Hand Lamination With Cellulose Acetate

By Y. P. KATHPALIA [1]

National Archives of India

ROBERT W. S. Turner in his article "To Repair or Despair" [2] has pointed out some limitations of the process of lamination for preserving records and has posed the question, "Is an archivist to repair or despair?" The National Archives of India as far back as 1951 gave serious thought to the problem and developed in its research laboratory a simple, cheap, yet effective method of rehabilitating records, employing the same materials as are used in the United States — cellulose acetate film and tissue paper — but avoiding the use of heat and high pressure. The details of this process, after an extensive series of tests, were published in *Indian Archives*.[3] But both the article and the process seem to have escaped the searching eyes of many archivists in other countries. The process has been in use in the National Archives of India since then, and the documents so repaired have as yet shown no sign of deterioration.

Besides eliminating the use of high temperature and heavy pressure, the Indian hand process improves upon the classical processes of reinforcement — silking and tissue reinforcement with starch or dextrine paste — for it (1) gives better legibility, (2) does not increase the likelihood of insect attack, (3) is suitable for the repair of documents written in water-soluble inks and colors and for documents with seals, and (4) is suitable for reuniting documents that are in several pieces.

A sandwich of the tissue paper, cellulose acetate film, and a flattened document is prepared just as for heat lamination and laid flat on a smooth glass plate. Acetone is then gently applied all over the document sandwich with a cotton-wool swab. The cellulose acetate foil, softened by the acetone, swells and acts as an adhesive

[1] The author, a member of the staff of the National Archives of India, was recently in the United States and demonstrated the hand method of lamination that he describes in this article.

[2] *American Archivist*, 20:315-319 (Oct. 1957).

[3] O. P. Goel, "Repair of Documents With Cellulose Acetate on Small Scale," in *Indian Archives*, 7:162-165 (July-Dec. 1953).

to join the tissue paper to the document. Care must be taken to see that the acetone applied is just enough to swell the cellulose acetate. After the application it is allowed to dry for a minute or so, during which time most of the acetone evaporates. The sandwich is then turned upside down and the other side is treated in the same way. This process of repair takes hardly 2 minutes. The newly repaired document is then kept under moderate pressure for 2 to 3 hours. The equipment, which is very cheap, and the materials required are a glass-topped table, cellulose acetate film, tissue paper, acetone, and cotton wool.

The process has nearly all the advantages of heat lamination. And the fact that it requires no expensive technical equipment and is simple and within the means of small libraries and archival establishments or even of private persons makes it especially attractive. Regarding its effectiveness I may quote from the article cited above:

> Accelerated aging tests carried out at the National Archives of India so far have shown that the coating given will last for a long period. Samples of repaired paper exposed to the sun for [one] hundred hours showed no adverse effects either in regard to color or the bonding strength of the coating. Sheets of paper reinforced by this process were found to have excellent strength both before and after aging. Tissue paper subjected to the same treatment responded likewise. Treated paper samples were aged and then recovered. The recovered samples and the untreated aged samples showed similar strength.[4]

Although the effectiveness of the process was well tested before its application, on the advice of the National Committee of the Archivists of India a comparative study was undertaken in the research laboratory of the National Archives of India, to evaluate the various repair processes. The study was made by Ranbir Kishore and the author of this article, and their findings were submitted to the committee in January 1957.

The processes of repair that were studied were those using (1) Japanese tissue paper and dextrine paste; (2) chiffon and dextrine paste; (3) Japanese tissue paper, cellulose acetate foil, and acetone; (4) chiffon, cellulose acetate foil, and acetone; and (5) conventional lamination with cellulose acetate foil at 300° F. and approximately 500 lbs. per sq. in. pressure, with and without Japanese tissue paper. The papers that were used in this study were: Specimen A, handmade paper (English), 1955; and specimen B, handmade paper (English), 1877.

The three properties of resistance to water, resistance to gaseous penetration, and durability under aging were kept in view while

[4] Goel, "Repair of Documents," in *Indian Archives*, 7:164.

TABLE 1

Reinforcement Process Adopted for the Specimen	Average Thickness in Inches		Resistance to Water Penetration (Complete immersion)	Resistance to Penetration of Acidic Gases (Sulfureted Hydrogen)	Fluorescence of Samples Under Ultraviolet Radiation
	Specimen		*Specimen*	*Specimen*	*Specimen*
	A	B	A and B	A and B	A and B
1. Reinforcement with Japanese tissue and dextrine paste	0.006″	0.0085″	Within 2-3 mins. of immersion the water penetrated the samples and they were uniformly wet.	The samples resisted penetration by gaseous vapors only for a few seconds.	Uniform bluish violet, dull
2. Reinforcement with chiffon and dextrine paste	0.0092″	0.125″			
3. Reinforcement with Japanese tissue, cellulose acetate, and acetone (hand process)	0.0054″	0.0078″	No water penetration up to 3-4 hrs. After this time the samples were more or less uniformly wet.	Resistance to gaseous vapors only for 10-15 mins., the penetration of the vapors uneven.	Uniform bluish violet
4. Reinforcement with chiffon, cellulose acetate, and acetone (hand process)	0.0085″	0.0112″			
5. Lamination with cellulose acetate under heat and pressure (300° F. and 500 lbs. per sq. in.)	0.004″	0.0065″	No water penetration up to 5-6 hrs. After this time the samples showed uneven wetting which increased when the samples were kept immersed in water overnight.	Very slight penetration within 10-15 mins.; extent of penetration much less than in processes 3 and 4.	Uniform bluish violet, bright
6. Lamination with cellulose acetate as above (5), but incorporating Japanese tissue	0.0025″	0.0075″			

Remarks: Cellulose acetate used as an adhesive with acetone is as uniform in thickness as dextrine paste applied with a brush; but, unlike the samples repaired with dextrine paste, those repaired with cellulose acetate foil and acetone by the hand process showed resistance to water and gaseous penetration. The degree of resistance was less than that of the specimens laminated under heat and pressure.

TABLE 2

Reinforcement Process Adopted for the Specimen	Endurance During Accelerated Aging Test for 72 hrs. at 100° C. (With Air Circulation)			
	Change in appearance and performance		Percentage retention of folding endurance (MIT folds)	
	Specimen A	*Specimen* B	*Specimen* A	*Specimen* B
1. Reinforcement with Japanese tissue and dextrine paste	No color change	No color change	39%	36%
2. Reinforcement with chiffon and dextrine paste	Slight yellow tinge; slight curling	Slight yellow tinge; slight curling	64%	63%
3. Reinforcement with Japanese tissue, cellulose acetate, and acetone (hand process)	No change in color; no curling observed	No change in color; no curling observed	41%	42%
4. Reinforcement with chiffon, cellulose acetate, and acetone (hand process)			70%	68%
5. Lamination with cellulose acetate under heat and pressure (300° F. and 500 lbs. per sq. in.)	No change in color; no curling observed	No change in color; no curling observed	29%	12%
6. Lamination as above (5), but incorporating Japanese tissue			32%	15%

Remarks: Paper reinforced by hand process, with chiffon or tissue and cellulose acetate and acetone shows about the same retention of folding endurance as paper treated by the dextrine repair process, but the retention of folding endurance in the case of lamination with heat and pressure is less satisfactory. Unlike the dextrine paste process the two processes using cellulose acetate with tissue or chiffon show no change in color and no curling.

testing the relative merits of the processes. In each test it was observed that the tensile strength and bursting strength of the samples were increased considerably and were little changed by aging. Only the folding endurance of the samples was therefore recorded.

Tables summarizing the results of the tests, together with the experimental data, are reproduced here as Tables 1 and 2. Each figure recorded is the arithmetic mean of a number of separate readings. These were taken to offset any variations in thickness resulting from differences in the handling of materials and adhesives. The data collected on the merits of the various repair

processes indicate that the specimens repaired by the acetone process are nearly as satisfactory as the heat-laminated samples. Only their resistance to water and gaseous penetration is less than that of documents laminated under heat and pressure.

During my recent visit to the United States I explained the process to T. R. Schellenberg, Assistant Archivist of the United States, and demonstrated it to James L. Gear of the Document Restoration Branch of the National Archives and William K. Wilson of the Paper Division of the National Bureau of Standards. These men expressed the opinion that the process of hand lamination holds promise, especially for small libraries and archival institutions that do not have and cannot afford facilities for conventional laminating equipment. Dr. Schellenberg is calling attention to this method of repair in his syllabus for training in archives administration, and the National Bureau of Standards and the National Archives are conducting a series of preliminary tests on the efficacy of the process.

Comments on Mr. Kathpalia's Article

By James L. Gear [5]

The hand lamination process of the National Archives of India, described by Y. P. Kathpalia, appears to be quite effective. It cannot take the place of heat lamination where mass production is essential, but it can be very useful to all archival establishments, both large and small. Smaller archives that have not and cannot afford expensive equipment for lamination will find that they can use the method effectively for most of their rehabilitation work. The National Archives of India is to be congratulated on this contribution in the field of archival repair.

From hand laminated samples I have obtained physical data for comparison with similar data from machine laminated samples. Although the data were obtained 24 hours after the samples were hand laminated, they are adequate at least for preliminary observations. The paper used in both processes was made from old rags by the National Bureau of Standards in 1936 and contained 28.2% calcium carbonate filler. The tissue used was 6½-lb. tissue, and the cellulose acetate used was formula P-911 of the Celanese Corp. of America. The machine laminated samples were produced at the National Archives under a pressure of 300 lbs. per sq. in.,

[5] Mr. Gear is Chief of the Document Restoration Branch, National Archives.

with steam applied to the press for 2 minutes and 15 seconds. The maximum temperature was 306° F. The hand laminated samples were prepared for me by Mr. Kathpalia in my laboratory.

The data from the physical tests of these samples are given in Table 3. These data show nearly equal physical properties in the hand and machine laminated samples. They indicate that hand lamination can be substituted for machine lamination or silking. The process can be used to advantage for repairing documents bearing wax seals, which up to now have been repaired by silking. The usefulness of the method will be limited only by the skill of the processor.

The method of hand lamination has now been adopted as an approved repair process in the National Archives. We have not used it extensively but have found it especially suitable for repairing torn pages in bound volumes.

TABLE 3

PHYSICAL PROPERTIES OF PAPER, FILM, AND TISSUE — HAND AND MACHINE LAMINATED

Direction of			Tensile lbs./15 mm. strip		Elongation %		Edge tear, lbs.		Internal tear, grams	
Paper	Film	Tissue	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine
|*			6.0		2.2		.30		26.8	
—			4.1		3.5		.40		29.6	
	|		4.4		14.0		2.3		3.0	
	—		3.4		28.5		**		3.0	
		|	4.6		2.3		†		12.0	
		—	†		†		†		†	
|	||	=	13.8	15.0	3.2	3.7	.9	.9	105	64
—	||	||	28.0	26.8	5.1	3.7	1.0	1.0	82	88

* Vertical and horizontal lines indicate machine direction and cross direction of film, tissue, or paper, one line for each sheet. Vertical lines indicate machine direction; horizontal lines indicate cross direction.

** Data not obtained.

† Tissue too weak to test.