Effect of Rodding on Flexural Resistance of Countertop Products

Background:
Conventional countertop materials such as granite, stone, marble etc. are inherently brittle and susceptible to fracture under sudden impact type load. The weakness is further aggravated by imperfections such as chips and small cracks typically introduced during fabrication. These in turn become points of crack initiation or stress risers. Sharp impact and repeated (dynamic) loads cause the countertops to break easily during installation and/or transportation. A practical and inexpensive approach to counter the weakness is to integrate a stronger and stiffer reinforcing element into the countertop. The function of the reinforcing elements, typically steel or fiberglass rods is to enhance the bending rigidity of the countertop.

The term *rodding* is commonly used to refer to embedding reinforcing rods into the brittle counter top products. Rodding provides a mechanism for transferring force from the weaker granite to the stronger and stiffer rod. In addition, load transfer occurs only if the reinforcing rod is positively and permanently bonded to the countertop. This is achieved with use of structural adhesives specifically formulated to adhere to both the countertop and the metal or polymeric rod. *Rod-It* is trade name of a rodding adhesive specifically formulated by IPS Corporation and distributed by Glue Warehouse for countertop fabrication.

In practice, rods are embedded in the underside of the countertop, at the front and back of sink and stove top cutouts. Several marble stone panels with rods embedded in the underside were submitted to the Durham laboratory for flexural testing. The panels were grooved to accept stainless steel bars 1/8 inch thick and 1/2 inch wide (with the 1/2 inch inserted).

Variables Studied:
1. Rod versus no-rod (reinforced vs. unreinforced stone)
2. Rod length - long versus short (16" versus 10.5")
3. Efficiency of comparative rodding adhesives – unidentified epoxy, unidentified polyester, MMA (Rod-It), and Diarex brand polyester.
4. Surface condition prior to adhesive application – dry, spray misted and wiped with a paper towel, wetted and dried with pressurized air stream, or immersed in water overnight and dried with pressurized air stream. Only Rod-It was tested wet and dry.

Results and Conclusions:
1. The test results show that rodding increases the load resistance significantly
2. The type of adhesive technology (Epoxy vs. Polyester) has significant effect on flex strength
3. Surface condition (slab drying process) prior to bonding showed no significant effect on strength True only for Rod-It, as other adhesives were only tested on dry stone.
4. The longer the rod the greater the strength; more testing needed to make firm conclusions Table 2 indicates the difference is not that great. In addition, only Rod-It was tested using long and short rods; other adhesives were tested using long rods only. Additionally, Rod-It short rod samples appear comparable to polyester long rod samples.

These conclusions are based on few data points which may or may not hold true with more rigorous testing. However, the results for the most part confirm both theoretical predictions and empirical observations.

Test Summary:

Granite stone samples measuring (18-20 inches long by 4 inches wide by 1.0 inch thick) were used for the flexural testing specifically aimed at understanding the effect of rodding on the strength of the slab. The samples were mounted with the rodded bottom surface resting on the supports i.e., bottom surface in tension whereas the finished top surface placed in flexural compression. The test panels are supported at the two end supports with one inch overhang on each end.

Tests were performed following ASTM D792 method on an Instron 8801 servo hydraulic testing machine with Blue Hill operating system and software. Figure below is a representation of a three point flex test specimen under a flexural loading.

ASTM D790 - Flexural Testing – 3 Point Flex Strength of adhesive joints

Results Summary:

Table 1: Rod versus no rod

Adhesive	Rod-It	None
Substrate	granite	granite
Rod	Rect. Steel	-
Surface Preparation	Dry	Dry
Stress at Failure (psi)	3084	1562
Failure Mode	Rod bent	-
# of specimens	5	5

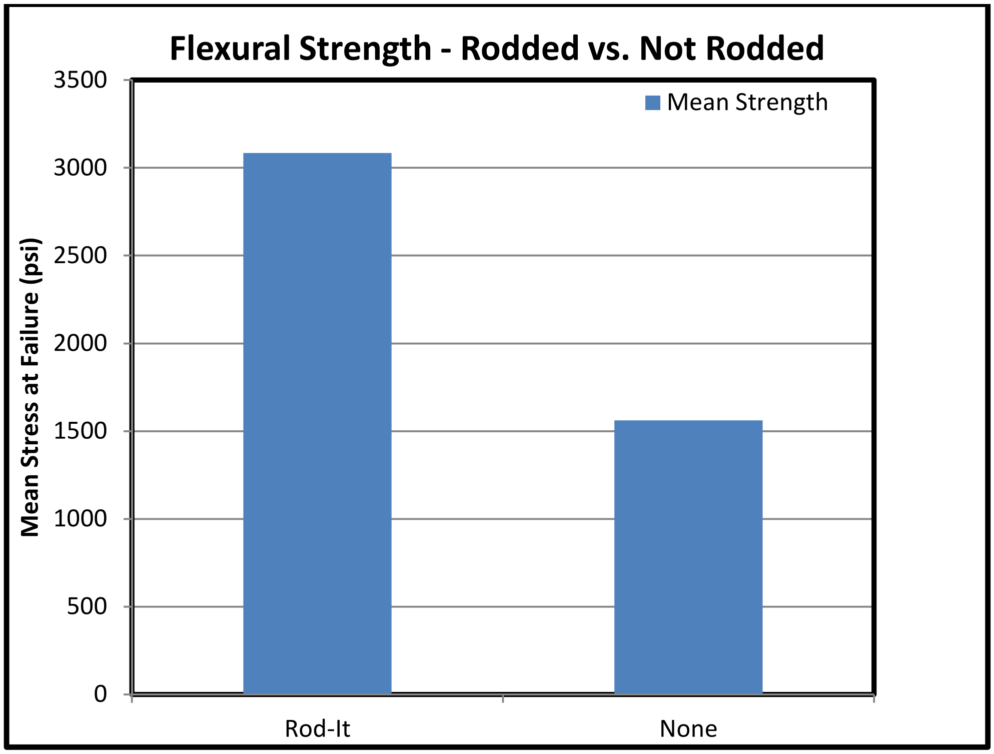


Table 2: Effect of rod length:

Adhesive	Rod-It	Rod-It
Substrate	granite	granite
Rod	16”	10.5”
Surface Preparation	wipe dry	dry
Stress at Failure (psi)	3084	2875
Failure Mode	Rod bent	Rod bent
# specimens	5	1

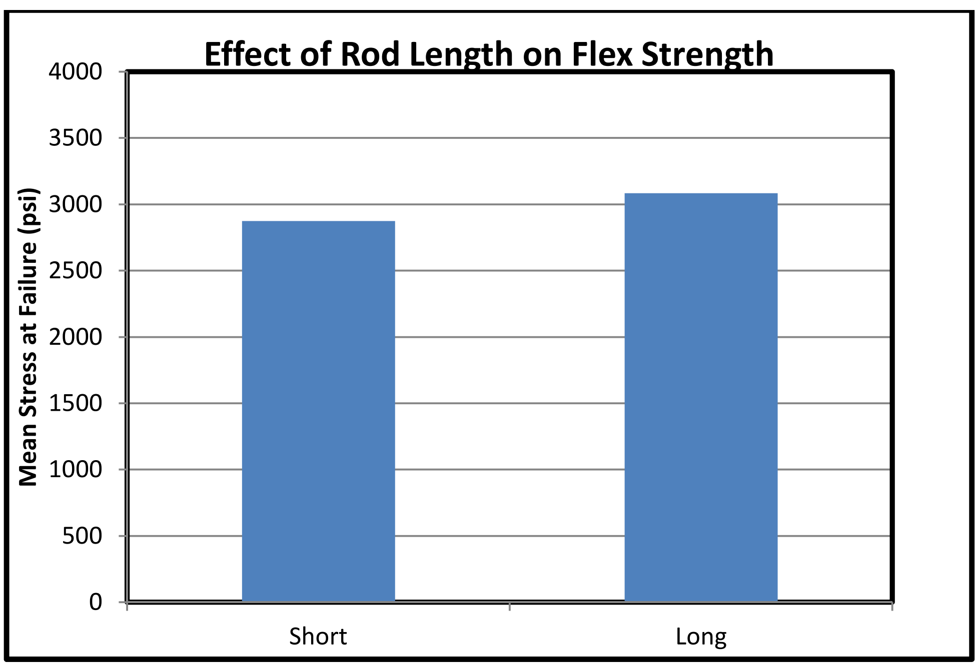


Table 3: Comparison of adhesive types

Adhesive	Epoxy	DIAREX Polyester	Polyester Adhesive	Rod-It
Substrate	granite	granite	granite	granite
Rod	Rect. Steel	Rectangular	Rectangular	Rect. Steel
Surface Preparation	Dry	Dry	Dry	Dry
Stress at Failure (psi)	3791	2878	2892	3084
Failure Mode	Rod bent	Rod bent	Rod bent	Rod bent
# of specimens	6	5	6	5

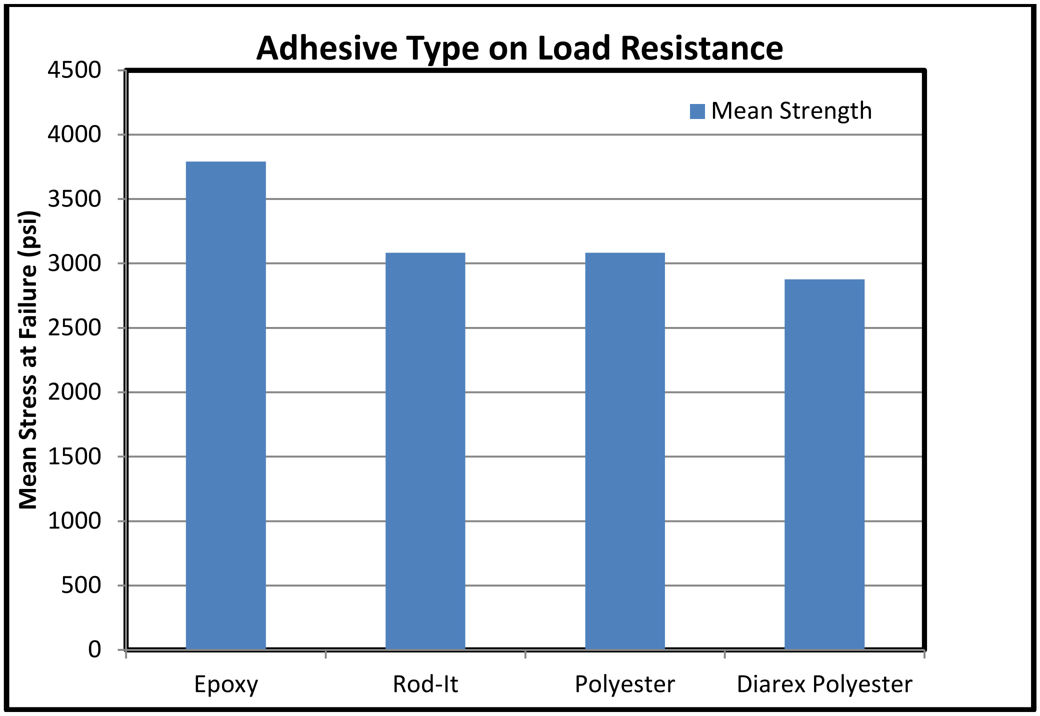
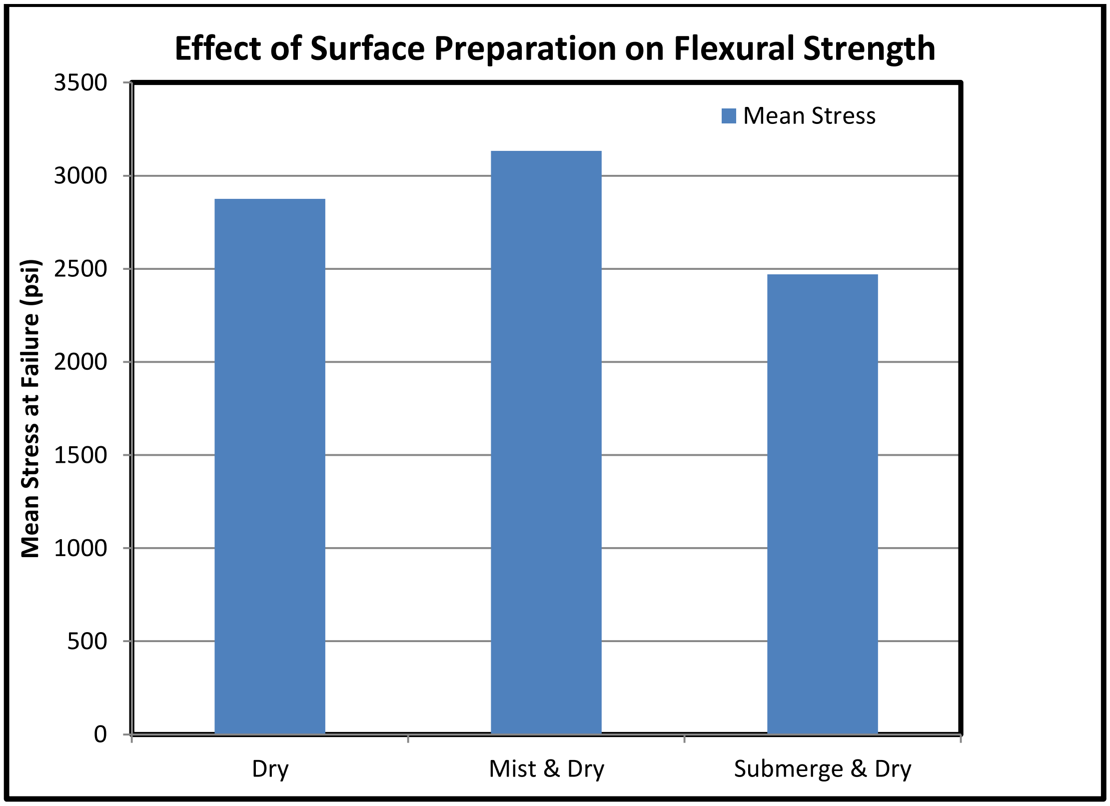
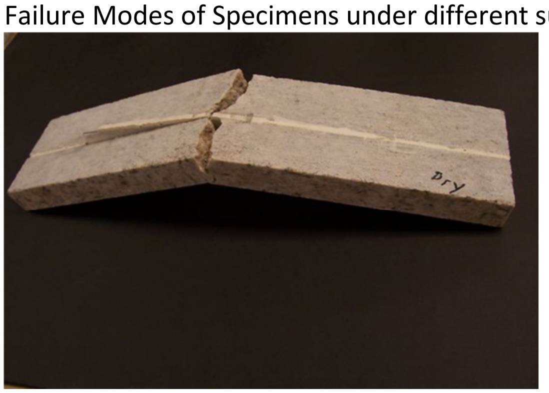


Table 4: Effect of surface preparation (adhesive cured for 96 hours at room temperature):

Adhesive	Rod-It	Rod-It	Rod-It
Substrate	granite	granite	granite
Steel Rod (length)	Short	Short	Short
Surface Preparation	dry	mist water, wipe dry	Water submerged, air dry
Stress at Failure (psi)	2875	3134	2471
Failure Mode	Bent rod & pulled out	Rod bent/embedded	Rod bent/embedded
# of specimens	1	1	1



Failure Modes of Specimens under different surface preparations:



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