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# Technological Advancement and Trends for Sustainability of Coated Duplex Board Making Industries in India

M. Vadivel, S. Sathiakeerthi, V. B. Shinde, A. SerSubramaniyam, N. Duraisamy

*M/s. Saraswati Udyog India Ltd, Kabilarmalai, P. Velur, TN, India.*

**Abstract:** *The paper industry occupies a prestigious position among the various enterprises globally. Increasing want of paper in the country which is growing at a rate of 6 - 7 %. All over the world for duplex board making mills have a bright future due to heavy demand by packaging, and e-commerce. Of the total industrial of packaging industries, the contribution of duplex board has been accounted as 32%. However, the major barriers in way of perceived growth are stiff global competition from overseas supplies. As there is a need for industry to be proactive and gear up to become technological and environmentally sustainable as well as globally competitive. To achieves better quality board the mill might expand its operational issues from raw material feeding to finishing. In these case studies the plant trials were taken in a board making mill having a cylinder mould operation and also applicable to multilayer Fourdrinier for getting improved stiffness, Bulk and Printers friendly coated duplex board along with the consideration of eco -friendly manufacturing methods (Zero liquid Discharge) and cost reduction by means of application of colloidal chemistry.*

**Key Words**: Wet End Sizing, Conductivity, Zero Liquid Discharge, Edge Penetration, Board Flatness, Bottom Curling, Top Curling, Waviness, Surface Sizing Agent, Precoat, Top Coat.

## 1.1.0. Introduction

The primary functions of board making process is the processing of waste paper to clean (1) stock of paper making involves number of cleaning to remove contaminants such as plastic bottles, plastic covers, iron clips, latex, wax, inks, etc. Also, one of the major technological issues are presence of high level of contaminants in imported waste paper, which requires appropriate process configuration with state-of-art process technologies to produce clean stock.

Many mills have a good flooring area for top layer as well as bottom, filler layer. Especially for top layer the sorting was carried out very carefully to avoid process contaminations. Some mills in India have a deinking system which allows some low grade raw materials into the system. The mill does not have the deinking system only should allow the high bright raw material for top layer. High cost top layer material which is used for board making is given in table No: 1.

**Table No: 1, Top Layer Raw materials**

| Sl No | Top Layer Raw materials |
|---|---|
| 1 | Coated Book stock – Imported |
| 2 | No : 1 White cuttings |
| 3 | Printed Office Cut – POC |
| 4 | Note Books & White Record |

**Fig No: 1,** Imported Waste Paper

Low cost filler and bottom layer material which are used for board making is given in table No: 2.

**Table No: 2,** Filler and Bottom Layer Raw materials

| Sl No | Filler and Bottom Layer Raw materials |
|---|---|
| 1 | Old News Paper ( ONP), Tamil , English , Malayalam |
| 2 | Indian Mixed waste & Box kraft |
| 3 | Mill broke |

**Fig No: 2, Filler and Bottom Layer Raw materials**

**(A).Filler Layer Raw material** **(B).Bottom Layer Raw material**

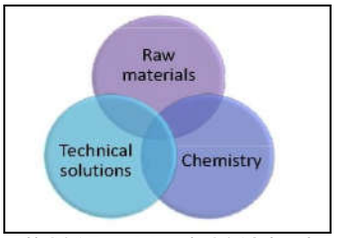
### 1.1.1. SCOPE OF THE STUDY

The present study has been focused on poor coating coverage, top curling and waviness issues. This is applicable to both wire and cylinder mould operation.

### 1.1.2. CUSTOMER COMPLAINTS REVIEW

The customer complaints report from 10 customers were reviewed by the technical team in laboratory and discussed with the process team. The complaints period were seriously analyzed and divided as like, Fig No: 3.

**Fig No: 3, Tools for solving customer complaints**




The customer complaint details for the year April 2017 to March 2018 is given in Table: 3.

**Table No: 3,** The customer complaints details for the year April 2017 to March 2018

| Sl. No | Nature of the complaints | CUSTOMER'S CODE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | I | J |
| 1 | Blanket Damage | 5 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Blade lines | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Board Bend | 10 | 5 | 9 | 3 | 7 | 3 | 9 | 3 | 3 | 2 |
| 4 | Bundle Shortage | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 5 | Board smell | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Cut sheets in reels / Bundles | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| 7 | Cross Cutting | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Creasing | 0 | 2 | 2 | 3 | 0 | 1 | 0 | 1 | 0 | 0 |
| 9 | Counting variation | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 10 | Dots After Lamintaion | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 11 | Feeding Problem | 0 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 12 | Gsm Variation | 5 | 2 | 4 | 5 | 6 | 2 | 0 | 2 | 0 | 0 |
| 13 | High Cobb | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Lumps | 0 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 15 | uncoated Mixup | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | Moisture& Gsm variation | 0 | 0 | 2 | 2 | 0 | 1 | 1 | 1 | 0 | 1 |
| 17 | More Specks | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | Poor coverage | 2 | 4 | 5 | 8 | 1 | 2 | 3 | 4 | 5 | 1 |
| 19 | Poor Bulk & Stiffness | 0 | 2 | 4 | 3 | 5 | 5 | 2 | 2 | 4 | 6 |
| 20 | Printing Problem | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 0 |
| 21 | Pasting Problem | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | Roughness | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 23 | Rough cutting | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | Size Variation | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |
| 25 | Shade variation | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | Speck & Block dots | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 27 | Top layer peel off | 0 | 2 | 0 | 4 | 0 | 2 | 3 | 4 | 0 | 0 |
| 28 | Top curling | 1 | 2 | 4 | 4 | 3 | 3 | 3 | 4 | 5 | 1 |
| 29 | Gsm variation | 1 | 1 | 2 | 4 | 3 | 1 | 3 | 2 | 0 | 1 |
| 30 | Weight Shortage | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 31 | Wrinkles | 0 | 1 | 1 | 2 | 0 | 0 | 2 | 0 | 1 | 0 |
| 32 | Waviness | 7 | 2 | 6 | 10 | 2 | 2 | 1 | 6 | 2 | 2 |

From the above table, the complaints were separated as major complaints and minor complaints. All the complaints were raised by the customer has been scrutinized by the technical team. The major complaints were tabulated and given in Table No: 4.

**Table No: 4,** Major customer complaints for the year April 2017 to March 2018

| Sl No | Nature of the complaints | Area of customer |
|---|---|---|
| 1 | Poor coverage | It was found from the table No: 3, 4 & 5, the major customer complaint was coating related & visual appearance related from all customers. |
| 2 | Top Curling | |
| 3 | Poor Bulk & stiffness | |
| 4 | Waviness | |

The coating related complaints were studied and eliminated by modifying the coating additives and its parts (2). Normally the binder ratio is 11 to 13%.The preparation and application of coating recipe is very important for coated board manufacturing process. Many coated duplex board Industries; the coating kitchen area is like a restricted area / cave. Even at present science and technology era all pulp and paper secrets were available in net, many mills coating kitchen recipe, might be unaware of lab chemist and also maintains as very secret which fails to consistent quality of board supply and fail problem solving. Fig No: 4, clearly explains coated duplex board structure.

**Fig No: 4,** Duplex Coated structure


**Solution for poor coverage**

The poor coverage which was eliminated by correcting the addition sequence of coating chemical while recipe preparation (3) and maintaining the other parameters. The disperser rpm 1500/750 (after binder addition) is maintained as per recommendation of supplier. The first solution for poor coverage was found due to addition of coating chemicals during the preparation and conditions maintained during operation. Table No: 5, shows the coating recipe order of addition.

**Table No: 5,** Coating recipe order of addition

| COATING RECIPE ORDER OF ADDITION | | | |
|---|---|---|---|
| **Sequence Addition** | **Order of Addition Existing I** | **Modified Order of addition I** | **Modified Order of addition II** |
| 1 | Water | Water | Water |
| 2 | Caustic | Caustic | Dispersing Agent |
| 3 | Dispersing Agent | Dispersing Agent | Caustic |
| 4 | Clay powder solid | Clay powder solid | Clay powder solid |
| 5 | Wet GCC | Wet GCC | Wet GCC |
| 6 | Binder | PVA | CMC |
| 7 | PVA | CMC | PVA |
| 8 | CMC | Lubricant | Binder |
| 9 | Lubricant | Binder | Lubricant |
| 10 | Cross linker | Cross linker | Cross linker |

While adding more clay, binder demand will increase. Wet Ground Calcium carbonate requires less binder. It is noted that the clay dispersant is not giving expected result more than 69% and also while preparation the level of agitator blade touching by the clay solution before starting the agitation is very important for better dispersion. Aspect ratio only applicable for clay. Some of the coarser particles required more solids content preparation to give better collision of each pigment particles. Precoat viscosity was maintained as 800 cps and top coat viscosity was maintained as 1200 cps. pH was maintained as 9.0 to 9.5. Poor coverage was observed due to base paper porosity(4) variation. OBA is added in-between

CMC and PVA.PVA is a OBA enhancer. The water retention is the important parameter for coverage issue as compared to all other process parameters which causes the binder migration. For small scale industries the cooling water jacket for storage and supply tanks is not possible, but the coating tray should cover the cooling tray which circulates the cooling water with a temperature of 5 to 10 °C. Modified order of addition II gave better result.

**Reasons for poor coverage was found and corrected as given below.**

a).Improper sequence of recipe preparation and quantity variation , b).Failure in selection of coating chemicals brand, c).Conditions maintained during coating operation , d).Water addition after preparation to maintain level, e).Negligence of scientific approach, f).Hardness of backing rolls, g).Before size press Cobb (200gsm to 250gsm)(5,6), h).Bar / blade life, i).Applicator rolls speed , j).Return coating colour amount and flow, k).Water retention , l). Required coater Hood pressure and velocity of hot air, m). Top layer formation and retention, n).Frequent machine breakdown, 0).Entry moisture to Precoat / Top coat .

### 1.1.3. MATERIALS AND METHODS

Six months plant study (from 01.01.2018 to 30.7.2019) was conducted in a board making mill operating at the speed of 150-250 mpm .The furnish was fixed as 60 % Imported SOP, 20% Note book and 10% White record, 10% local for top layer and 50 % colour record, 50% Tamil newspaper, for bottom layer 40 % mill broke 60% Indian mixed waste.

### 1.1.4. TOP CURLING

From the customer complaints, It was concluded that the top curling was a major complaints which is not a printers friendly physical nature of coated board. Immediate action was taken by the plant trial to get rid off from this issue. The coating circuit was studied. There are two types of coating circuits (7) . The types are, Board first enters to bottom coater the passed to precoat and finally coated by top coater. Second coating circuits are board first contact thro precoat and passed to bottom coater and finally top coater. Two types of coating circuits was studied and finalized.

**Table No: 6,** Trial Run I: Precoat + Bottom coat +Top coat circuit

| Process control Parameters | | | | | | Total quantity Top curling |
|---|---|---|---|---|---|---|
| Date | Gsm | Press Break | MG Break | Before size press cobb | Final Board cobb T/B | |
| 01.01.18 | 200 | 1 | 0 | 238 | 30 / 40 | Trial Run I was found that entire production yields a top curling board |
| 02.01.18 | 200 | 2 | 1 | 268 | 32 / 43 | |
| 03.01.18 | 200 | 0 | 0 | 351 | 31 / 40 | |
| 04.01.18 | 200 | 2 | 1 | 351 | 30 / 45 | |
| 05.01.18 | 230 | 1 | 1 | 272 | 32 / 41 | |
| 06.01.18 | 230 | 3 | 2 | 353 | 32 / 45 | |
| 07.01.18 | 230 | 1 | 1 | 402 | 29 / 40 | |
| 08.01.18 | 230 | 1 | 2 | 282 | 36 / 44 | |
| 09.01.18 | 230 | 2 | 1 | 352 | 38 / 44 | |
| 10.01.18 | 230 | 3 | 0 | 288 | 30 / 45 | |
| 11.01.18 | 250 | 2 | 0 | 322 | 33 / 40 | |
| 12.01.18 | 250 | 1 | 1 | 356 | 31 / 44 | |
| 13.01.18 | 250 | 3 | 0 | 367 | 34 / 43 | |
| 14.01.18 | 250 | 1 | 0 | 297 | 32 / 45 | |

**Table No: 7,** Trial Run II: Precoat + Bottom coat +Top coat circuit

| Process control Parameters | | | | | | | Total quantity Top curling |
|---|---|---|---|---|---|---|---|
| Date | Gsm | Press Break | MG Break | Before size press cobb | Final Board cobb T/B | Size press starch gpl | |
| 01.02.18 | 200 | 1 | 0 | 238 | 32 / 40 | 100 | Trial Run II was found that entire production yields a top curling board<br><br>. Water penetration = 90-140gsm |
| 02.02.18 | 200 | 1 | 1 | 264 | 31 / 43 | 100 | |
| 03.02.18 | 200 | 2 | 1 | 353 | 31 / 40 | 100 | |
| 04.02.18 | 200 | 3 | 0 | 357 | 30 / 45 | 100 | |
| 05.02.18 | 230 | 4 | 2 | 273 | 31 / 41 | 100 | |
| 06.02.18 | 230 | 3 | 2 | 352 | 31 / 45 | 100 | |
| 07.02.18 | 230 | 2 | 1 | 401 | 30 / 40 | 100 | |
| 08.02.18 | 230 | 2 | 2 | 289 | 36 / 44 | 100 | |
| 09.02.18 | 230 | 3 | 1 | 350 | 38 / 44 | 100 | |
| 10.02.18 | 230 | 1 | 2 | 289 | 30 / 45 | 100 | |
| 11.02.18 | 250 | 1 | 1 | 329 | 33 / 40 | 100 | |
| 12.02.18 | 250 | 1 | 1 | 302 | 31 / 44 | 100 | |
| 13.02.18 | 250 | 2 | 2 | 382 | 34 / 43 | 100 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14.02.18 | 250 | 3 | 3 | 274 | 32 / 45 | 100 | |
| 15.02.18 | 250 | 1 | 2 | 286 | 31 / 44 | 100 | |

**Table No: 8,** Trial Run III: Bottom coat + precoat +Top coat circuit

| Process control Parameters | | | | | | | Total quantity Top curling |
|---|---|---|---|---|---|---|---|
| Date | Gsm | Press Break | MG Break | Before size press cobb | Final Board cobb T/B | Size press starch gpl | |
| 01.03.18 | 200 | 1 | 0 | 236 | 30 / 40 | 85 | Trial Run III 75% Top curling eliminated |
| 02.03.18 | 200 | 2 | 1 | 269 | 32 / 43 | 85 | |
| 03.03.18 | 200 | 0 | 0 | 355 | 31 / 40 | 85 | |
| 04.03.18 | 200 | 2 | 1 | 355 | 30 / 45 | 85 | |
| 05.03.18 | 230 | 1 | 1 | 275 | 32 / 41 | 85 | |
| 06.03.18 | 230 | 3 | 2 | 355 | 32 / 45 | 85 | |
| 07.03.18 | 230 | 1 | 1 | 404 | 29 / 40 | 85 | |
| 08.03.18 | 230 | 1 | 2 | 284 | 36 / 44 | 85 | |
| 09.03.18 | 230 | 2 | 1 | 354 | 38 / 44 | 85 | |
| 10.03.18 | 230 | 3 | 0 | 284 | 30 / 45 | 85 | |
| 11.03.18 | 250 | 2 | 0 | 324 | 33 / 40 | 85 | |
| 12.03.18 | 250 | 1 | 1 | 304 | 31 / 44 | 85 | |
| 13.03.18 | 250 | 3 | 0 | 384 | 34 / 43 | 85 | |
| 14.03.18 | 250 | 1 | 0 | 274 | 32 / 45 | 85 | |
| 15.03.18 | 250 | 2 | 1 | 284 | 31 / 44 | 85 | |

**Table No: 9,** Trial Run IV: Bottom coat + Precoat +Top coat circuit

| Process control Parameters | | | | | | | | Total quantity Top curling |
|---|---|---|---|---|---|---|---|---|
| Date | Gsm | Press Break | MG Break | Before size press cobb | Final Board cobb T/B | Size press starch gpl | Bottom coater Starch gpl | |
| 01.04.18 | 200 | 1 | 0 | 236 | 30 / 40 | 85 | 40 | Trial Run IV 85% Top curling eliminated |
| 02.04.18 | 200 | 2 | 1 | 269 | 32 / 43 | 85 | 40 | |
| 03.04.18 | 200 | 0 | 0 | 355 | 31 / 40 | 85 | 40 | |
| 04.04.18 | 200 | 2 | 1 | 355 | 30 / 45 | 85 | 40 | |
| 05.04.18 | 230 | 1 | 1 | 275 | 32 / 41 | 85 | 40 | |
| 06.04.18 | 230 | 3 | 2 | 355 | 32 / 45 | 85 | 40 | |
| 07.04.18 | 230 | 1 | 1 | 404 | 29 / 40 | 85 | 40 | |
| 08.04.18 | 230 | 1 | 2 | 284 | 36 / 44 | 85 | 40 | |
| 09.04.18 | 230 | 2 | 1 | 354 | 38 / 44 | 85 | 40 | |
| 10.04.18 | 230 | 3 | 0 | 284 | 30 / 45 | 85 | 40 | |
| 11.04.18 | 250 | 2 | 0 | 324 | 33 / 40 | 85 | 40 | |
| 12.04.18 | 250 | 1 | 1 | 304 | 31 / 44 | 85 | 40 | |
| 13.04.18 | 250 | 3 | 0 | 384 | 34 / 43 | 85 | 40 | |
| 14.04.18 | 250 | 1 | 0 | 274 | 32 / 45 | 85 | 40 | |
| 15.04.18 | 250 | 2 | 1 | 284 | 31 / 44 | 85 | 40 | |

**Table No: 10,** Trial Run V: Bottom coat + Precoat +Top coat circuit

| Process control Parameters | | | | | | | | Total quantity Top curling |
|---|---|---|---|---|---|---|---|---|
| Date | Gsm | Press Break | MG Break | Before size press cobb | Final Board cobb T/B | Size press starch gpl | Bottom coater Starch gpl | |
| 01.05.18 | 200 | 1 | 0 | 236 | 30 / 40 | 85 | 20 | Trial Run IV 98% Top curling eliminated |
| 02.05.18 | 200 | 2 | 1 | 269 | 32 / 43 | 85 | 20 | |
| 03.05.18 | 200 | 0 | 0 | 355 | 31 / 40 | 85 | 20 | |
| 04.05.18 | 200 | 2 | 1 | 355 | 30 / 45 | 85 | 20 | |
| 05.05.18 | 230 | 1 | 1 | 275 | 32 / 41 | 85 | 20 | |
| 06.05.18 | 230 | 3 | 2 | 355 | 32 / 45 | 85 | 20 | |
| 07.05.18 | 230 | 1 | 1 | 404 | 29 / 40 | 85 | 20 | |
| 08.05.18 | 230 | 1 | 2 | 284 | 36 / 44 | 85 | 20 | |
| 09.05.18 | 230 | 2 | 1 | 354 | 38 / 44 | 85 | 20 | |
| 10.05.18 | 230 | 3 | 0 | 284 | 30 / 45 | 85 | 20 | |
| 11.05.18 | 250 | 2 | 0 | 324 | 33 / 40 | 85 | 20 | |
| 12.05.18 | 250 | 1 | 1 | 304 | 31 / 44 | 85 | 20 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 13.05.18 | 250 | 3 | 0 | 384 | 34 / 43 | 85 | 20 | |
| 14.05.18 | 250 | 1 | 0 | 274 | 32 / 45 | 85 | 20 | |
| 15.05.18 | 250 | 2 | 1 | 284 | 31 / 44 | 85 | 20 | |

Table No: 6 show the trial run to eliminate the top curling with the existing operating conditions. It fails to give the desired results. Again the trial run 7,8 had been taken with reducing the size press starch gpl from 120 gpl to 100 gpl, gave poor results. Then the trial run 9 was conducted to eliminate the top curling which gave 75% desired results. So finally it was concluded from trial no ;10, that the starch penetration was the main reason even though the blower air pressure was maintained at 60 m/sec (8).To avoid the starch penetration, the bottom coater gpl was reduced from 40 gpl to 20 gpl.The board became flat on trial no ;10, as Fig No;6.

**Fig No: 5, Top curling Board**

**Fig No:6, Flat Board**

**1.1.5. Waviness :** Fig no:7 shows the waviness board

**Fig No: 7. Waviness**

**Solution for Waviness**

Waviness is a surface property which was directly related to profile variation. The concerned parent roll was subjected to profile test variation by 10 x 10 cutter . Order Gsm was 300. The profile variation was found that minimum gsm 285 gsm maximum gsm was 315. Even though it was in the range of **± 5 %,** in same sheet the one side edge has 285 gsm and opposite have 315 gsm. This higher gsm side sheet automatically came downwards and causes waviness. The moisture, caliper, bulk are direct relationship with gsm. After adjusting the profile variation, no waviness was found. Final packing was done with polyethylene covers followed by gunny bag to avoid weather and seasonal changes impact.

**Solution for Top curling**

Top curling was managed with the help of steam trend. Drying of board is not easy as like paper. It is very complicated. Poor drying causes (9, 10) lumpiness, poor gloss, and curling problem to the board. In India many mills gets dryer screen which had been bought as a second hand from the writing and printing paper machines .Even though It's life was over already, the same dryer screen was employed in board machine which causes, dryer mark, poor dimensional stability by itself, difficult to operate by auto guide, surface roughness on board and finally results curling. Top curling problem was adjusted by the steam pressure at top / bottom dryer group respectively. It was instructed to machine / boiler crews to operate / maintain minimum 8 kg / $cm^2$ for high pressure line and 3.5 kg / $cm^2$ for low pressure line. Fail to maintain above pressure the working principle of thermo-compressor will severely affect.

**Conclusions**

The coating recipe preparation and application is very important factor for poor coverage. Then the top curling, starch penetration and drying after coating is to be concentrated very carefully. Care should be taken while selecting the chemicals. All the pulp and paper chemicals have been recommended / invented mostly for virgin pulp and for fresh water only. Common application of paper chemicals will not help to the mill for profit making and sustainability. Whenever possible to avoid the chemical application at wet end makes the healthy environment which help to decrease the corrosion, conductivity

of backwater,). Giving importance to lab might be considered as well as supplier's opinion for achieving quality and profitability. The scientific approach is the only way to get quality and profitability for paper / board industries in India.

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