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ADHESION OF VARIOUS PLASTERS TO VARIOUS BASES

by

B. M. O'Kelly

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Division of Building Research

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PREFACE

Problems involving bond strength of plaster have arisen at various times over a number of years. Some experimental work has been carried out by the Division from time to time in attempts to answer specific questions. The results of this are now reported to record some information on a field of investigation which though of practical importance has not always been particularly rewarding.

The author, a chemist and a research officer with the Building Materials Section, was concerned with plastering materials from 1952 until his departure in 1960 to join an industrial research laboratory. These results of some of his work on bond of plaster were compiled by him but unfortunately reporting of them has been delayed.

Ottawa,
October 1963

N. B. Hutcheon,
Assistant Director.

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ADHESION OF VARIOUS PLASTERS

TO VARIOUS BASES

by

B. M. O'Kelly

It is the purpose of this report to present in convenient form, for purposes of reference, some information concerning the bond of various plasters to various bases.

2. ORGANIZATION

Although the information provided here is incomplete in that by no means have all of the conventional bases and plasters been considered, it is believed that the results presented provide useful guidance. The results were obtained from different plaster and base assemblages using two testing techniques. Insofar as this is feasible the results are broken down under the headings of the bases to which the plaster was applied. Further organization of the results was not possible. It is hoped that the comments made regarding each group of results will prevent confusion.

3. DESCRIPTION OF TESTS

3.1 Test Method (A)

A sample of the base to be tested (1 ft sq) was cut. In almost all cases the base was reinforced by nailing or gluing it to a 1-ft sq of 3/4-in. plywood. The gluing technique was by far the most effective method of reinforcing. A 1/4-in. deep demountable brass frame 9 1/2 by 9 1/2 in. was laid on the sample of base. A suitable plaster (e. g., perlite, vermiculite, or sand/plaster) was prepared and used to fill the mould. The plaster surface was then screeded off level using the edges of the mould as guides. After curing for 24 hr at 70°F and close to 100 per cent R.H., the sample was removed from the mould and allowed to dry to a constant weight at 72°F and 50 per cent R.H. When the sample was dry, a 9 1/2- by 9 1/2-in. sheet of 1/8-in. foam rubber was glued to the top surface of the 1/4-in. layer of plaster that had been applied to the base. A 9 1/2- by 9 1/2-in. sheet of 3/4-in. plywood was, in turn, glued to the top surface of the 1/8-in. foam rubber sheet. A suitable harness was attached to the plywood sheet by means of wood screws; the assembly was then placed in a testing machine and the bond determined.

It was thought that the use of a comparatively large test area would ensure a realistic measure of the bond. In fact it has been found that it is virtually impossible to load these samples evenly and it is believed that very often failure occurs at an area where stress is higher than average and that this failure is then propagated across the surface. In addition to this local failure effect, it was found that very often, in addition to failure at the applied plaster/lath interface, failure or disruption of the core of the lath occurred. This latter effect is believed to be more important than the former. These considerations indicate that the apparent bond found by Method (A) will be lower than the true bond. Reference to Method (B) would make it seem that Method (A) gives results that are about half the true value.

3.2 Test Method (B)

Usually, as in Method (A) (and using the same moulds), sheets of 1/4-in. thick plaster are applied to the base to be tested. If this is not convenient, however, it suffices to spread the plaster on the base with a trowel so as to produce a smooth-surfaced layer of plaster of about 1/4-in. thickness, although any thickness up to 3/4 in. can be used. The samples are cured and dried as in Method (A). Again with Method (B) it is possible to test the adhesion of plaster on existing walls and ceilings.

In Method (B) a fly-cutter is used to isolate a 2-in. diameter disk from the prepared sample, wall, or ceiling by cutting a 1/8-in. wide circular groove down into the plaster to the base that is under test. A 2-in. aluminum disk carrying a threaded stud is then glued to the isolated disk with a suitable adhesive. A pulling device operated by compressed gas (1) is screwed to the threaded stud, and the sample is loaded to failure. Failure occurs either in the applied plaster/base interface or, in the case of material of relatively low strength, in the top surface of the base. The only drawback of Method (B) is that it is a little difficult to cut an accurate groove into the sanded plaster and it is sometimes difficult to find a convenient adhesive that will glue the aluminum disk to the applied plaster with a bond greater than that between the applied plaster and its base.

There is evidence (See Section 4.1.3) that the bond found in the laboratory will certainly be no higher than that found for a corresponding job assemblage.

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(1) O'Kelly, B. M. Portable adhesion testing device. Am. Soc. Testing Mats. Bull.No. 250, December 1960, p. 32-33. (Reprinted as NRC 6048.)

4. EXPERIMENTAL CONDITIONS AND TEST RESULTS

4.1 Adhesion of 2 1/2:1 Vermiculite Plaster to Gypsum Lath

4.1.1 Experimental conditions

Five wood frames were constructed and lathed on both faces with gypsum lath to give 10 panels 6 by 8 ft each. One-half-in. screeds were nailed to each panel. Over a 2-day period all 10 panels were plastered with a 1/2-in. coat of 2 1/2:1 vermiculite plaster. The panels were treated further; but this treatment is considered in Section 4.2. Suffice here to say that the further treatment divided the 10 panels into a total of 16 separate test areas.

As the panels were being plastered samples were removed from time to time and used to prepare laboratory test panels as described in Section 3.2.

The panels were allowed to set and dry in an uncontrolled laboratory atmosphere during August and September. Each panel in turn was then laid horizontally across two trestles, and adhesion disks were isolated from each panel with the aid of a suitable fly-cutter, by cutting down through the plaster to (but not into) the gypsum lath. Eight to 10 samples from each of the 16 test areas were isolated, yielding a total of 142 samples.

A total of 120 samples were isolated from the small laboratory panels.

4.1.2 Results

4.1.2.1 Results from 142 large-panel tests

Bond (psi)		
Minimum	Average	Maximum
24.8	37.3	45.2

4.1.2.2 Results from 120 laboratory-panel tests

Bond (psi)		
Minimum	Average	Maximum
21.5	28.6	34.4

4.1.3 Discussion of results

The group of 142 large panel test results and the group of 120 laboratory test results were normally distributed. It appears from the results that there is a difference in the bond formed in the laboratory-panel tests and the large-panel tests. A statistical analysis (Student's "t" test) confirmed this. It would be rash to extrapolate these findings to the extent of supposing that all laboratory-scale tests give lower adhesion values than large-scale or "job" tests. Nevertheless it may be concluded with some certainty that the laboratory-(small)-panel test is not likely to give higher values than a full-scale test.

4.2 Adhesion of Putty-coat to a 2 1/2:1 Vermiculite Base-coats of Varying Ages

4.2.1 Experimental conditions

The 10 panels of 2 1/2:1 vermiculite plaster described in Section 4.1.1 were used for the tests of putty-coat bond. On the day following that on which the base-coat plastering was finished, one of the panels of base-coat plaster was finished with an (allegedly) 2:1 (by volume) lime putty: plaster white-coat. A 2:1 white-coat is not unusual in Quebec Province. In Ontario a 3:1 mix is customary. The following day a second base-coat panel was putty-coated and so on for 10 consecutive days until all 10 panels were finished. Prior to applying the white-coat or putty-coat some of the panels were wetted over their entire surface or over the left or right half of the surface. Each panel was considered to be one test area unless half of the panel was wetted down and half left dry, in which case the wetted half was one test area and the dry half a second test area. In this way a total of 16 test areas were employed. In each test area 20 adhesion disks were isolated using a fly-cutter to cut through the white-coat until the base-coat showed over 80 to 90 per cent of the bottom of the groove being cut. When, in the testing of the bond, a portion of the white-coat remained on the base-coat the test was rejected and a second disk isolated in the immediate vicinity of the rejected test.

Analysis of scrapings from the 10 panels showed the composition of the putty-coats to be as follows:

Parts of Lime-putty (by Volume) to
One Volume of Plaster of Paris

Panel Number									
1A	1B	2A	2B	3A	3B	4A	4B	5A	5B
1.8	2.0	1.8	1.8	2.0	2.0	1.4	2.3	2.2	2.0

4.2.2 Results

Results are given in Table I. As the white-coats were applied to base-coats of various ages, the results are given in terms of the maximum, minimum and average bonds formed to a base-coat of a particular age. Likewise, as some of the base-coats were wetted down (either over all the surface or over half only) the results are grouped to allow the effect of this treatment to be seen. As some of the bond failures were clean breaks between the base-coat and the putty-coat, and some were failures in the body of the base-coat, an auxiliary table (Table IB) is given for the "clean-break" failures.

It is worthy of note that none of the white-coats showed any crazing or fire-checking, even when wetted with water.

4.2.3 Discussion of results

A statistical examination of the white-coat bond results indicates that all the results belong to the same statistical population. There is thus no essential difference between a clean-break and a failure in the body of the base-coat. It also follows that the wetting of the base-coat prior to application of the white-coat has a negligible effect, and also that the age of the base-coat when plastered has a negligible effect.

The fact that the age of the base-coat is unimportant is quite surprising since current job practice is to regard the age of a vermiculite base-coat when putty-coated as of great importance. It may be that the composition of the white-coat is of importance. Further work is obviously needed. For the moment, however, it may be concluded that the age of the base-coat (up to 237 hours at any rate) is not important for the white-coat plaster mix used.

4.3 Adhesion of Unaggregated Hardwall Plaster to Gypsum Lath Showing Effect of Cutting Through Lath Paper on Bond Formed

4.3.1 Experimental conditions

Laboratory samples were prepared as described in Section 3.2 using gypsum lath and a mixture of hardwall plaster and water in the ratio of 2:1 by weight. The 1/4-in. deep brass moulds were used.

In isolating the test disks the fly-cutter was allowed, in some cases, to cut down through the lath paper into the core of the gypsum lath. The remainder of the grooves extended only to the face of the lath.

4.3.2 Results

Depth of Groove	Bond Formed (psi)			No. of Disks Tested
	Minimum	Average	Maximum	
Groove cut through lath paper	11.9	19.1	26.3	6
Groove cut to surface of lath paper	23.9	28.7	32.5	7

It is noteworthy that where the groove extended into the lath the "bond" failure occurred by tearing out of the core of the gypsum lath. Where the groove extended to the surface of the lath paper only, failure occurred in the laminations of the paper.

4.3.3 Discussion of results

It is of interest to compare the results of the seven "surface-cut" failures with those reported in Section 4.1.2.2. The average for the latter was 28.6 psi. The presence or absence of vermiculite did not appear to have any large-scale effect. The results of the tests in Section 4.3.2 show clearly the important part played by the lath paper in conferring the necessary properties to gypsum lath.

4.4 Adhesion of Unaggregated Hardwall Plaster to Various Forms of Foamed Polystyrene and to a Sample of Corkboard

4.4.1 Experimental conditions

Using brass moulds 1/4 in. deep, laboratory samples were prepared as described in Section 3.2. After 2 days in conditions of nearly 100 per cent R.H. and 70°F, all samples were removed and taken out of the moulds. Test disks were isolated using a fly-cutter. All cuts extended into the body of the substrate. The samples of foamed polystyrene were, in all cases, 12 by 12 by 1 in. Types A, B and D were composed of small foamed polystyrene beads adhering together. Type C appeared to have been manufactured as a unit.

In some cases, the test panels were prepared in duplicate and, prior to isolation of the test disks, one panel and adhering plaster was clamped to a screen of a Gilson automatic sieving machine and vibrated for

15 minutes. Two in. disks were then isolated and the adhesion was determined.

It should be noted that one type of polystyrene was tested twice because a portion of the hardwall plaster mix used for the tests in Section 4. 3 was used to prepare adhesion panels with a sheet of type A and fire-resistant type B foamed polystyrene.

4. 4. 2 Results

Results are given in Table II.

4. 4. 3 Discussion of results

All failures on corkboard or foamed polystyrene involved failure either at the plaster/substrate interface or in the body of the substrate. There appeared to be no relation between the type of failure and the bond formed.

A statistical analysis of the results yielded the information that type C foamed polystyrene (both fire-resistant and non-fire-resistant types) give a superior bond both before and after vibration. For the unvibrated samples the fire-resistant type C gave a greater bond than the non-fire-resistant. After vibration there was no appreciable difference between the two foams of type C.

A tentative conclusion to be drawn from these tests is that bond to fire-resistant type C is somewhat sensitive to vibration, but can afford to be since it starts off at a higher level than the other type. In general, type C has a better bond than any other type of foamed polystyrene.

4. 5 Adhesion of Unaggregated Retarded Gypsum Plaster to Foamed Polystyrene

4. 5. 1 Experimental conditions

Using the 1/4-in. deep brass moulds, adhesion samples were prepared, conditioned, dried and tested as described in Section 3. 1.

Failure of the adhesion samples appeared, in most cases, to be initiated at load stress concentration points. For this reason the bond found in all cases is believed to be a minimum value. There were almost as many patterns of failure as there were samples.

The tests were carried out in duplicate or, at most, in triplicate, and all results obtained are given. Bases other than type C are bead-type foamed polystyrene.

4.5.2 Results

		Base (foamed polystyrene)				
		Type A	Type B	Type C	Type C*	Type D
Bond formed (psi)	1	6.60	5.14	4.48	2.93	5.07
	2	6.86	6.49	3.94	> 2.93	3.59
	3	6.19	-	-	-	-
Average		6.55	5.83	4.21	2.93+	4.33

* fire-resistant

4.5.3 Discussion of results

A comparison of the tests reported in Section 4.4.2 shows a factor of about 2 to 3 in the value of bond found in favour of the "small-sample" tests. This is the usual ratio. It is believed that the results of the large-sample tests reported in Section 4.5.2 are minimum values only.

4.6 Adhesion of Sanded (1 1/2:1) Hardwall Plaster on Foamed Polystyrene and Corkboard

4.6.1 Experimental conditions

Samples were prepared, conditioned, dried and tested as described in Section 3.1. Bases, other than type C and corkboard, are bead-type foamed polystyrene. All tests were carried out in duplicate.

4.6.2 Results

		Base					
		Type A	Type B*	Type C	Type C*	Type D	Corkboard
Bond formed (psi)	1	2.03	4.50	4.66	5.15	2.57	4.28
	2	1.93	5.15	3.64	4.66	3.55	3.44
Average		1.98	4.83	4.15	4.91	3.06	3.86

* fire-resistant

4.6.3 Discussion of results

The low bond value found for type A polystyrene is unaccountable and should be viewed with reserve. For the rest, the addition of sand does not appear to have had any marked effect on the bond.

4.7 Adhesion of Portland Cement Plaster to Various Forms of Foamed Polystyrene

4.7.1 Experimental conditions

The test procedure described in Section 3.1 was used. Although all the types of polystyrene previously tested were used in this test, some of the samples were so poor that they served only to give a minimum value for bond. The mix used was (by volume): sand = 3 parts; portland cement (+10 per cent lime putty) = 1 part; water = 1/5 part.

4.7.2 Results

		Base			
		Type A	Type B	Type C	Type D
Bond formed (psi)	1	All	4.48	4.68	3.70
	2	poor	4.47	4.77	3.81
	3	samples	4.22	-	2.72
Average		> 3.08	4.39	4.73	3.41

4.7.3 Discussion of results

The bond formed to the polystyrene appears to depend more on the polystyrene than on the plaster used. Compare Sections 4.7.2, 4.6.2, and 4.5.2.

4.8 Variation of Adhesion to Gypsum Lath with Variation in Sand:Plaster Ratio

4.8.1 Experimental conditions

A sand conforming to the requirements of CSA Specification A.82.57 was used in the tests. The sand was mixed dry with plaster of paris in proportions of 1:1, 1:2, 1:3, 1:4, and 1:5. Sheets of plaster 1/4 in. thick and 9 1/2 in. square were prepared as in Section 3. 2 and, when dry, 2-in. test disks were isolated with a fly-cutter and the adhesion was determined.

4. 8. 2 Results

Results are given in Table III.

4. 8. 3 Discussion of results

There is an obvious tendency for the bond formed to decrease as the sand:plaster ratio is increased. This tendency is also manifested in the nature of the bond failure. Up to a 3:1 ratio the failure is by delamination of paper. For ratios of 4:1 and 5:1 the tenacity of the bond is much reduced so that the failure occurs by a clean separation of applied plaster from lath paper.

4. 9 Adhesion of Putty-coat - Vermiculite Base-coat System with Various Bases and Treatments

4. 9. 1 Experimental conditions

Five wood frames similar to those used in Section 4. 1 were constructed and lathed on both faces to give 10 test faces each 6 by 8 ft. One side of each panel was lathed with gypsum lath; the other side was provided with one of five different bases. The base-coat of 2 1/2:1 vermiculite plaster was applied to all faces in 1 day, followed at different times for different faces by the application of the putty-coat. One-half of each test area was wetted before application of the putty-coat; the other half was left dry.

Frames, or panels, are identified by numbers 1 to 5. Side A of each panel was lathed with gypsum lath, the other face, designated B, carried a different base. Bases for 1B, 2B, 3B, 4B, and 5B were fibre-board, fire-resistant (blue) foamed polystyrene, standard (white) foamed polystyrene, polystyrene bead board, and cork, respectively.

Panels were plastered in May and were left in a large well-ventilated (but not conditioned) laboratory prior to testing for periods from 2 to 3 months. Adhesion disks of 2-in. dia. and 25 in number, were then isolated, using the power-operated fly-cutter on each of the 20 different test areas. Ten disks were cut to the bottom of the putty-coat only; ten were cut to approximately half the depth of the base-coat; in each case 5 were cut to the surface of the plaster base. These are subsequently designated as shallow-cut, deep-cut and base-cut, respectively. Thus, a total of 500 separate disks were provided for testing according to Method B of Section 3. 2.

4.9.2 Results

The results are given in Table IV in terms of average, maximum and minimum values obtained for each group of 10 (or 5) disks. They are grouped according to panel, base, wetting, and depth of cut, with age of base-coat at time of application of putty-coat given. The number of clean breaks in which the putty-coat parted relatively cleanly from the base-coat are also indicated for the shallow-cut cases. A summary of the results, giving averages of groups only, is presented in Table V.

4.9.3 Discussion of results

The results obtained are generally uniform, considering the nature of the system and the possible variations in various factors involved. Those obtained for A panels with gypsum lath are remarkably consistent. As in previous work, no effect of the wetting prior to application of putty-coat, or of the influence of prior drying of the base-coat from 1 to 9 days, is shown. The relatively small variation between shallow-, deep- and base-cuts for A panels, particularly when compared to those for B panels, suggests that the bond of base-coat to base, and the bond between putty and base-coat were in general about equal to the inherent strength of the base-coat. This does not take into account possible stress concentration effects due to the depth and sharpness of the cut, which was in all cases made with a square-end fly-cutter 1/8 in. wide. (This will be the subject of another report.)

The results for B panels, on bases other than gypsum lath, are somewhat more variable, but the uniformity obtained in A panels suggests that this is real and must therefore be attributable somehow to the types of bases used. As in the case of A panels, there is little reason to conclude that prewetting of the base-coat has any significant effect. These panels were completed, however, after only 2 days of drying of the base-coat. The base-cuts in all cases showed greatly reduced strengths, no doubt reflecting the generally weaker nature of the base materials other than gypsum. Deep cuts, half-way through the base-coat, tend to show reduced strengths and if these are valid, must be due either to some influence of the base on the quality of the base-coat, or to a lack of support during testing, thus inducing higher stresses for a given load as a result of increased base resilience. The low result for fibreboard could have been due to its high water absorption capacity which affected the bond, or to its low strength. An examination of the base-cut failures on it shows failure of the board by delamination in thin layers close to the surface, indicating that board strength and not the bond was the limiting factor.

There would seem to be some merit in using the three depths of cut for two-coat systems as a regular procedure, since it does provide some basis for judging the base-coat strength and its bond to the base as well as the putty-coat to base-coat bond.

5. AN ACCOUNT OF A TEST TO ASSESS THE WORTH OF A PLASTER BONDING AGENT

5.1 Technical Description of Bonding Agent

The literature issued by the manufacturer includes the following description. "The bonding agent is inert to oxygen, stable when dry, vermin-proof, non-toxic, incapable of supporting flame and has a temperature range of from -35°F to +300°F without failure of bond. It is a resinous water emulsion of brushing or spraying consistency that will bond new base coat or finished coat of plaster to concrete, metal, and other structural surfaces."

5.2 Description of Test

The object of the test was to find out if the bonding agent

(a) affected normal bonding properties adversely,

(b) produced a satisfactory bond of plaster to a substrate to which the plaster would normally not adhere satisfactorily.

Guided by these considerations it was decided to apply a coat of the bonding agent to various materials and apply an unaggregated gypsum plaster to the samples coated with the bonding agent and to other samples of the same materials which had not been coated.

The materials chosen for the test were gypsum lath, dense concrete-block, an asbestos cement board, a tempered compressed wood-fibre board (rough side), and a sheet of glass.

A patch of bonding-agent approximately 1 ft by 10 in. was painted on the gypsum lath, asbestos cement board, wood-fibre board, and sheet of glass. Half of one surface of the concrete block was painted with the bonding agent.

After two days, the various substrates received an application of an unaggregated quick-set gypsum plaster, spread over the surface of the substrate using a trowel, and applied in such a way as to cover both painted and unpainted areas. The plaster coat was about 1/4 in. thick.

After four days the plaster application was judged to be substantially dry. Two-in. diameter disks were isolated from the plaster sheets using a fly-cutter designed for the purpose.

The test then proceeded as described in Section 3.2.

5.3 Results

Results are presented in Table VI. The level of adhesion on some of the surfaces coated with the bonding agent was so high that the glue holding the aluminum disks to the test plaster disk failed to hold. If, after repeated efforts, such failure continued to occur, the bond is reported as a minimum value which, in fact, represents the adhesion of the glue to the plaster rather than of the plaster to the substrate.

5.4 Discussion of Results

The interpretation of the results is complicated by the number of times failure occurred, not at the plaster/substrate interface, but in the glue. The results will be considered in terms of the substrates used.

Gypsum lath: Failure on both coated and uncoated lath occurred in the lamination of the paper covering of the lath. The bonding agent had no effect. It is important to note that the bond was not decreased by the bonding agent.

Concrete block: The results show that plaster adheres well to concrete block but the bond is somewhat sensitive to vibration. Where the bonding agent was applied the bond was greatly enhanced, and was, it was tentatively concluded, not as sensitive to vibration.

Asbestos cement board: The plaster bonded surprisingly well to the board that was not coated with bonding agent. The number of glue failures on the board coated with bonding agent complicates the results. It is believed, however, that the results on boards with bonding agent indicate better bond than those on untreated boards.

Wood fibreboard: These results are the most erratic. From them it can only be concluded that the bonding agent did not decrease the bond formed, and may perhaps have tended to enhance it.

Glass sheet: This is a dramatic demonstration of the action of the bonding agent. These results make it difficult not to conclude that the action of the bonding agent will be affected by the surface to which it is applied. The glass sheet did not affect the nature of the bonding agent, and a good bond was formed. Where a bond is developed (on bonding agent) inferior to that developed on the glass coated with bonding agent, it does not seem unreasonable to suppose that the substrate in the former case has adversely affected the action of the bonding agent.

In general, the conclusion may be drawn that the bonding agent will not adversely affect the bond formed to a given substrate, and in some cases may be expected to enhance this bond very markedly. No conclusions can be drawn regarding the durability of the bond formed on bonding agent.

5.5 Effect of Wetting on Bond to Bonding Agent

5.5.1 Description of test

In an effort to evaluate the sensitivity of the bond on the bonding agent to moisture, some samples (glass, cement board, concrete block) were kept over a weekend at 100 per cent R.H. and 70°F. After removal to the laboratory for half a day, the bond was determined.

5.5.2 Results

Results are given in Table VII.

5.5.3 Discussion of results

The results appear to show that a wetting and drying cycle do not noticeably affect the bond to the bonding agent.

6. CONCLUDING REMARKS

The usual plaster system is a complex one from the standpoint of bond. Not only is bond difficult to measure, even by destructive methods, but there are a great many variables involved. The materials themselves are not highly uniform in quality. The small disk method may be criticized quite properly for the unknown and probably unrealistic stress patterns that are induced by the discontinuities produced by the cutting necessary for patch isolation, and by the gluing of a metal disk to a plaster surface having different elastic properties. The strengths obtained must be regarded therefore as strengths that are exceeded by the real system rather than as true strength values.

Unfortunately, this method may not always rank systems in the right order, because of differences in brittleness that may in turn provide different responses to the stress concentrations produced by the geometry of the isolated test disk. Despite these difficulties, the small disk method does appear to have merit and promises to be useful. It is already evident from the results which have been presented that by its use, some problems from the field can be usefully examined.

7. ACKNOWLEDGEMENT

The author was ably assisted by G. Quenneville who carried out the majority of the tests reported.

TABLE I

(A) BOND FORMED (psi)

Age of Base-coat when Plastered (hours)	Base-coat Wetted				Base-coat Not Wetted			
	Minimum	Average	Maximum	No. of samples	Minimum	Average	Maximum	No. of samples
48	34.8	47.2	62.0	20	-	-	-	-
70	42.8	53.2	58.2	20	-	-	-	-
93	36.5	48.2	65.1	20	-	-	-	-
117	32.9	44.4	54.6	20	32.4	41.6	50.3	20
144	38.4	50.1	58.0	20	48.2	57.5	63.7	20
162	34.2	50.0	64.2	20	-	-	-	-
168	39.4	50.1	58.7	20	36.7	49.3	53.9	20
190	42.0	50.0	65.3	20	45.1	55.7	67.3	20
213	29.3	38.7	53.4	20	37.9	43.4	53.9	20
237	34.6	42.8	50.8	20	36.2	44.8	53.4	20

(B) AUXILIARY TABLE OF "CLEAN-BREAKS"

48	34.8	46.5	62.0	19	-	-	-	-
70	48.4	53.4	58.2	8	-	-	-	-
93	36.5	48.3	65.1	17	-	-	-	-
117	32.9	45.8	54.6	11	34.8	44.2	50.3	7
144	38.4	47.4	51.5	10	48.2	57.6	62.9	8
162	39.1	47.1	53.4	7	-	-	-	-
168	45.3	53.2	58.0	7	36.7	44.9	53.9	5
190	42.0	51.5	65.3	7	45.1	50.0	52.9	3
213	33.0	37.7	42.7	7	37.9	42.6	46.8	10
237	39.6	43.3	50.8	7	36.3	41.7	46.5	6

TABLE II

Type of Foamed Poly-styrene	Bond Formed (psi)							
	Not Vibrated				Vibrated			
	Minimum	Average	Maximum	No. of disks tested	Minimum	Average	Maximum	No. of disks tested
*A	9.5	11.5	16.2	9	-	-	-	-
*B (fire-resistant)	9.5	12.5	16.2	12	-	-	-	-
A	12.6	14.8	16.1	14	12.0	14.1	16.7	15
B (Non fire-resistant)	11.2	13.0	14.3	14	12.5	14.0	15.4	15
C (fire-resistant)	15.8	22.1	26.8	15	16.8	19.9	23.9	16
C (Non fire-resistant)	14.3	17.8	23.8	15	14.6	18.4	22.2	13
D	11.2	12.7	14.2	15	11.9	13.60	15.5	16
Corkboard	8.8	10.0	11.7	6	9.3	9.5	10.5	7

* Same mix as that used for tests in Section 4.3

TABLE III

Sand:Plaster Ratio	Bond (psi)				Remarks
	Minimum	Average	Maximum	No. of disks tested	
1:1	34.8	37.2	39.6	6	Delamination of lath paper in all failures.
2:1	27.7	31.5	33.4	6	Delamination of lath paper in all failures.
3:1	26.2	32.4	35.8	6	Delamination of lath paper in all failures.
4:1	25.3	31.0	35.3	6	5 failures had very thin layer of paper of plaster. 1 failure involved delamination of lath paper.
5:1	22.9	23.9	24.4	6	All failures were clean separations of plaster from lath paper.

Description	Max (psi)	Avg (psi)	Min (psi)	Samples
Panel 1				
Face A - Gypsum Lath - 1 day				
not wetted, shallow-cut	41	36.7	27	10
deep-cut	42	37.8	31	10
base-cut	38	33.8	31	5
wetted, shallow-cut	46	40.7	35	10
deep-cut	41	37.5	30	10
base-cut	39	35.4	31	5
Face B - Fibreboard - 2 days				
not wetted, shallow-cut	38	31.4	29	10
deep-cut	32	27.6	22	10
base-cut	9	7.2	5	5
wetted, shallow-cut	42	31.0	28	10
deep-cut	29	24.0	18	10
base-cut	6	5.8	5	5
Panel 2				
Face A - Gypsum Lath - 2 days				
not wetted, shallow-cut	35	31.8	27	10
deep-cut	36	32.4	29	10
base-cut	35	31.2	29	5
wetted, shallow-cut	35	31.8	28	10
deep-cut	37	31.1	26	10
base-cut	32	29.4	26	5
Face B - Foamed Polystyrene (blue) - 2 days				
not wetted, shallow-cut	29	21.5	17	10
deep-cut	28	22.9	19	10
base-cut	19	16.6	15	5
wetted, shallow-cut	34	24.6	21	10
deep-cut	26	21.3	17	10
base-cut	14	11.8	10	5
Panel 3				
Face A - Gypsum Lath - 7 days				
not wetted, shallow-cut	45	39.3	30	10
deep-cut	42	38.6	32	10
base-cut	38	35.6	34	5
wetted, shallow-cut	43	37.7	32	10
deep-cut	44	36.5	31	10
base-cut	42	36.6	30	5
Face B - Foamed Polystyrene - 2 days				
not wetted, shallow-cut	40	34.5	29	10
deep-cut	30	28.0	25	10
base-cut	15	14.4	13	5
wetted, shallow-cut	39	34.4	31	10
deep-cut	34	30.3	23	10
base-cut	17	14.8	13	5
Panel 4				
Face A - Gypsum Lath - 8 days				
not wetted, shallow-cut	42	36.9	27	10
deep-cut	38	34.1	31	10
base-cut	40	36.0	28	5
wetted, shallow-cut	38	35.9	32	10
deep-cut	41	34.0	29	10
base-cut	37	34.2	32	5
Face B - Polystyrene Bead Board - 2 days				
not wetted, shallow-cut	37	31.3	25	10
deep-cut	36	28.0	23	10
base-cut	19	18.0	17	5
wetted, shallow-cut	39	34.3	29	10
deep-cut	33	25.4	15	10
base-cut	19	17.4	15	5
Panel 5				
Face A - Gypsum Lath - 9 days				
not wetted, shallow-cut	34	30.9	29	9
deep-cut	30	27.9	22	10
base-cut	30	27.4	25	5
wetted, shallow-cut	36	31.4	28	10
deep-cut	34	30.4	27	10
base-cut	36	32.6	28	5
Face B - Cork - 2 days				
not wetted, shallow-cut	31	25.5	21	10
deep-cut	25	19.2	13	10
base-cut	13	11.4	10	5
wetted, shallow-cut	25	19.6	12	10
deep-cut	30	23.5	18	10
base-cut	13	11.2	10	5

TABLE IV

ADHESION IN WHITE COAT VERMICULITE BASE-COAT SYSTEM WITH VARIOUS BASES AND TREATMENTS

TABLE V

SUMMARY OF RESULTS FROM TABLE IV

Panel	Age at final coat (days)	Base	Adhesion Results (psi)						Clean-Breaks Shallow-Cut	
			Not wetted			Wetted				
			Shallow	Deep	Base	Shallow	Deep	Base	Not wetted	wetted
1A	1	Gypsum	36.7	37.8	33.8	40.7	37.5	35.4	7	3
2A	2	Gypsum	31.8	32.4	31.2	31.8	31.1	29.4	4	4
3A	7	Gypsum	39.3	38.6	35.6	37.7	36.5	36.6	6	1
4A	8	Gypsum	36.9	34.1	36.0	35.9	34.0	34.2	7	8
5A	9	Gypsum	30.9	27.9	27.4	31.4	30.4	32.6	0	1
Avg			35.1	34.2	32.8	35.5	33.9	33.6		
1B	2	Fibre board	31.4	27.6	7.2	31.0	24.0	5.8	4	2
2B	2	Blue Styro-foam	21.5	22.9	16.6	24.6	21.3	11.8	6	3
3B	2	Styro-foam	30.3	28.0	14.4	34.4	34.5	14.8	7	6
4B	2	Bead Board	31.3	28.0	18.0	34.3	25.4	17.4	7	5
5B	2	Cork	25.5	19.2	11.4	19.6	23.5	11.2	0	7
Avg			28.0	25.1	13.5	28.8	25.7	12.2		

TABLE VI

Bond (psi)

Substrate	A	B	C	D	E	F	Remarks
Gypsum lath	35.8 Clean break	38.2 Clean break	36.5 Clean break	37.7 Clean break	36.5 Clean break	34.9 Clean break	
Gypsum lath and bonding agent	37.0 Clean break	35.1 Clean break	31.3 Clean break	35.3 Clean break	31.0 Clean break	36.2 Clean break	
Concrete block	33.4	See remarks	See remarks	68.2 Clean break	76.3 Clean break	-	No bond. Possibly due to vibration of fly-cutter
Concrete block and bonding agent	> 68.2**	> 105.0**	> 84.5**	> 71.6**	-	-	**Glue failure
Asbestos cement board	> 50.2**	40.2 Clean break	52.0 Clean break	51.5 Clean break	38.7 Clean break		**Glue failure
Asbestos cement board and bonding agent	> 45.6**	> 36.8**	66.8 Clean break	> 48.7**	> 69.3**	89.2*	*10% plaster left on substrate **Glue failure
Wood-fibreboard	21.5 Clean break	16.5 Clean break	16.2 Clean break	14.4 Clean break	13.4 Clean break	22.6 Clean break	
Wood fibreboard and bonding agent	81.1**	21.9 Clean break	15.3 Clean break	26.7 Clean break	18.6**	72.5 Clean break	**1/2 in. wide semi-circular bond left on substrate
Glass sheet	No bond	No bond	No bond	No bond	No bond	No bond	
Glass sheet and bonding agent	> 58.8**	> 69.3**	> 82.0**	> 97.3**	-	-	**Glue failure

<u>TABLE VII</u>

Bond (psi)

Substrate	A	B	Remarks
Glass + bonding agent	> 50.6**	78.2*	**Glue failure *30% of plaster remained on substrate
Asbestos cement board + bonding agent	> 78.7**	75.3*	**Glue failure *40% of plaster remained on substrate
Concrete block + bonding agent	27.7 Clean break	26.7 Clean break	The sample, even after 1/2 day, noticeably damp. The block may have been subject to liquid water.