THE ADHESIVE AND SEALANT COUNCIL, INC.

Work Plan: Investigation of Adhesive Applications for Stronger and More Disaster-Resistant Roof Assemblies (Phase I)

Submitted to:

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Project Overview

PATH has recently completed the development of a roadmap to identify R&D that will lead to improvements in the performance of roofs in residential buildings. Structural performance during thunderstorms, hurricanes, tropical storms, and other wind events is one of the major strategies of the roadmap.

Since the late 1980s and early 1990s - when events like Hurricanes Hugo and Andrew pushed disaster mitigation to the front of the agenda of many industry sectors related to building, engineering, insurance, standards, codes, and rehabilitation – the industry has made great strides toward improving the structural system of new homes. Relatively little has been accomplished in terms of improving the older existing housing stock.

Even with the progress to date, we may have done little to actually reduce the potential for damage in extreme wind events. Though roof sheathing installed under new building codes has performed better in storms, keeping roof sheathing on a home during high winds still remains a challenge. Water damage that results from even a small amount of roof sheathing loss can inflict a large amount of damage to the interior of a building, even if the "structural system" is basically intact.

The current solutions for roof sheathing attachment are prone to error. The importance of fastener schedules is not well understood by the carpentry profession, and even the design professions. Old rules of thumb are still widely used for fastener spacing. Fasteners often miss the underlying framing members.

A need exists to create practical and effective fastening systems that can be used in new construction and in retrofit applications to further reduce the loss of roof sheathing in wind events. Applied directly to the roof framing members, the risk of missing underlying members vanishes with adhesives. Adhesives offer a potential solution, either as the primary fastening system or as a redundant system.

Adhesives are already used for some types of roof sheathing in manufactured and modular homes. This project focuses on bringing these systems, and the appropriate level of quality control, to the new construction site. We would also investigate the use of adhesives for strengthening of roof sheathing fastening in existing homes in high risk areas.

The activities necessary to address this opportunity are presented below in two phases. The current contract award only covers Phase 1. Therefore, only Phase 1 is presented in detail. Phase 2 is included to show the complete project, however, costs and activities for Phase 2 depend to a great extent on the outcomes from Phase 1 and will be better defined as the project progresses.

Project Tasks, Products and Delivery Schedule

Use of adhesives in roof sheathing fastening systems is currently recommended by some building scientists, government organizations (including HUD), and institutes (such as IBHS). Though the beneficial properties of adhesives for use in fastening roof sheathing are recognized by multiple sources, their proper application is not synthesized in such a way as to be officially recognized, adopted, and promulgated by code. This project will work to identify, develop, and test adhesive roof sheathing fastening systems that could be shown to meet and exceed current code requirements. These systems will be developed and documented with the intention of preparing the technology for inclusion into code or standard status.

Phase I: Adhesive Roof Sheathing Fastening System Identification and Preliminary Testing

Task 1: Assess Performance Requirements and Develop Criteria for Adhesive Consideration

The primary objective of Task 1 will be determining what criteria will be used to identify adhesives which could be used as a roof sheathing fastening system for new and retrofit applications. The main emphasis will be on the structural performance needed to hold down roof sheathing products using adhesives alone or in combination with mechanical fasteners.

Activities under Task 1 will include the following:

- Conduct a review of residential code requirements, industry standards, manufacturer's data, lab reports, and case studies for approved or proven methods of adhesive roof sheathing fastening as a primary or secondary fastening implement. Determine which codes currently permit adhesives as secondary or primary roof sheathing fastening system (e.g. Florida, IRC, Hawaiian codes), and under what basis adhesives are permitted (e.g. prescription, engineered, manufactured, etc.).
- Investigate the rationale and engineering basis behind code approved roof sheathing fastening systems. Determine the effective uplift resistance provided by code approved roof sheathing fastening systems. Use this number as a baseline for developing an adhesive roof sheathing fastening system for new and retrofit applications.
- For retrofit and new applications, develop adhesive application schedules based on engineered models that would satisfy various wind loads identified on code wind maps.

Task 1 Deliverables: Supply a matrix identifying code-approved systems and uplift resistance or wind speed approved rating for new and retrofit roof sheathing fastening systems.

Task complete: August 7, 2006

Task 2: Data Collection

Within Task 2, Newport staff will compile information on adhesives used for similar or relevant applications to roof sheathing fastening. This will consist of an initial canvassing of the ASC membership and their products to match them against the performance criteria identified in Task 1. A scan of research literature, trade press, and manufacturer product data will then be performed to develop a list of currently available adhesives that demonstrate potential for integration into roof sheathing fastening systems. The search will also examine adhesives used in manufactured housing and non-residential building.

For adhesive manufacturers, the data will need to compiled and closely evaluated. This is not a simple task. Adhesives are not currently marketed for the applications proposed in this project. Therefore, manufacturer data typically does not include the information needed to assess an application like roof sheathing attachment. For example, the information below in Figure 1 comes from an adhesive manufacturer product that may have application for roof sheathing, but the physical and chemical characteristics listed here would seem to preclude the product from the proposed roofing application. However, the data included here just represents the test data necessary for its current application, not necessarily the limits of the application. Thus the task of collecting data from the manufacturers and assessing the data becomes a more involved task with substantial investigation and collaboration with potential manufacturers.

The next step is to include a wider range of manufacturers, search for additional studies and test data (for example accelerated aging tests that indicate long-term performance), and assess the applicability and limitations for this project. For example, there are several references to reports on adhesive use in retrofit applications as an added layer of protection when used in combination with a nailed quarter-round. This is the typical "belt and suspenders" approach that does not have any supporting test data so that it could only improve performance. This project is designed to evaluate adhesives in lieu of other fasteners or with reduced fastening schedules and basing it on objective criteria by wind speed that could be thoroughly tested in Phase 2, included in user guides, and submitted to code bodies.

Figure 1- Sample Adhesive Performance Data

Physical & Chemical Characteristics:

Vehicle:	Synthetic Rubber
Volatile:	Petroleum Solvents
Flash Point:	<0°F
Solids:	77% by weight
Weight/Gallon:	11.3 lbs
Odor:	Strong Solvent
Color:	Gray
Consistency:	Smooth Paste
Application Temperature Range:	40°F - 120°F
Service Temperature Range:	-20˚F to 140˚F
Bonded Strength:	500 + psi
Open Time:	20 Minutes
Freeze/Thaw Stability:	5 cycles
Coverage:	29 fl. oz. cartridge: 1/4" bead covers 89 linear feet. 3/8" bead covers 41 linear feet. 10.3 fl. oz. cartridge: 1/4" bead covers 32 linear feet. 3/8" bead covers 14 linear feet.
Shelf Life:	1 Year
MSDS No.	10302

The data search will progress with the following objectives:

- Develop a list of potential adhesives and distinguish those adhesives which have the potential of satisfying or exceeding code performance criteria for roof sheathing fastening systems as a primary system versus those adhesives that should be used in tandem with other fasteners.
- Identify the conditions and requirements for proper application of these adhesives, as specified by the manufacturer. Determine if both field application and factory application are practical.
- Determine if manufacturer-supplied adhesive ratings are applicable to code requirements. That is, is the adhesive rating label easily translated to demonstrate compliance with building code requirements for roof sheathing fastening systems?

Task 2 Deliverable: Matrix of adhesives with potential to be implemented as a primary or secondary roof sheathing fastening system, as identified by third party sources or manufacturer data. This adhesive matrix will include properties such as: primary fastener potential, secondary fastener potential, field applicable, product rating translates easily to code requirements, etc.

Task complete: January 8, 2007

Task 3: Cost Analysis

The marketability of any adhesive roof sheathing fastening system identified within this Task 2 will depend heavily on its initial and installed costs. Task 3 will involve analysis of the costs of using adhesives and identify the benefits for new and retrofit applications. This should include a comparison to current best practices.

As per recognized practice, square footage cost estimates for retrofit and new roof sheathing fastening systems based on sheathing used, nail pattern employed, and adhesive use will be computed. This number will prove a valuable reference for builders considering implementing this technology. Square foot costs will be presented in relation to design basic wind speeds. A sample table is shown below.

	Basic Wind Speed						
Fastening System	90	100	110	120	130	140	150
Code Referenced 8d common nail Sheathing: 19/32"	$\frac{\$a}{ft^2}$	$\frac{\$b}{ft^2}$	$\frac{\$c}{ft^2}$	$\frac{\$d}{ft^2}$	$\frac{\$e}{ft^2}$	$\frac{\$f}{ft^2}$	$\frac{\$g}{ft^2}$
"Super Adhesive X" applied with 3/8" bead Sheathing: ¾"	$\frac{\$h}{ft^2}$	$\frac{\$i}{ft^2}$	$\frac{\$j}{ft^2}$	$\frac{\$k}{ft^2}$	$\frac{\$l}{ft^2}$	$\frac{\$m}{ft^2}$	$\frac{\$n}{ft^2}$

Alternatively, data may be presented normalized according to uplift resistance provided. This normalized number would give the builder or homeowner an idea of how much "bang for the buck" they were getting by using various roof sheathing fastening systems. For example, one potential normalized metric is dollars per square foot per pound of uplift resisted.

As a component of the cost analysis of various adhesive roof sheathing fastening systems, the ASC and Newport team will work to identify current market barriers to use of adhesives for roof sheathing fastening systems. For example, if the use of adhesives requires the use of another trade or if this step interrupts the normal sequencing of sheathing installation, such issues would be noted to better characterize the cost data.

Task 3 Deliverable: Summary of basic cost estimates of adhesive roof sheathing fastening systems as compared to current practice.

Task complete: February 26, 2007

Task 4: Preliminary Testing of Adhesive Roof Sheathing Fastening Systems

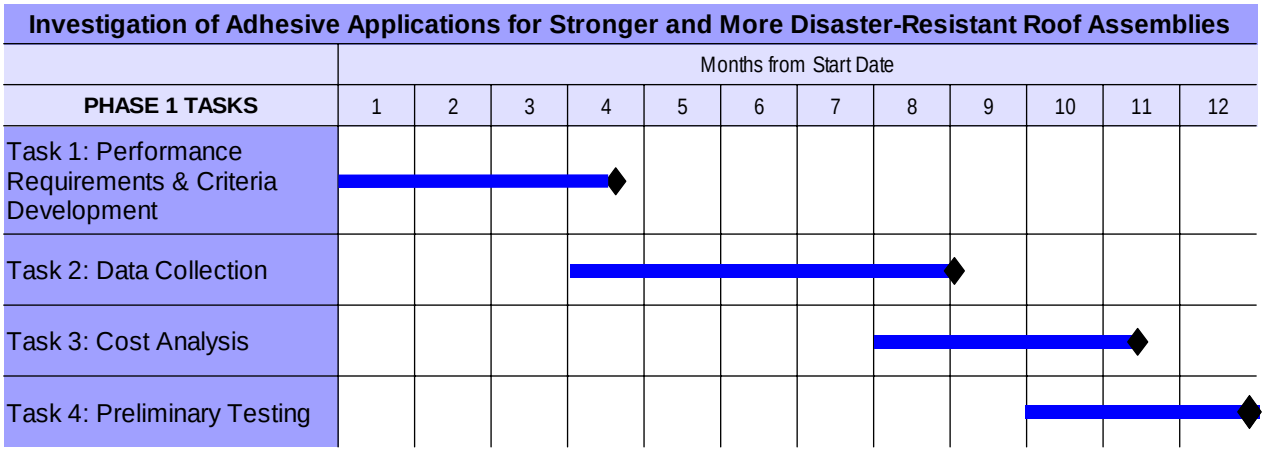
For any innovative building material or system to gain market acceptance and code or standard approval, testing and verification must be performed. From those adhesive systems that have been identified as having the potential to meet or exceed code requirements while presenting an affordable alternative to current practice, a sample set will be chosen to undergo preliminary testing. For the selected adhesives, tests will be designed with the assistance of ASC and conducted within the participating company laboratory. The primary function of these preliminary tests will be to evaluate the product's performance and determine whether the adhesive system should be further evaluated for inclusion in code or development of a standard.

The tests will be developed by Newport, and Newport will observe and document test results. The cost of testing will be funded by ASC or its members, and conducted at an ASC member's facility, or an independent test lab. Should funding permit, tests will be designed with the objective of collecting data that can be submitted as evidence in developing future code or standards.

Task 4 Deliverable: Lab test report and final report on Phase 1. This will be a complete stand-alone report suitable for posting on HUD User, and be extremely valuable in assessing the potential for adhesives in roofing.

Task complete: April 15, 2007

The Gantt chart below illustrates the projected schedule timeframe for each of the Phase 1 tasks. The total timeframe for the project is 52 weeks.



Gantt Chart for Phase 1

Phase II: Extensive Testing and Dissemination

While the task descriptions above characterize the current scope of work (Phase 1), below is a brief description of what might be accomplished in a Phase II should the project be continued. While Phase 1 focuses on identifying adhesives that could potentially be used as a roof sheathing fastening system, Phase 2 employs extensive testing to determine which selected adhesive systems can perform to industry standards. A second major component of Phase 2 is a broad dissemination effort of the data collected on adhesive roof sheathing fastening systems. This dissemination effort will focus on effective and efficient delivery of relevant information to target audiences of builders, contractors, and code officials.

Task 5: Adhesive Roof Sheathing Fastening System Testing

A successful testing plan involves having the foresight to evaluate the utility of the outcome. The testing plan employed under Task 5 will be carefully prepared to produce results that can be evaluated for code inclusion or standard development. To accomplish this objective, Newport and ASC will coordinate with the ICC evaluation service or a standards body to identify what experimental data is required for code inclusion or standard development.

Based on this information, a testing plan will be developed by Newport. Tests will be conducted by ASC, an ASC member, or a third party if a conflict of interest is perceived by code or standards body. Tests will be observed and documented by Newport. The testing plan will be conducted on the system(s) that have been determined to possess the greatest market viability (best mix of affordability and uplift resistance).

Task 5 Deliverable: Brief report summarizing experimental findings.

Timeline: Twenty four weeks from start of Phase 2.

Task 6: Field Demonstrations

After the lab tests are completed, field installations will be conducted to evaluate and demonstrate the practical application of adhesive roof sheathing fastening systems. The focus of this task will concern installation only, and will not delve into in-situ testing of the technology. Field demonstrations will be performed on at least two units – one new and one retrofit.

Newport will identify a builder who is willing to do an installation case study to characterize installation of new roof decking with a selected adhesive system, and will observe and document the installation on a new house. Observations will include roof profile, time of installation, skills and tools required, challenges, and costs.

At a second site, Newport will work with a remodeler, builder, or homeowner to identify a home and retrofit the home with a selected adhesive roof sheathing fastening system. Observations will include roof profile, time of installation, skills and tools required, challenges, and costs. Results for both demonstrations will be documented by Newport.

Task 6 Deliverable: Brief report documenting retrofit and new installation of adhesive roof sheathing fastening system.

Timeline: Forty weeks from start of Phase 2.

Task 7: Information Dissemination

The Newport and ASC team view Task 7 as one of the most important tasks of the project. If this project is to truly have an effect on the homebuilding market while improving the durability of homes, the information synthesized within this project must be effectively delivered to homebuilders, contractors, homeowners, and code officials. It is also crucial that the information reach its target audience in a form that is both digestible and useful. The deliverable will be tailored with this objective in mind.

Two "how to" user guides will be developed under Task 7. One guide will be drafted for builders and contractors to explain application of adhesive products or systems for use in roof sheathing fastening. This guide may be expanded to provide a retrofit or re-roofing guide for contractors and homeowners as applicable. A second guide will be drafted for code officials and designers. This guide will combine test results of adhesive roof sheathing fastening system performance with practical installation instructions.

Finally, the Newport ASC team will assess different code approval strategies to recommend to industry as appropriate to the testing results of adhesive roof sheathing fastening systems evaluated under Task 5.

Task 7 Deliverable: Two guides providing direction and rationale in implementing adhesive roof sheathing fastening system for new and retrofit roofing applications to two different audiences: builders/contractors and code officials/designers.

Timeline: Fifty two weeks from start of Phase 2.