Fold Endurance

Sappi Printer Technical Service

877 SappiHelp (727 7443)

Problem

Printed and folded, the finished product exhibits objectionable flaking, cracking, or splitting along the spine of the fold. The problem may be surface stress primarily affecting the ink and overcoat, or it may be the result of fiber stress and rupture causing the uplifting of paper fiber and coating.

Definition

The three primary characteristics of paper which contribute to foldability are inherent fiber strength, the fibers ability to effectively delaminate at the score, and sheet pliability. Fiber strength is influenced by species selection and enhanced by moderate levels of refining and wet-pressing to obtain fiber fibrillation and bonding. Paper pliability can be accomplished by increasing paper moisture since water has the effect of elasticizing the fibers.

Paper coatings are typically rich in pigments such as calcium carbonate and clay, which are bound to the paper surface with latex and/or natural starch. Except for latex, these materials tend to be brittle and therefore challenged to absorb the forces created during the folding process. Therefore, it follows that a higher coat- weight sheet tends to be more prone to cracking issues as compared to a sheet with lower coatweight.

Tearing and splitting on the fold can especially be an issue when folding dry, lightweight web signatures in grain direction. In general, fold endurance on lightweight papers, 70# text and under, is stronger and more resistant against splitting when folded in cross-grain direction, whereas, fold endurance on heavyweight papers, 100# text and higher, better resists cracking when scored and folded in grain direction. Tearing and splitting on the fold is not usually a problem with heavyweight papers.

Pressroom factors, print applications, bindery process, and ambient environment can adversely affect foldability by potentially compromising any or all of these same primary characteristics of paper which provide strength.

Causes

PAPER

- Although flexible coating binders and properly blended pulp fibers can minimize cracking, coated papers are typically more susceptible to crack-at-the-fold than are uncoated papers.
- Heavier basis weights are much more likely to crack since fibers on the outside fold push out far beyond their breaking point, relative to lighter basis weights with a much smaller fold radius.

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- Coating-intensive papers with low fiber content may be more prone to crack-at-fold.
- Low or reduced moisture content due to exposure to low ambient relative humidity or high heat.
- Grades with a higher percentage of post-consumer recycled fiber (PCW) may be more susceptible to cracking due to diminished fiber size and strength.

PRODUCTION PROCESSES

- Moisture loss from high dryer or curing heat and/or exposure to uncontrolled dry environments.
- Folding cross-grain direction on 100# text or higher basis weights.
- Ineffective pre-scoring or lack of scoring on 100# text or higher basis weights.
- Excessive impression squeeze, folder roller-nip pressure, stress from multiple folds, or stacker drum pressure.
- High IR, UV lamp, or web dryer temperatures.
- Surface brittleness caused by over-cured or over-dried UV or aqueous topcoats.
- UV or aqueous topcoats formulated with limited flexibility.
- Scoring and folding across heavy, dark colored solids and overcoats.

Options and Solutions

SCORING THE FOLD

When to consider scoring:

- Text weights of 100# or greater and all cover weights.
- Cross-grain or multiple folds.
- Heavy ink or over-coat coverage on outside cover folds or crossover folds.

SCORING CONSIDERATIONS

- Application of a water/alcohol solution or any moisture-inducing device to soften paper fibers at the point-of-score/fold will increase fiber strength and flexibility.
- Score strike should enter the outside spine of the fold to reduce fiber stress. When compressing pulp fibers into the fold, there will be less susceptibility to crack on the outside spine of the fold.

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— The width of the score is important when considering inside spine capacity and the creation of a softer, crack-free fold. Higher caliper cover weights demand a wider channel score. A generally-accepted starting point is a matrix die-score 3 times the thickness of the paper in width struck twice as deep as the paper is thick. Cross-grain die-scores may demand a higher ratio of 3.5:1 in channel width.

— Die-scoring in the proper direction with the appropriate width and depth matrix die-score is the most effective score application in minimizing cracking-at-the-fold.

— Rotary scores can also be effective when the application produces an embossed score through a wheel to slotted cavity application. Wheel to steel anvil roll rotary scores are much less effective and sometimes counter-productive by crushing and damaging the paper fiber and/or coating.

FOLDING CONSIDERATIONS

— Maintain relative humidity in the 40%–50% range (Europe = 47%–57%) and allow time for full paper acclimation.

— Minimize nip pressures wherever possible and progressively increase fold-nip clearance for each successive fold as the product thickness doubles through the folder.

— Slowing production speed may improve fold performance by allowing more time for the paper fibers to respond to the stress of folding pressure.

— Short runs, specialty work, or critical compound folds may perform better when hand-folded.

— Folders equipped with wheel to slotted cavity scoring devices will minimize cracking and splitting while maintaining a straight travel path and square folds with minimal fold-nip pressures.

PRESSROOM CONSIDERATIONS

General

— Maintain relative humidity in the 40%–50% range (Europe = 47%–57%) and allow time for full paper acclimation.

— Avoid or minimize extreme exposure to heat or low relative humidity to maintain as much moisture content in the paper as possible.

— On-press scoring should only be considered when the capability exists to produce an embossed score in the proper direction to avoid fiber rupture against the fold.

Fold Endurance (continued)

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— Avoid over-cure of UV coatings that may compromise surface elasticity. Consult with supplier to determine if UV or aqueous coating formulations offer maximum elasticity.

Sheetfed

— Minimize IR dryer heat whenever possible.

— Maximize cooling and/or heat evacuation associated with Interdeck and Hybrid UV ink curing and the aqueous coat drying processes.

— Favor layouts with folds running in paper grain direction, especially on heavy cover weights.

Web Heatset

— Minimal dryer temps will help retain moisture content. This consideration may also maximize ink gloss while minimizing “web fluting” and static.

— Re-moisturization with the silicone/water applicator will offer some moisture restoration, but excessive use may cause surface welting on light-weight papers.

— In-line rotary devices utilizing a wheel to slotted cavity scoring application will help form plow or former folds with minimal cracking or damage to the paper. In some cases, a micro-perf wheel may perform better than a score wheel.

— Application of water/alcohol solution through a water needle prior to the former-fold will help soften the paper fibers, making them more pliable to minimize cracking on in-line folds.

— Monitor folds in paper grain direction for splitting or tearing that may fall apart in binding. This may be particular concern on center-spread folds when running light-weight papers.

— Reduce nip or jaw pressure whenever possible to soften the fold. Consider perfing combination folds that trim or grind off to provide escape for entrapped air that may cause “gusseting” or cracking.

— Some delivery stackers further induce cracking by flexing or crushing the spine fold—minimize, stacking, or belt pressure whenever possible or hand-fly signatures off delivery belts.

— As a result of diminished moisture content after heat-set drying, printed signatures and sheets will regain moisture and expand relative to their environment. If possible, allow for complete re-acclimation before beginning binding operations as this will minimize cracking or buckling on the spine and continued web growth outside the text. The general consideration for full re-acclimation is at least 4 days in a climate-controlled environment of 45% Rh @ 72° F. (22° C.).