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Cross directional warp in a corrugator: why it occurs and how to correct it

What is cross directional warp?

In cross directional warp, the line of curvature (warp) moves across the corrugator. Another way of saying this is that the line of curvature is parallel to the flutes (Fig. 1).

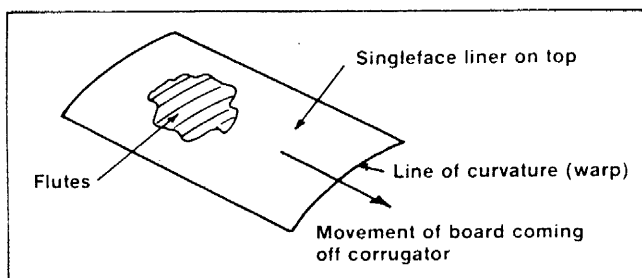


Fig. 1. Cross directional warp.

What causes cross directional warp?

Cross directional warp occurs because of two interacting realities.

The first reality has to do with the nature of paper. Paper is hygroexpansive. This means that as paper picks up moisture (hygro), it will grow in size (expansive). As paper loses moisture, it shrinks in size. If we start with a piece of paper at 7% moisture, which is about what we expect for paper exposed to normal room air, and expose that piece of paper to 90% humidity, the paper will get wetter and bigger. Now if we dry the paper back to 7%, it will shrink to a size that is smaller than it was originally.

The second reality is that corrugated board consists of several sheets of paper. Unless you are very lucky, these sheets of paper will not have exactly the same moisture contents when they are combined in the corrugator. Yet after the different sheets are combined into board and after the board is exposed to a given humidity, all of the sheets will come to the same moisture equilibrium.

All sheets may have started at different moistures, yet they end up at the same moisture. This means that they may expand and/or shrink by different amounts. The mechanical forces created in the board structure result in warp.

The degree of shrinkage and expansion is much greater in the cross direction of paper than it is in the

machine direction of paper.

Studies conducted by the Corrugated Industries Development Corporation (CID) have found that the moisture content differences between the two liners is the most significant causer of warp. The moisture content of the medium, unless it exceeds 10 or 11%, is neutral in causing warp.

What are the varieties of cross directional warp?

There are two basic types: up warp, also known as normal warp as shown in Fig. 2, and down warp, also known as reverse warp as shown in Fig. 3. There are combinations of cross direction warp, such as shown in Fig. 4.

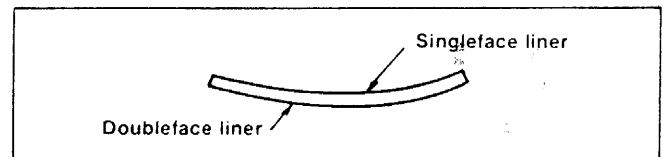


Fig. 2. Up warp.

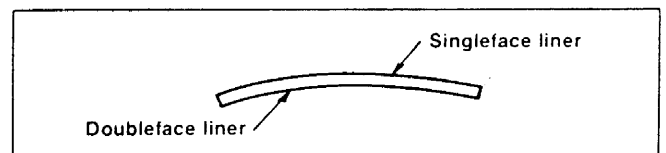


Fig. 3. Down warp.

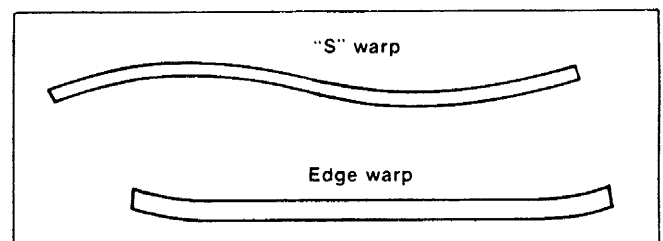


Fig. 4. Combination warps.

How does up warp occur?

When the singleface web and doubleface liner are combined in the hot plate section, they are both flat. If the singleface liner is wetter than the doubleface liner when the board is combined, the two will come to the same moisture content in storage. The singleface liner will dry and shrink. The forces created by this shrinkage will pull the edges of the board up. The doubleface liner will become more moist and expand; the expansion forces will push the edges of the board up (see Fig. 5).

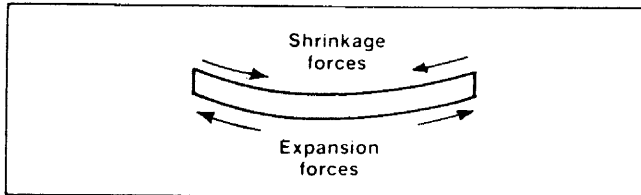


Fig. 5. Forces which cause up warp.

How does down warp occur?

Down warp occurs because the doubleface liner is wetter than the singleface liner at the time of combining. The singleface liner expands and the doubleface liner shrinks in coming to equilibrium (see Fig. 6).

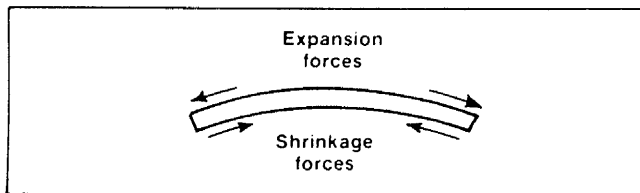


Fig. 6. Forces which cause down warp.

What is the only way to eliminate cross directional warp?

Make sure that the moisture contents of the singleface liner and the doubleface liner are equal at the time the two liners are combined in the hot plate section.

What affects the moisture contents of the liners at the time of combining?

1. The moisture contents of the liners at the time they are received from the mill.
2. The amount of adhesive applied at the singlefacer and at the doublefacer.
3. The amount of steam shower used at the singlefacer.
4. The amount of heat the liners are exposed to from preheaters and hot plates.
5. The amount of water applied to the surface of liners due to coating additions or water sprays.

What is the best action to take when warp occurs?

Take action that will work to bring the moisture contents of the two liners closer to equality at the time

they are combined.

There are several tools that can affect liner moisture at the time of combining. These are preheater wraps, corrugator temperatures, corrugator speed, shower steam, synchronized speed, adhesive addition and others.

The next two sections list steps that should be taken to correct up warp and down warp conditions. You may want to post these at the corrugator.

How to correct an up warp condition

1. Reduce bridge storage to a minimum and operate singlefacer and doublefacer at synchronized speeds.
2. Reduce or eliminate any singleface web water sprays.
3. Increase singleface liner wrap.
4. Increase wrap of singleface web on bridge preheater.
5. Decrease or eliminate doublefacer liner preheater wrap.
6. Reduce shower steam if flute formation is not affected.
7. Reduce singleface glue application (if good bond is not sacrificed).
8. Turn off shower on doublefacer belt if being used.
9. Reduce corrugator speed if singleface liner is very wet.
10. Reduce heat on doublefacer. Raise some hold down rolls; lower tilting hot plates, if available.
11. Wrap singleface web on both bridge preheater and double face liner preheater (double wrap).
12. Wrap glue line side of liner to the single face liner preheater (over the top).

NOTE 1: Do not add adhesive to correct warp.

NOTE 2: Recommendations made to correct up warp conditions are to be followed in order listed. If Step 1 is sufficient to correct conditions, stop at this point, or over correction may occur, causing opposite warp condition.

How to correct a down warp condition

1. Reduce bridge storage to a minimum and operate singlefacer and doublefacer at synchronized speed.
2. Increase preheater wrap on doubleface liner.
3. Decrease singleface liner preheater wrap.
4. Decrease preheater wrap on singleface web.
5. Make full use of all steam showers on singlefacer.
6. Use segmented water spray on singleface web.
7. Reduce doublefacer glue application (if good bond is not sacrificed).
8. Increase heat on latter sections of hot plates; make sure all ballast rolls are down; make sure all tilting hot plates are up.
9. Reduce corrugator speed if doubleface liner is very wet.
10. Double wrap doubleface liner using doubleface liner and bridge preheater.

NOTE 1: Do not add adhesive to correct warp.

NOTE 2: Recommendations made above are to be followed in order listed. If Step 1 is sufficient to correct condition, stop at this point or over correction may occur, causing opposite warp condition. ■