would be much less likely to be damaged than the normal cardboard cartridges. The crew believed there may be a small labor savings using the DAP product compared to cartridge adhesive and further stated they would very likely purchase the DAP adhesive if available even at a higher cost after factoring in the higher coverage rates, not because of the potential labor savings, but due to the ease-of-application and low-mess benefits.

The study was conducted at the NAHB Research Center's observational research facility in Upper Marlboro, Maryland, in December 2012.

## STUDY DESIGN AND APPROACH

The NAHB Research Center organized the construction of seven (7) structural wood floor systems in its Upper Marlboro, Maryland observational research facility. The objective was to replicate conditions typical for a residential floor system--including an installation crew, floor design, and materials used--to compare the installation time and adhesive application rates of cartridge subfloor adhesive and the new DAP urethane-based adhesive. The floor specifications were:

- 2x10 lumber joists, 16" on-center spacing
- 23/32-inch commodity OSB subflooring, T&G
- Traditional cartridge subfloor adhesive and the DAP urethane-based alternative
- Appropriate nail size and spacing, applied with a pneumatic fastening gun
- Built on a wall of 36" height from the work floor, constructed of 2x6 lumber
- Each floor dimensions were 12' by 24' for a total of 288 square feet



Figure 1: View of the floors from the observation deck level prior to the subflooring installation trials

The three (3) member carpentry crew was selected for this project because the Research Center's past experience with this crew indicated that they have high level of framing experience, good communication skills, a consistent work pattern as a crew, a broad range of experience that spans new custom and production homes and remodeling, and a willingness to work with non-standard materials and equipment. Extraordinary care was taken to assure the comparisons were fair and balanced.

### **Description of Adhesives and Dispensers**

The cartridge adhesive used in the comparison was purchased by the NAHB Research Center from the in-stock supply of a local lumber retailer. The manufacturer and brand of the comparison adhesive will not be reported, but the Research Center confirmed that it is a popular and widely-available, multi-purpose construction and subfloor adhesive in the 28 fluid ounce size (828ml). The manufacturer literature stated this product to be a low-VOC product meeting APA AFG-01 and ASTM D 3498. The total weight of the unopened adhesive cartridge was 46 ounces, as weighed on a calibrated scale, and the actual weight of the usable contents was about 42 ounces. The cartridge adhesive applicator, or "caulk gun," weighed 32.4 ounces. Total combined weight of the full cartridge and dispenser gun was 78.4 ounces, or 4.9 pounds. The estimated weight when the contents are half-emptied is 57.5 ounces, or 3.6 pounds.

Full canisters of the DAP adhesive and dispenser guns were supplied by DAP. The DAP adhesive is urethane-based and is provided in a pressurized metal canister in a nominal 24 ounce size. The applicator is a readily-available polyurethane expanding foam dispensing gun commonly used for air sealing in homes and buildings. The weight of the unopened DAP adhesive canister was 28 ounces. The actual weight of the usable contents was 23 ounces. The weight of the adhesive gun prior to use was 12.0 ounces. The total combined weight of the full canister and gun was 40.2 ounces, or 2.5 pounds. The estimated weight when the contents are half-emptied is 28.8 ounces, or 1.8 pounds.

The carpentry crew members reported that they had never used this type of dispenser gun. The adhesive brands of both cartridge and DAP adhesives were not revealed to the carpentry crew.



Figure 2: Cartridge subfloor adhesive and applicator (Left) and DAP adhesive and applicator (right)

## CONDUCT OF THE STUDY

When the first two mockups of the floors were completed, prior to the subflooring installation, the carpentry crew was assembled to get instruction. They were asked to practice using the DAP adhesive until the observing researchers were confident the crew could dispense the new DAP product in a controlled and consistent manner and could reload adhesive canisters when empty. Each crew member was confident in his ability to operate the dispenser with DAP adhesive within a few minutes.

The work area was readied for the study by preparing all tools and materials needed to complete the subfloor installation and assembling them in a convenient place equally distant from both the trial floors. The crew was instructed to use the cartridge adhesive for the first floor until the installation of the subflooring was complete. The crew discussed their work process

among themselves and made assignments to workers for specific tasks before beginning. One NAHB Research Center staff member observed and recorded the work using Group Timing Technique (GTT). GTT is a work sampling procedure that allows a single observer to accurately record the installation time of several workers and distinguish between multiple activities. The observer records each worker's specific activity at fixed intervals. In this study, activities were recorded every 30 seconds.

When the first installation trial was completed, the crew was given a 15 minute break prior to beginning the second installation using the DAP adhesive. One trial each of the different adhesive types was completed by the end of the first day. When completed, the carpentry crew and lab staff dismantled and removed the entire floor and the carpentry crew constructed a new floor 2x10 frame to begin next pair of trials. Using the same process described above, a total of five (5) trials were conducted on the second day, beginning with the DAP product and alternating adhesives between trials.

The original study design was to conduct three trials each for the cartridge adhesive and the new DAP product over a two day period. However, by the end of the first two installation trials (one of each adhesive type), it was apparent that crew needed more time to develop a consistent work process to minimize variations in the way they installed the subflooring. At the beginning of the second day, laboratory staff held a conference with the carpentry crew and decided to reassign workers to tasks they were more accustomed to doing—one to supply material, another to apply adhesive and place/position the subflooring panels, and the third to primarily nail. They continued with these work assignments throughout second day. Three (3) installations used the DAP subfloor adhesive and two (2) used the cartridge adhesive. An inspection of the time and motion data upon completion of the trials revealed a much greater consistency between trials for a more reliable comparison, so average times from the second day only were used in the final comparison and analysis. Video recordings were made of the workers while all observers viewed from behind one-way glass.





**Figure 3: Carpentry crew and floor at the completion of the third trial.**

### **Time And Motion Study Results**

The results presented below represent the average amount of productive man-hours, by task, to install subflooring onto the floor joists of the 288 square foot floors for: 1) a traditional cartridge subfloor adhesive and 2) the new DAP urethane-based adhesive. Non-productive time was recorded but removed from these tabulations—including activities such as personal breaks, tool or equipment issues, rework (correcting mistakes), and idle time.

|  | <b>Cartridge Adhesive</b> | <b>DAP Adhesive</b> |
|--|---------------------------|---------------------|
| Obtain/Organize Materials              | 7.5                       | 6.7                 |
| Task Planning and Equipment Set-Up     | 0.3                       | 0.5                 |
| Measure/Mark/Cut Subfloor Material     | 5.8                       | 5.5                 |
| Adhesive Application                   | 8.7                       | 7.5                 |
| Adhesive Cartridge Load/Change         | 2.0                       | 0.2                 |
| Placement and Positioning of Panels    | 12.5                      | 12.3                |
| Nailing Subfloor to Joists             | 14.3                      | 15.2                |
| <b>TOTAL PRODUCTIVE TIME (minutes)</b> | <b>51.2</b>               | <b>47.8</b>         |

**Figure 4: Time and Motion Study Results**

Time saving for the DAP product was primarily seen in a reduction in obtaining/loading the adhesive material into the dispensing gun due to the higher coverage rates. There was also a slight advantage for the DAP product in adhesive application time. The impact of the new DAP subfloor adhesive on other activities in subfloor installation was minor. An average of 3.4 minutes of productive time was saved for the 288 square foot floor installation trials compared to the cartridge adhesive. Projecting this savings to a typical 2,400 square foot home with structural wood panel subflooring, workers could potentially reduce the installation time by 28 man-minutes.

### Application Rates

The amount of material used for the trials was determined by weighing the adhesive containers before and after each trial to determine the weight of materials used. Each floor had 72 linear feet of rim joist and 204 linear feet of open-span joist. One adhesive cartridge failed upon loading into the caulk gun and pressurizing and was not included in calculating usage rates.

|   | Trial #1 | Trial #2 | Trial #3 | Average |
|---|----------|----------|----------|---------|
| <b>Tradition Cartridge Adhesive (grams)</b> | 3201.7*  | 2514.4   | 2874.5   | 2863.5  |
| Cartridge Usage Rate g/LF                   | 11.60*   | 12.33    | 14.09    | 12.67   |
| <b>DAP Adhesive (grams)</b>                 | 325.2    | 316.8    | 244.0    | 295.3   |
| DAP Usage Rate g/LF                         | 1.59     | 1.55     | 1.20     | 1.45    |

**Figure 5: Application Rate Averages over three trials**

\*Workers applied adhesive to the rim joists and open-span joists in this trial but omitted adhesive on the rim joists in the remaining trials. Trial #1 for the cartridge adhesive had 276 linear feet of adhesive application and the remaining had 204 linear feet.

Based on the study, one canister of the DAP covered 449 linear feet of joist.<sup>1</sup> Comparatively, the 28-ounce cartridge of subfloor adhesive covered 94.7 linear feet of joist.<sup>2</sup> At these rates of application, one canister of the DAP product was used for every 4-3/4 tubes of cartridge adhesive.

<sup>1</sup> Prior to the first subfloor installation trial, carpentry crew were given a demonstration of the DAP adhesive with an adhesive bead of approximately 1/2-inch in diameter.

<sup>2</sup> The cartridge adhesive manufacturer's literature stated coverage rates for the 828ml cartridge to be 38.1 linear feet with a 3/8-inch diameter bead and 85.8 linear feet with a 1/4-inch bead.

## FEEDBACK FROM THE INSTALLATION CREW

At the conclusion of the final installation trials of the second day, the installation crew discussed their experiences with both the traditional cartridge adhesive and the DAP adhesive. When asked about what they typically use on the jobsite, they shared that cartridge adhesive was all they had ever used or seen.

The first reaction when asked what they thought of cartridge subfloor adhesive was “it’s messy.” It dripped onto floors when applied and can be tracked into other parts of the construction site and into vehicles and ruin shoes and clothes. They also discussed waste from cartridges damaged from job site handling and during transport and from ‘blow ups’ in both hot vehicles or while pressuring the cartridge to apply in very cold weather. Cartridges made of cardboard material are ruined when exposed to water such as when inadvertently left exposed in the rain. The cartridge tips sometimes bend or break, rendering the remaining adhesive unusable.

Cartridge adhesive dispensed from “caulk guns” was said to be “front heavy” and difficult to control when applying to joists. Pressure built up when applying and adhesive sometimes continues to dispense even after the trigger was released, resulting in spills and drips. According to the crew, cartridge adhesive has a short shelf-life when unopened, and after piercing the seal, it can be stored only for a few weeks. When asked about what they liked about cartridge adhesive, they replied that it was what they knew how to use and it worked well in damp conditions.

The construction crew identified improvements in the DAP adhesive with its packaging and dispensing compared to cartridge adhesive. The adhesive and dispenser were noticeably lighter and of a shorter length which would be advantageous on large projects and operating in tight spaces. The metal cans were believed to be more durable and less susceptible to damage by rough handling or exposure to water. Cartridge change-outs were considered quick and easy. The crew liked the dispensing gun’s metal tip due to its rigidity and perceived durability.

The carpentry crew was very pleased with the DAP adhesive and the dispensing gun’s greater control and ease of handling. Amount of adhesive could be controlled for greater or lesser flow with a quick adjustment and, when they released the trigger, flow of adhesive ceased immediately. The bead of adhesive came out as foam and seemed to stick immediately to the joist without rolling off or dripping. When asked about labor savings, the crew stated while there

may be minor savings in labor, the reduced mess and easier handling benefits were most valuable to them.

The crew agreed that they would readily pay \$40 per 24-ounce canister of the DAP product. At higher price points (\$50 or \$60 per canister), the crew was less likely to switch from cartridge adhesive to the new DAP product unless they were working a high-end job where it was crucial that adhesive spillage would be unacceptable. Before they would purchase the DAP adhesive, they would need to have answers to a couple questions about its use and performance: 1) how well does it perform when applied to damp surfaces, and 2) how does it dispense in very cold weather?

## **ABOUT THE NAHB RESEARCH CENTER**

The NAHB Research Center (Research Center) was established in 1964 to provide independent third-party research, testing, education, and technical evaluation support for a wide range of public and private sector organizations. As a wholly-owned subsidiary of the 150,000-member National Association of Home Builders (NAHB), the Research Center's mission is to promote innovation in housing technology to improve the quality, durability, affordability, and environmental performance of homes and home building products.

The Research Center operates a state-of-the-art marketing research facility located in the Baltimore/Washington metro area that is designed specifically for construction marketing. A portion of this facility is dedicated to conducting observational research, which includes two levels of one-way glass overlooking a laboratory floor where researchers and clients can observe the installation of materials in construction assemblies for structures up to 30 feet high. The observational research area is equipped with modern audio visual recording equipment with six fixed, remote-controlled cameras, two portable cameras, and lapel microphones for all workers. The observational facility was the location of this study.