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Design, Development and Analysis of Power Drive System of Calcination Drum

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Abstract

Now a day's Solid Waste Management is one of the major challenges faced by many countries around the world. Inadequate collection, recycling or treatment and uncontrolled disposal of waste in dumps can lead to severe hazards, such as health risks and environmental pollution. The management of solid waste typically involves its collection, transport, processing and recycling or disposal. Collection includes the gathering of solid waste and recyclable materials, and the transport of these materials, after collection, to the location where the collection vehicle is emptied. For generation of energy from municipal solid waste the device named 'Calcination Drum' is developed by Engineers. There are some norms, rules and regulations must have to follow by Municipal Corporation Committee for reuse, recycle and utilization of Municipal sewage solid waste. Under this rules and regulation research and development on generation of Methane gas by using municipal waste is going on.

Keywords: Calcination Drum, Support Roller Shaft, Guide ring, Analysis software.

1. INTRODUCTION

Solid waste management is becoming matter of great concern due to increasing population. Generally, in most cities one common method is adopted for waste disposal i.e. dumping on the grounds present outside the cities. If the non-degradable wastes are not dumped properly then it may cause the severe effects like air pollution, diseases etc; considering all these ill effects it is necessary that the wastes should be dumped properly after segregation (degradable and non-degradable). Hence engineers developed one drum named Calcination Drum.

Fig.1: Photo of Calcination Drum.

2. DESIGN OF SUPPORT ROLLER SHAFT

Material selection is a step in the process of designing any physical object. In the context of product design, the main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of candidate materials. Most of the times; failure arises due to improper selection of materials. In previous design the material used for shaft was **EN 8**. Now we are selecting other material EN 24 to obtain the desired output. The material selected for shaft is **EN 24** as it is a popular grade of through hardening alloy steel due to its excellent machinability conditions. It is used in the components such as gears, shafts, studs and bolts; its hardness is in the range 248/ 302 HB. **EN 24** can be surface hardened to create components with enhanced wear resistance by induction/ nitriding processing.

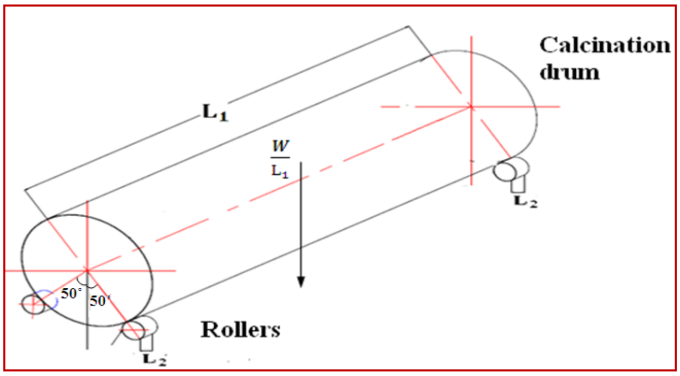

Fig. 2: Schematic Diagram of Calcination Drum.

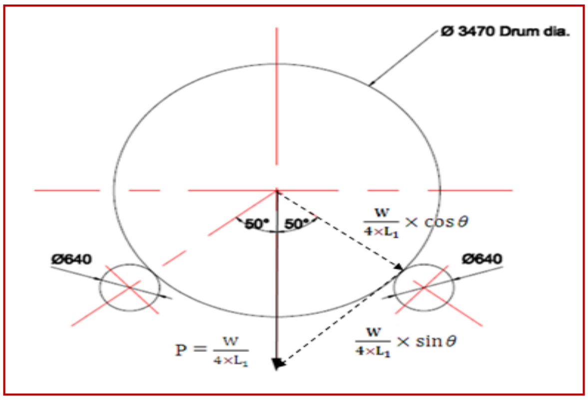

Fig. 3: Forces acting on Roller.

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The diagram shows the schematic view of Calcination drum

Where,

W = Dynamic Load of Municipal sewage=160 tones

L1= Length of Calcination drum =10.4 m

L2 = Length of Roller =0.35 m

Fig. shows the schematic diagram of Calcination Drum. The dynamic load is assumed to be uniformly distributed across the length of drum i.e. (W/L1). This load will be acting on 4 rollers at angle of 50˚ and will be uniformly distributed among 4 rollers and after that following the standard procedure the diameter of shaft is calculated

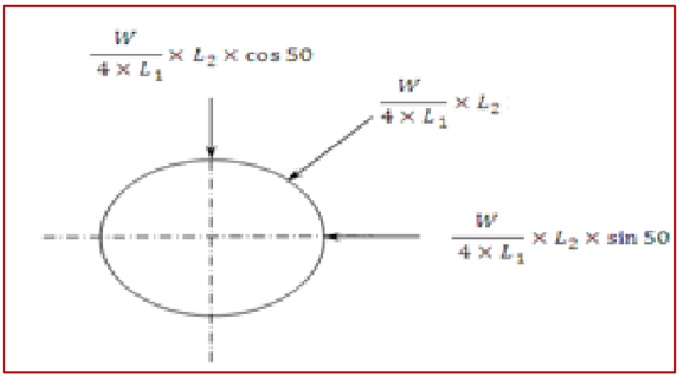

Fig.4: Forces acting on support roller shaft.

First of all, we are considering forces in vertical plane. The shear force and bending moment diagram is as follows:

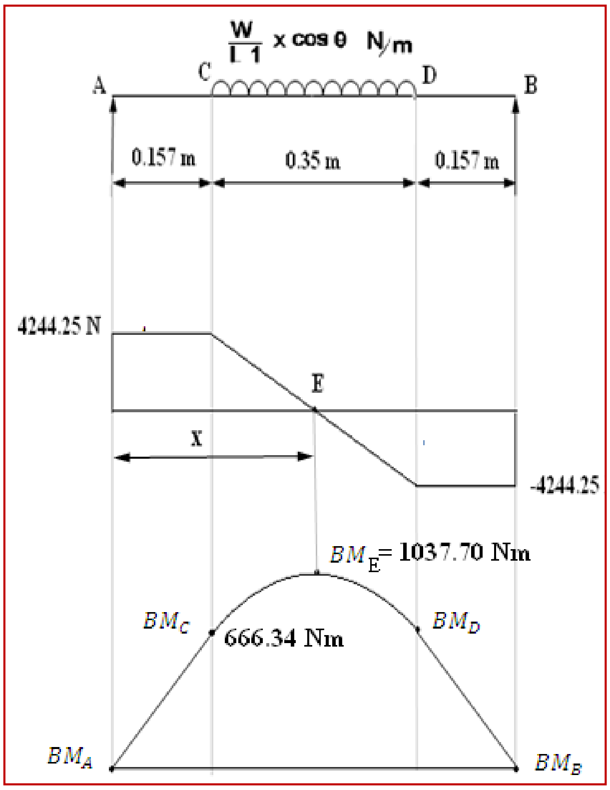

Fig.5: Shear force and bending moment diagram for vertical plane.

The maximum bending moment was found to be 1037.70 Nm.

For horizontal plane the shear force and bending moment diagram is as follows

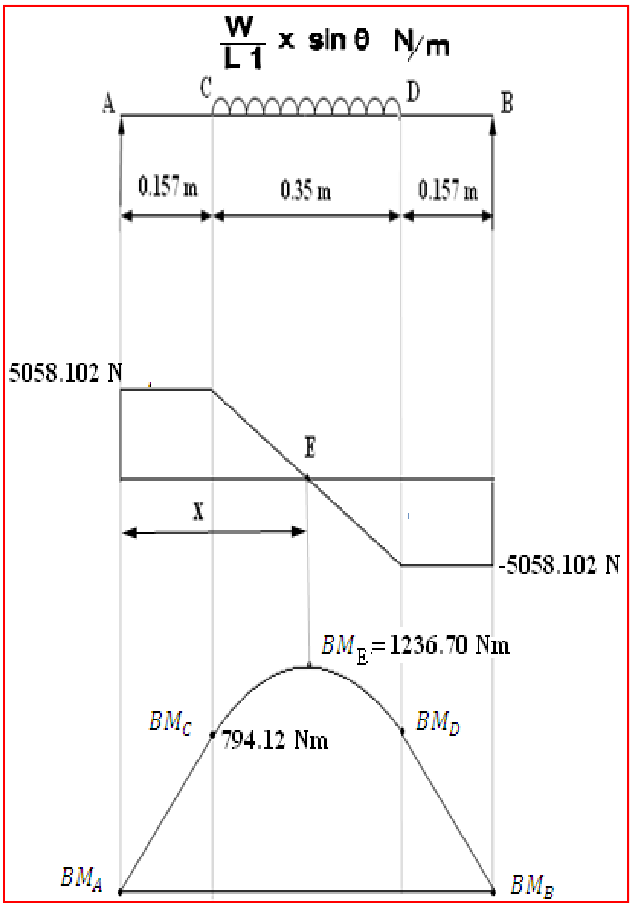

Fig.6: Shear force and bending moment diagram for horizontal plane.

The maximum bending moment was found to be 1236.70 Nm.

Resultant bending moment is given as,

$$M_B = \sqrt{(1037.70)^2 + (1236.70)^2}$$

$$M_B = 1614.38 \text{ Nm} = 1614.38 \times 10^3 \text{Nmm}$$

From Calculation,

$$M_e = \frac{\pi}{32} \times d^3 \times \sigma_b$$

$$\sigma_b = \text{ bending stress} = \frac{\text{Sult}}{4}$$

Factor of safety = 4

$$\sigma_b = \frac{850}{4} = 212.2 \text{N/mm}^2$$

$$3951.26 \times 10^3 = \frac{\pi}{32} \times d^3 \times 212.2$$

d = 57.46 mm

Here by considering the extra jerk and by thumb rule we are going to take the diameter as 155 mm. The material selected for shaft is EN 24. Based on the diameter we have selected the spherical roller bearing from SKF catalogue. It is expected that the bearing should function properly for 5 years i.e. 43800 hrs. Hence by considering the load acting on bearing. We have selected the bearing having the designation 22336 CCK/W33.The selected bearing satisfies our requirement.

3. ANALYSIS RESULTS FOR SHAFT, GUIDE RING & DRUM

A] Shaft

For the analysis of shaft, we have considered the element solid 185. Assumptions & Recommendations for analysis are to be considered.

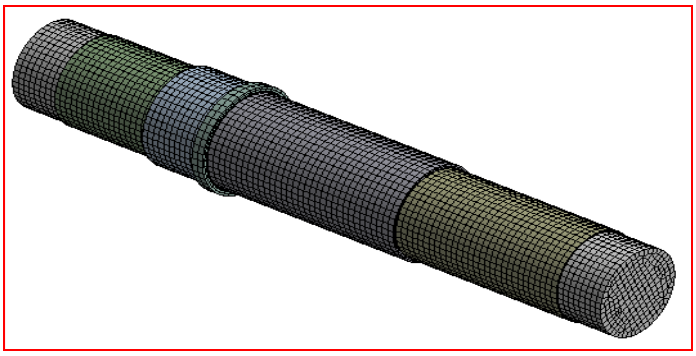

Fig.7: Detailed meshing of support roller shaft

Table 1: Material Properties

Sr. No	Properties	Other parts	Shaft
1	Young's Modulus	$2 \times 10^5\ MPa$	$2.1 \times 10^5\ MPa$
2	Poisson's Ratio	0.3	0.3
3	Density	$7.85 \times 10^{-6}\ kg/mm^3$	$7.85 \times 10^{-6}\ kg/mm^3$
4	Yield Stress	250 MPa	650 MPa

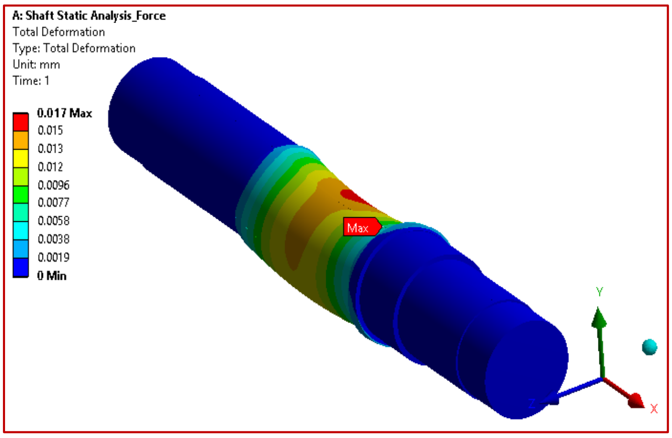

Fig.8: Total Deformation of Shaft in Static Condition

Red zone shows the prime area where deformation occurs most. Value of total deformation decreases as it moves away from the maximum point of deformation and it is denoted by colour patterns of deformation plot**.** Deformation is occurring near central portion on which roller is mounted. Different colour profile represents different value of deformation; these values are mentioned beside the deformation picture. As colour profile changes from red to blue the value of total deformation decreases. Value of deformation obtained by FEA analysis of shaft is 0.017mm

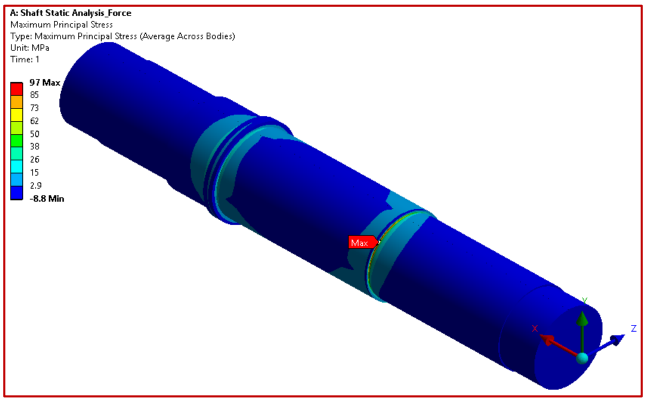

Fig.9: Von Mises Stress in Shaft

From Fig. 9 it is found that maximum stress is 97 MPa.

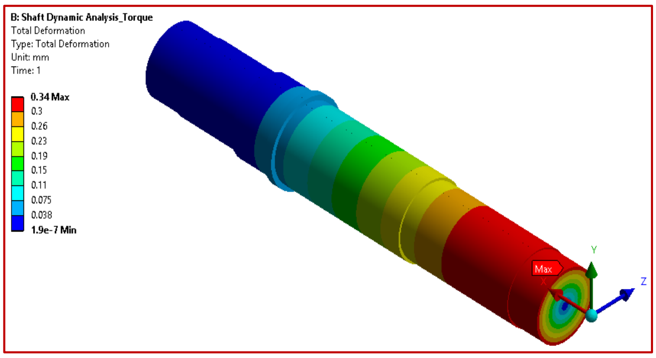

Fig.9: Total Deformation of Shaft in Dynamic Condition.

The fig 9 shows the analysis of shaft in dynamic condition. The shaft is in rotating condition. The deformation was observed to be 0.34 mm.

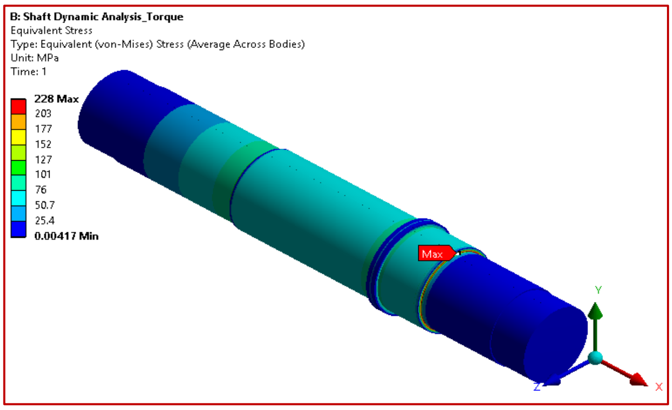

Fig.10: Von Mises Stress in Shaft under Dynamic Condition

The maximum stress was found to be 228 MPa. The stress concentration takes place at the place at region at which abrupt change in cross section takes place. The stresses in different regions are shown with different colours.

B] Guide Ring

For the analysis of guide ring, we have considered the element solid 186. Assumptions & Recommendations for analysis are to be considered.

No. of Elements	10654	Element Type: SOLID186
No. of Nodes	74438	

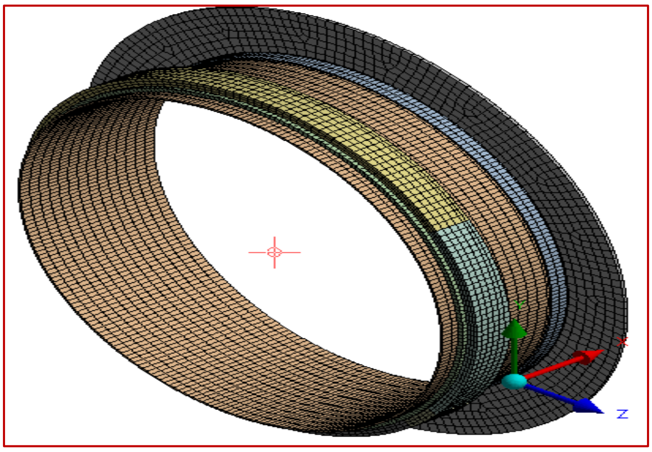

Fig. 11: Guide ring FEA model

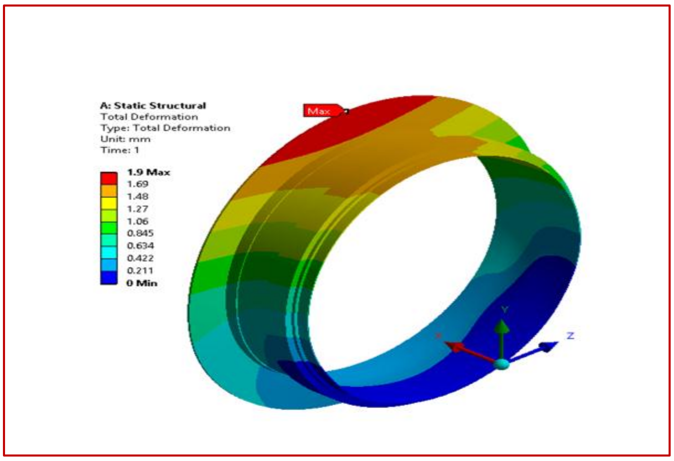

Fig.12: Total Deformation of Guide Ring in Static Condition

Value of deformation obtained by FEA analysis for Guide Ring is 1.9mm.

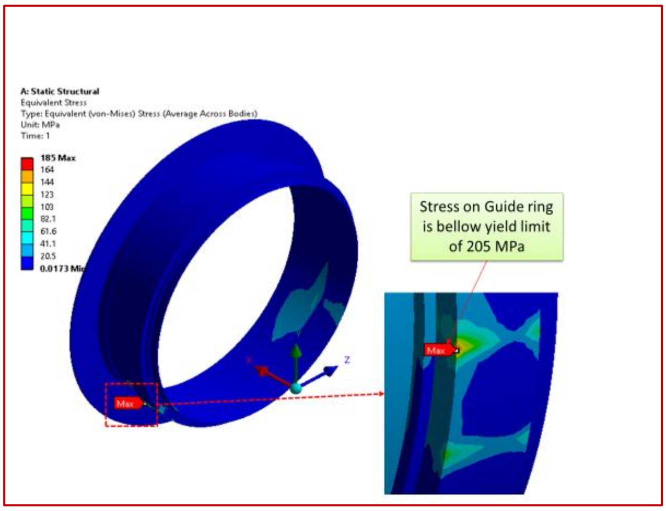

Fig.13: Von-Mises Stress of Guide Ring in Static Condition

From Von-Mises Stress obtained value 185 MPa.

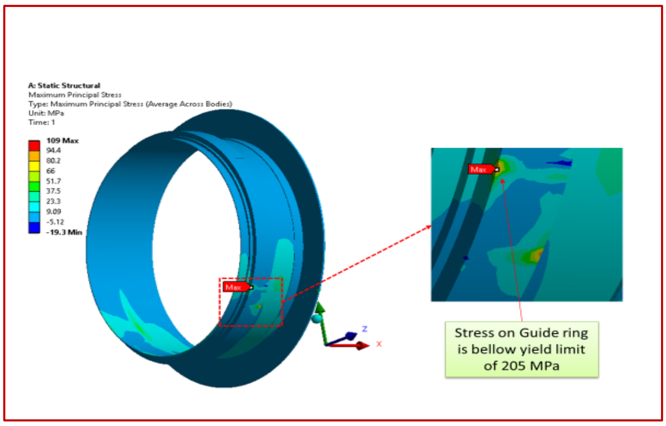

Fig.14: Maximum Principal Stress of Guide Ring in Static Condition

Maximum Principal Stress from analysis 109 MPa.

C] Calcination Drum

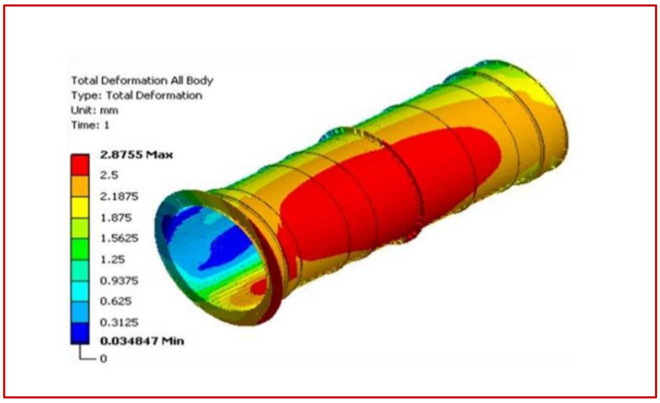

Fig.15: Total Deformation of Drum in Static Condition

Maximum deformation obtained in Drum 2.87mm.

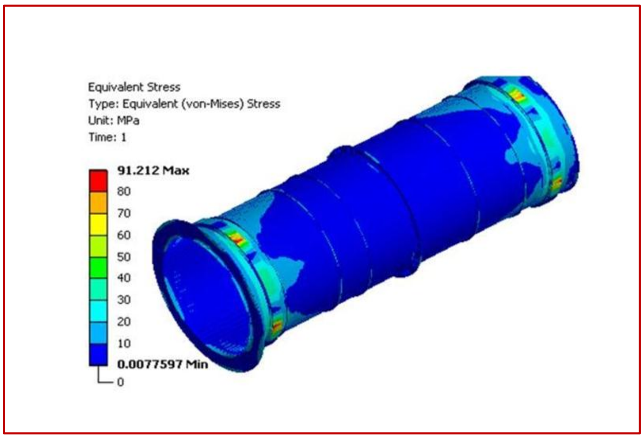

Fig.16: Von-Mises Stress of Drum in Static Condition

From figure obtained stress value 91 MPa.

4. CONCLUSION & FUTURE SCOPE

Conclusion

In this project we have redesigned the components and assembly by considering extreme loading conditions. In this project work we have finalized the drawing and dimensions by using analytical and analysis software.

Guide ring Analysis

1. Maximum Deformation in the model was found to be **1.9mm.**
2. Maximum Stress in the material are found to be **185 MPa** which is less than the Yield Strength of Material (**250 MPa**) hence Design is Safe for given Loading & Boundary Conditions.
3. Based on the analysis performed, results seen are safe in terms of stresses as well as deflection. Since worst loading condition may not be regular, the design is safe.

Shaft Analysis

1. Maximum Deformation in the model are found in Static condition **0.017mm** & Dynamic condition **0.34mm**.

2. Maximum Stress in the Shaft are found in Static condition **97 MPa** & Dynamic condition **228 MPa** which is less than the Yield Strength of Material (**650 MPa**) hence Design is Safe for given Loading & Boundary Conditions.

3. Based on the analysis performed, results seen are safe in terms of stresses as well as deflection. Since worst loading condition may not be regular, the design is safe.

Drum Analysis

1. Maximum deformation in the model found **2.87mm**.
2. Maximum Stress in the material are found to be **91.212** MPa which is less than the Yield Strength of Material (**250 MPa**) hence Design is Safe for given Loading & Boundary Conditions.

Future Scope

In many application calcinations drum type assembly are used for many applications and there are many names used as per Engineering applications. In some cases, we call it as rotary mixer, segregator etc. The design and arrangement of components used in this type of rotary drum unit is similar but as per application and manufacturer there are many design and sizes are available. In this field the standardization of all this component and assembly is required and it is very much important.

According to capacity and application standard modular design is required. During the maintenance also the manufacturer and customers are facing many problems due to tailor made design also we can't predict its reliability. So, more focus is required on design of different arrangement and subassemblies are used in this calcinations drum.

5. References

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