

bettering BUR *tolerances*

Jim D. Koontz, P.E.
President, Roof Engineering Inc.

Within the last few years many roofing contractors have experienced growing requirements from owners, designers, and manufacturers to remove built-up roof samples for laboratory analysis. The purpose of the testing is to determine conformity of the application with a specification. Another primary reason for removing the samples has been to maintain some degree of quality control. This has subjected the roofing contractor to fairly close scrutiny of his workmanship. These roof test samples are normally removed and tested in accordance with ASTM D2829 or ASTM D3617.

Items such as flood coat, amount of adhered aggregate, number of plies, headlap, interply asphalt, and interply voids are generally measured and reported under the ASTM procedures. The contractor's finished product is then

compared to some acceptable standard with a range or tolerance. This tolerance can mean the difference between acceptance or rejection of the roofing system. The tolerance that is imposed upon the roofing system can come from three primary sources: manufacturers, designers/owners, or associations.

The manufacturers are primarily the group who have set the tolerances within the industry. Chart #1 lists the application tolerances for ten major manufacturers of asphalt roofing systems. Chart #2 shows manufacturers of pitch roofing systems.

Many of the built-up roof manufacturers take a position with respect to flood coat, interply bitumen, and desired headlap. Very few manufacturers, however, take a position with respect to minimum and maximum limits as they relate to adhered aggregate, ply headlap, or interply voids. Note in Charts #1 and #2 that there can be quite a bit of variation from one manufacturer to another.

The asphalt manufacturers have somewhat of a general range of 60 pounds per square, + 15 percent for flood coat, 25 pounds per square + 15 percent for interply, and generally a two inch

CHART 1
ASPHALT SYSTEMS

	CELOTEX	CERTAINTEED	CONGLASS	EVANS	FLINTKOTE	GAF	MANVILLE	OCF	TAMKO
FLOOD COAT LBS./SQ.	60 ± 15% 51 - 69	60 52.80 - 67.70	40	-	60 ± 15%	60 ± 15% 51 - 69	60 ± 15% 51 - 69	60	60 ± 15%
ADHERED AGGREGATE LBS./SQ.	75%	-	-	-	-	-	-	-	-
INTERPLY BITUMEN LBS./SQ.	25 ± 15% FIBERGLAS 23 ± 15% ORGANIC	25 ± 12% 22 - 28	- 25	25 AVERAGE	25 ± 15%	25 ± 15%	23 ± 15% 18 - 26.45	25	23 ± 15%
HEADLAP/INCHES	2"	-	-	-	2 1/4"	2 1/4"	2"	2"	2"
SQUARE INCHES OF VOIDS/PER SQ. FT./PLY	-	-	-	-	-	-	-	2 1/2" DIAMETER	-

BUILT-UP-ROOF MANUFACTURER'S RECOMMENDED APPLICATION TOLERANCES

CHART 2 PITCH SYSTEMS

	CELOTEX	GAF	KOPPERS	OCF
FLOOD COAT LBS./SQ.	75 ± 15% ORGANIC 60 ± 15% FIBERGLAS	75 ± 15%	75 APPROX.	75
ADHERED AGGREGATE LBS./SQ.	-	-	-	-
INTERPLY BITUMEN LBS./SQ.	25 ± 15% ORGANIC 20 ± 15% FIBERGLAS	25 ± 15%	25 AVERAGE	30
HEADLAP/INCHES	-	2"	2"	2"
SQUARE INCHES OF VOIDS/PER SQ. FT./PLY	-	-	-	1½"

BUILT-UP-ROOFS MANUFACTURER'S RECOMMENDED APPLICATION TOLERANCES

headlap. The coal tar pitch built-up roof manufacturers generally have a flood coat of 75 pounds, an interply mopping of 25 pounds, and a headlap of two inches. On a per square basis, both asphalt and pitch manufacturers generally recommend 400 pounds of aggregate or gravel surfacing and 300 pounds of slag.

A second group that is certainly beginning to dictate it's own tolerances is that of designers/owners. On some occasions, designers/owners will prepare their own tolerances. One such group that has prepared tolerances is the Air Force, as specified in their Manual 91-36.

In writing Architectural Engineering Specifications, many designers/owners will list a standard with a tolerance. On many occasions the designers/owners will follow the direct recommendations of the manufacturers, and in these cases they are simply stating that they will require the roofing system to be installed in accordance with the manufacturer's recommendation.

The third group that has proposed some variations is that of Associations. Foremost among these groups is the National Roofing Contractor's Association. In their N.R.C.A. Manual, tolerances are listed for a number of different types of roofing systems. Historically, the N.R.C.A. has listed a larger variability in the acceptance range, particularly with respect to aggregate, flood coat, and interply.

The N.R.C.A. has in the past listed standards with a tolerance range of +25 percent, as contained within the N.R.C.A. Manual. This naturally gives a

roofing contractor a much wider variance of acceptability.

It is our understanding the N.R.C.A. has recently proposed new tolerances for Built-Up Roofing Systems. Some of the new N.R.C.A. proposed tolerances will have a much wider range than previously recommended, particularly with respect to interply bitumen rates.

Where all of this leads is sometimes quite confusion for designers/owners, roofing contractors, and in some cases, manufacturers. Depending upon which group is consulted, up to three different positions on the standards for application with a tolerance could be proposed.

The objective of this article is to present a report on the actual application rates that are being installed in the field. A data base was generated using approximately 550 lab samples taken from twenty states and removed from over 100 different Built-Up Roof projects. Over eighty percent of all samples were removed from new roofing

CHART 3

ASPHALT DATA BASE

	SAMPLE AVERAGE	STANDARD DEVIATION
FLOOD COAT LBS./SQ.	57.9	34.5
ADHERED AGGREGATE LBS./SQ.	245.9	128.5
INTERPLY BITUMEN LBS./SQ.	26.3	6.7
HEADLAP/INCHES	1.98	1.21
SQUARE INCHES OF VOIDS/PER SQ. FT./PLY	.68	1.67

CONTRACTORS APPLICATION RATES

projects. The data was collected from both government projects and private projects. The government projects included samples from the Air Force, the Army, the General Services Administration, and the United States Postal Service.

The samples were tested in accordance with ASTM D 2829. The results were then entered into a data base that was compiled on an IBM computer. The data was extracted and analyzed according to various categories. Two major categories that were analyzed included a comparison between asphalt and pitch systems, as well as a comparison between government and non-government projects. In both categories, items such as flood coat, adhered aggregate, interply bitumen, headlap, and voids per ply per square foot were examined.

ASPHALT AND PITCH SYSTEMS

The data base was initially separated into two distinct groups, asphalt and pitch systems (refer to charts #3 and #4). The first trend apparent in the data base is that the average flood coat, interply bitumen, and headlap are fairly close to the built-up roof membrane manufacturer's recommendation. This is particularly true with respect to flood coat and headlaps. The interply bitumen application rates in both pitch and asphalt are slightly above the generally recommended 25 pounds per square.

The standard deviations for adhered aggregate, interply bitumen, and headlap are all fairly close when comparing

CHART 4

PITCH DATA BASE

	SAMPLE AVERAGE	STANDARD DEVIATION
FLOOD COAT LBS./SQ.	74.9	29.9
ADHERED AGGREGATE LBS./SQ.	269.6	144.6
INTERPLY BITUMEN LBS./SQ.	28.6	6.5
HEADLAP/INCHES	1.95	.91
SQUARE INCHES OF VOIDS/PER SQ. FT./PLY	.67	1.34

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CHART 5
GOVERNMENT PROJECTS
VS.
PRIVATE PROJECTS

	ASPHALT DATA BASE				PITCH DATA BASE			
	GOVERNMENT PROJECTS		PRIVATE PROJECTS		GOVERNMENT PROJECTS		PRIVATE PROJECTS	
	SAMPLE AVERAGE	STANDARD DEVIATION	SAMPLE AVERAGE	STANDARD DEVIATION	SAMPLE AVERAGE	STANDARD DEVIATION	SAMPLE AVERAGE	STANDARD DEVIATION
FLOOD COAT LBS./SQ.	65.3	35.2	44.9	29.3	77.6	31.4	66.3	23.7
ADHERED AGGREGATE LBS./SQ.	267.6	126.5	200.38	127.12	268.9	149.7	275.6	133.8
INTERPLY BITUMEN LBS./SQ.	26.9	5.8	25.4	7.8	28.0	6.3	30.3	7.0
HEAD LAP/INCHES	2.09	1.09	1.79	1.36	2.00	.78	1.82	1.25
SQUARE INCHES OF VOIDS /PER SQ. FT./PLY	.63	1.62	.78	1.75	.50	.89	1.13	1.95

CONTRACTORS APPLICATION RATES

asphalt to pitch built-up roof systems. This is particularly true for the mean interply moppings of asphalt and pitch. Although the pitch is slightly higher than the asphalt, the standard deviations for asphalt and for pitch is 6.7 pounds per square and 6.5 pounds per square respectively.

With respect to the headlap, both with asphalt and pitch, the roofing contractors are installing on average an approximate 2" headlap as recommended by most manufacturers. One standard deviation with asphalt places headlaps in the range of .77 inch to 3.19 inches. With pitch, one standard deviation places the headlap in the range of 1.04 inches to 2.86 inches. This again is relatively close to the tolerance recommended by manufacturers, the government, and associations.

Using a 25 pounds per square interply mopping and a 60 pounds per square flood coat, the manufacturer's recommended amount of asphalt usage would be 164.25 pounds per square for a four ply system with 2" headlap. It appears that with asphalt systems, the contractors are installing on an average 167.57 pounds per square, which is slightly more than recommended by membrane manufacturers.

With respect to pitch systems, contractors installing the same four-ply system with a 2" headlap, on average,

are installing 194.16 pounds per square. This compares to 179.25 pounds per square that would normally be recommended by pitch system manufacturers based on a 25 pound interply and a 75 pound flood coat. It again appears that contractors are installing slightly more pitch than is required by the manufacturers. On the average, however, roofing contractors are close to the interply and flood coats as recommended by pitch and asphalt manufacturers.

The averages for adhered aggregate, both with asphalt and pitch, appear to be fairly close, with the average aggregate adhered in asphalt being 245.9 pounds per square and the average pitch adhered aggregate being 269.6 pounds per square. Both of these averages are generally above what is recommended both by manufacturers, the government, and roofing associations.

FEDERAL AND PRIVATE PROJECTS

The data was also broken into two other basic groups, federal government projects and private projects. A basic question is, what is the difference in roofing contractors application between government projects and private projects? The government samples were extracted from projects on United States Air Force Bases, Army Bases, United

States Post Offices, and Federal Buildings under control of the General Services Administration. Refer to Chart #5 for a comparison of government to private projects.

In examining the data comparing the government projects to the private projects, several factors are observed. The average flood coat on government projects with both asphalt and pitch appears to be slightly higher than required by the manufacturer's specifications. On private projects, contractors are installing somewhat less than recommended by manufacturers, particularly as it applies to asphalt. An average flood coat of asphalt was 44.9 pounds per square as compared to a GO pounds per square flood coat recommended by manufacturers. It also appears that the pitch flood coat used on private projects is slightly less than that recommended by manufacturers.

With respect to the adhered aggregate, it appears that on government projects and on private projects using pitch the contractors are retaining a satisfactory level of adhesion. Regarding private asphalt projects, the average of 200.38 pounds per square of embedded aggregate is slightly below the recommended average of the government and manufacturers.

In examining interply, it appears that on all projects, contractors are installing on

an average a slightly higher interply mopping than required. It was noted, however, that the standard deviations on government projects are less than that on private projects. There is a wider range of interply bitumen application noted on private projects than government projects.

With respect to interply voids, note that in Chart #3 and Chart #4 the number of square inches of voids per foot in asphalt and pitch systems are fairly close. There is just a slightly higher amount of voids occurring in asphalt systems as opposed to pitch systems.

With respect to interply voids on government versus private projects, as shown in Chart #5, it appears that the variance in void amount is less on government projects than private projects. It is also interesting to note that the highest and lowest ranges of interply voids occur with pitch. On government pitch projects, substantially fewer voids per square foot per ply occur. Fewer voids on government projects could be due to closer quality control that may be occurring on federal projects, such as more attention to storage of materials,

brooming of felts, and point of application temperatures. The interply void results are indicating a wider variability or higher standard deviation of application on private projects as opposed to government projects.

On government projects, contractors are installing headlaps in compliance with the manufacturer's recommendations. The average headlap on private projects is slightly less than that specified by manufacturers. The contractors also have a much wider standard deviation on private projects.

CONCLUSIONS

Several basic conclusions can be drawn from the data generated as of this date:

1. On an average, with respect to flood coat, adhered aggregate, interply, and headlap, contractors are installing the quantities fairly close to that recommended by membrane manufacturers.
2. Contractors are using a slightly higher amount of both pitch and asphalt than required, as it relates to interply bitumen.
3. On government contracts, contractors are installing roofing systems with less

variability than on private projects. This may be the result of closer inspection performed by the government, or it may be the result of contractors taking greater care on government projects. In any event, there is a closer to average application tolerance on federal projects as opposed to private projects.

NOTE — Jim D. Koontz, P.E., President of Roof Engineering Inc., has been involved in the roofing industry for the past twenty years as a contractor and roof consultant. Roof Engineering Inc. is primarily engaged in the design of new roofing and reroofing projects combined with inspection, consulting, and laboratory analysis of roofing materials. Offices are maintained in Denver, Dallas, and Houston, with the main office located at Hobbs, New Mexico.

Assistance in preparing this article was provided by Vickie Crenshaw, Civil Engineer.