STATUS REPORT: STRUCTURAL PERFORMANCE

Project 2695-20/2695-70--Compressive Failure of Linerboard

The Compression Failure Morphology study is centered on the determination of the role of fiber bonding and fiber stiffness in the compression failure of linerboard. Work during the last quarter on the Institute funded project, has been concentrated on obtaining photographs of the sequence of events which take place within the fiber mat of the liner during the compression loading cycle. Four different filming techniques have been tried, preliminary indications are that all of these techniques will yield positive results.

The four techniques include the use of a 35mm camera, a television camera, a 16mm movie camera, and videotaping with the output signal from the scanning electron microscope (SEM). In addition, two different test fixtures have been used to hold the sample of linerboard. The first fixture is an IPC modification to the Weyerhaeuser compression tester. This fixture has been described in the FKBG Status Report issued January, 1978. The liner test sample used with this instrument is 7.9 inches long and .79 inches wide. The second fixture was developed at IPC and permits the liner to be loaded in compression while the liner and the test fixture are placed within the SEM (Figure 1 and 2). The fixture consists of 5 cylinders; the largest two cylinders form the base of the fixture and serve to align

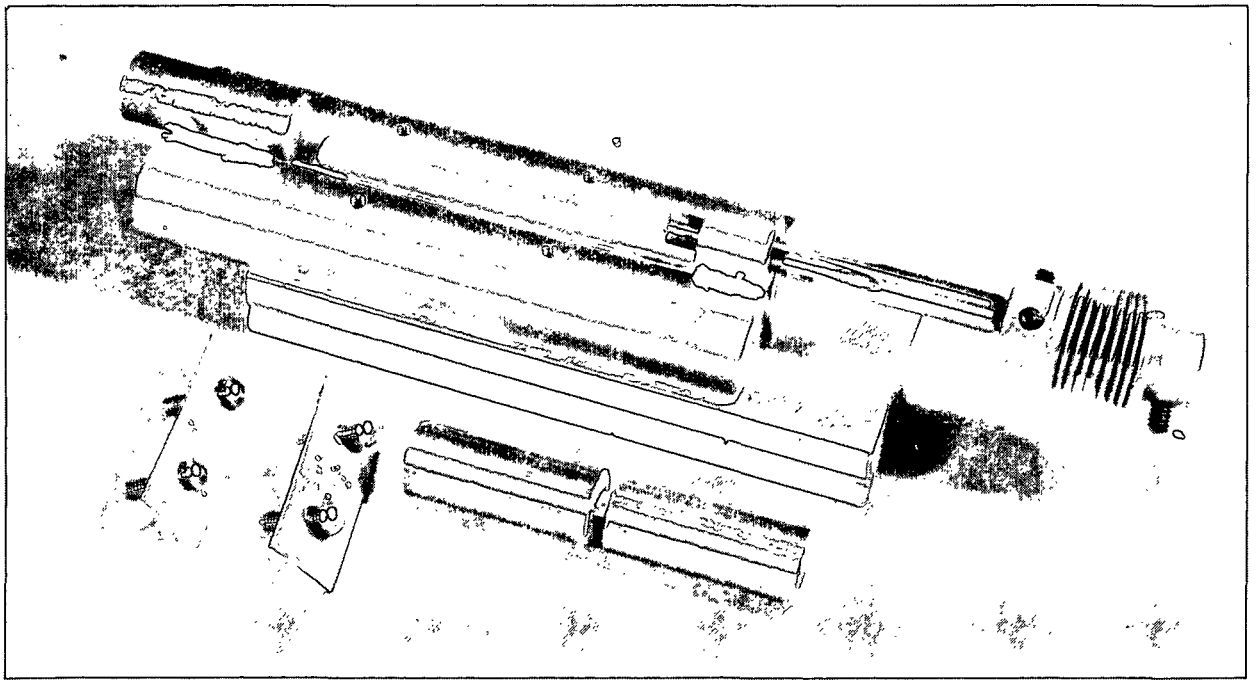

Figure 1--Short Span Test Fixture (unassembled)

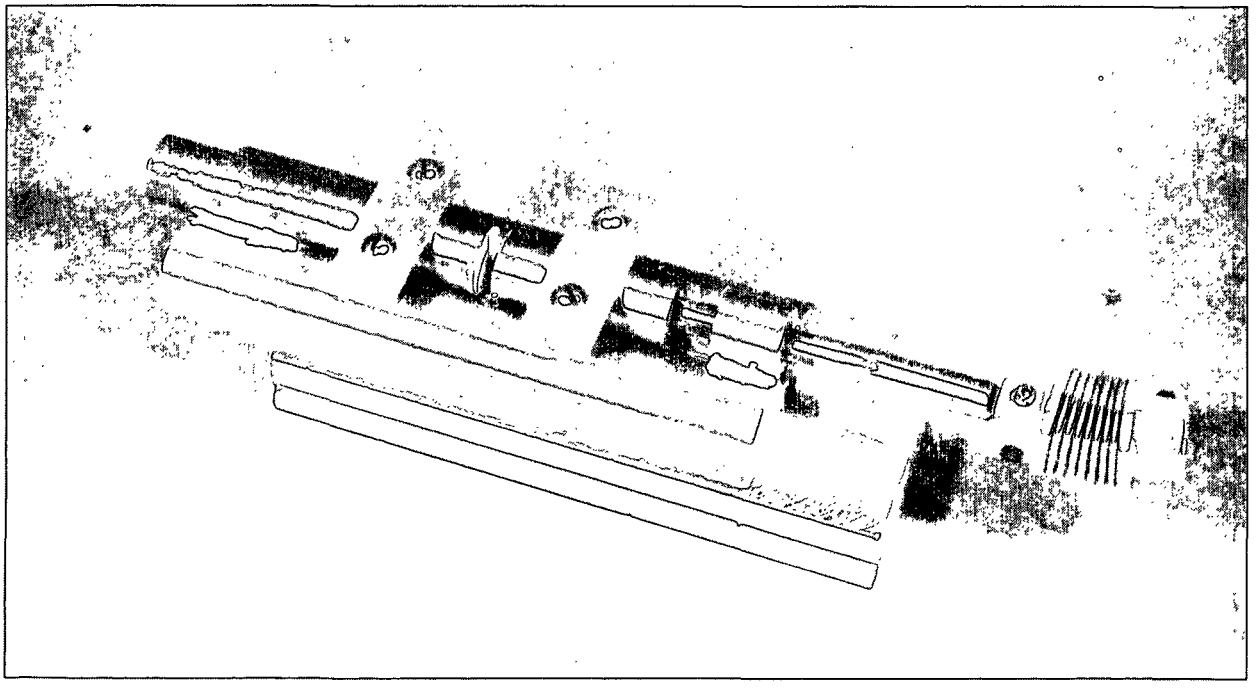

Figure 2--Short Span Test Fixture (assembled)

the cylinders which load the test sample. The two smaller cylinders are the loading platens, compressing the liner between them. A ring in the front and small cylinder in the back of the fixture reacts the compressive load with the two large cylinders and completes the loading frame. The compressive load is applied to the loading cylinders by turning a threaded machine screw which is positioned between the loading cylinders and the front plate.

The sample tested in this fixture is .12 inches long and .5 inches wide. The small test sample has less strain energy and the actual compression failure occurs at a slower rate because of the reduced energy. This fixture has been labeled the IPC short span test fixture.

Successful photographs have been taken of the sequence of events within the liner during compression failure. Photographs taken with the 35mm camera and the IPC short span test fixture show that the fiber mat delaminates before complete collapse of the specimen (Figure 3). Camera speed is 5 frames per second. The sequence is for a 90 lb. liner loaded in the cross machine direction, although the same sequence of events have been observed for a liner loaded in the machine direction. The sequence shows the liner as the load is first applied; as the load is increased a gap appears in the fiber mat due to delamination. An increasing load results in a growing delamination zone and the liner begins to buckle. Further loading

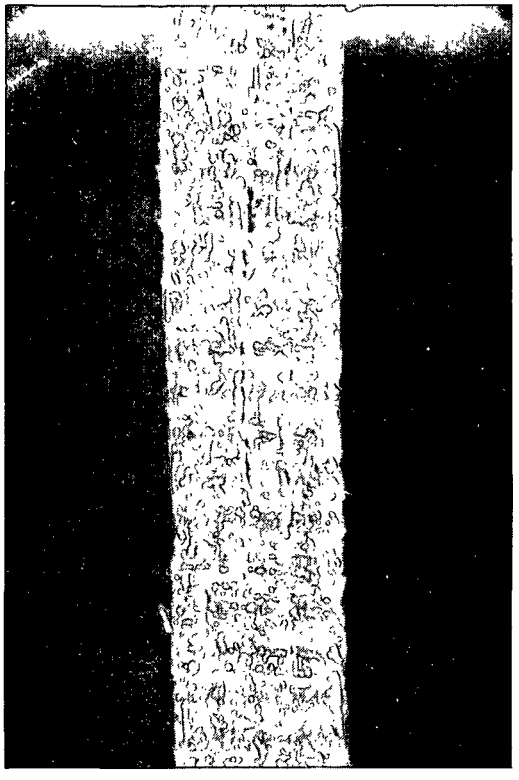

Figure 3a--Liner unloaded

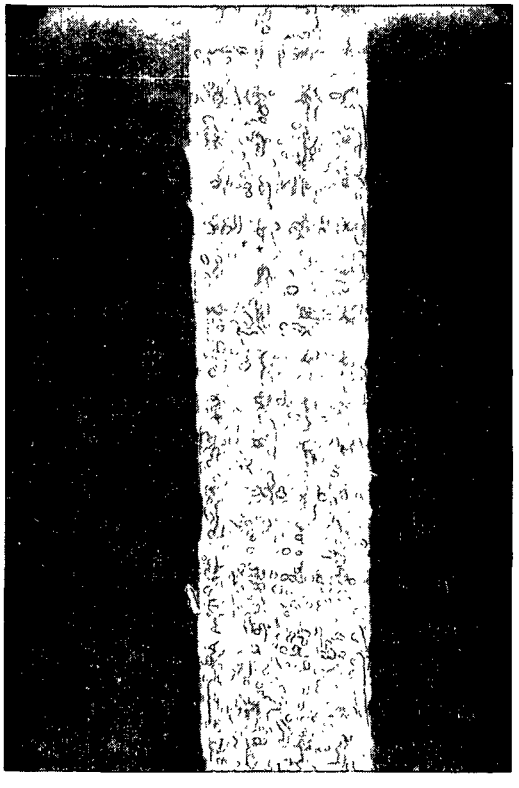

Figure 3b--Liner in Compression, Delamination begins to occur

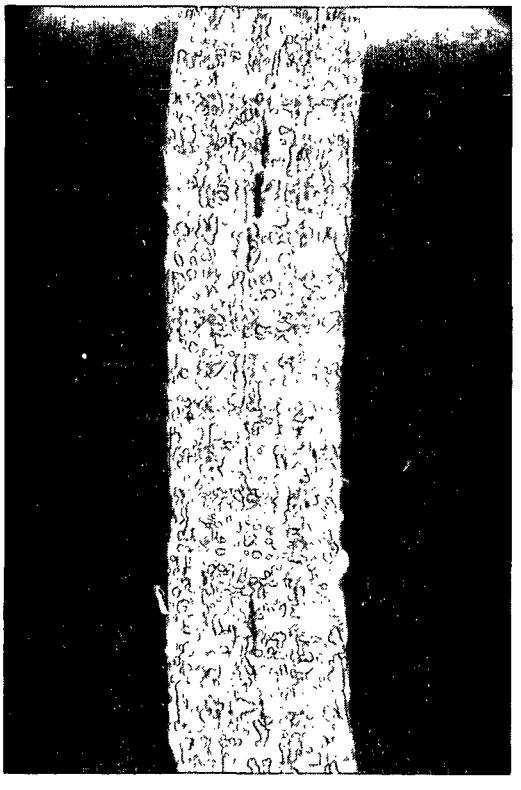

Figure 3c--Compression Load Increases, Delamination increases

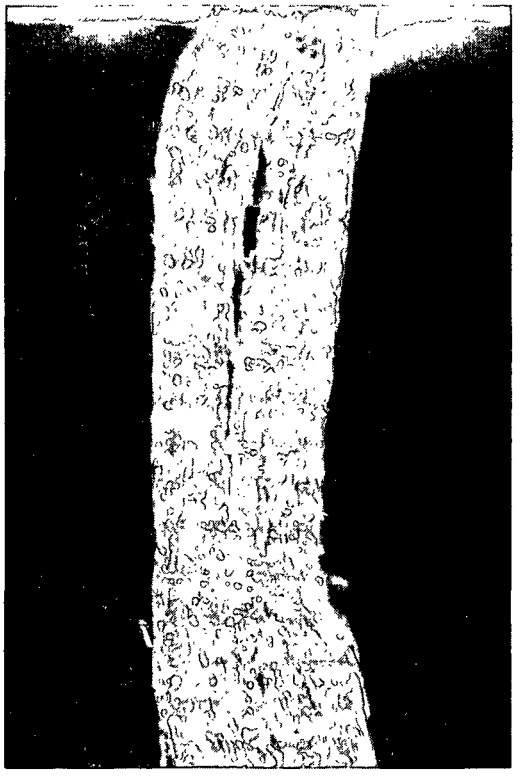

Figure 3d--Compression Load Increasing, Liner collapse

produces collapse of the liner.

A more detailed study of the fiber mat was initiated by placing the liner and IPC short span test fixture in the SEM while loading the liner in compression. A video tape was made from the signal received from the SEM while the liner was failing in compression. The SEM allows a study of individual fibers and the bonds between individual fibers. The systematic use of this powerful tool will provide a valuable supplement to our other filming techniques.

A television video tape has been produced of the magnified view of the edge of the liner while in the IPC Modified fixture. Both the machine and cross machine loading has been recorded. Analysis of the video tape reveals zones of delamination occuring before liner collapse in at least some of the test samples. The large specimen size results in a rapid failure sequence which makes interpretation of the actual failure sequence difficult. The television camera operates at the equivalent speed of 35 frames per second. Work has begun to film this rapid sequence with the 16mm movie camera which has a variable speed ranging from approximately 200 frames per second to 22,000 frames per second. No results are available to date. When this last technique has been developed, a systematic analysis will begin of compression failure of commercial linerboard and medium using these four filming techniques.