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A TRANSVERSAL MOBILE COUPLING VIRTUAL MODELLING

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Abstract— Virtual Modeling of mechanical structures as multibody systems, with a minimum number of bodies, in the aim of real time simulation of the product dynamic behavior, using computer performing software, is a necessity. For a company, it saves time in product developing, reduces the number of physical prototypes and experiments, reduces the prices of product and also, increases the quality of product. The paper presents aspects regarding the modeling of a mobile coupling as multibody system, using ADAMS. First there is presented the coupling parts geometry 3D modeling. Then are defined the geometrical and kinematical restrictions between the parts. Finally, there are presented some aspects about the simulation and the results of this. In the final part of the paper, there are presented the conclusion.

Keywords— Mobile transversal coupling, multibody system, geometrical and kinematical constraints, virtual modeling, simulation.

I. Introduction

THE paper presents the modeling and the kinematic simulation of a mobile transversal coupling, as multibody system, to obtain the relative motions in joints, using ADAMS. The relative joints motion is useful in design process of the coupling. Depending by this, it is possible to replace the kinematical linkage between the shafts with an elastic intermediary element having a special design, as recommended in [1], [2].

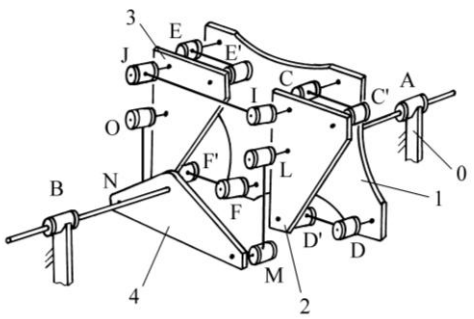

Fig. 1. Transversal mobile coupling structural scheme and the associated mechanism

The studied transversal coupling (Fig. 1) is a new solution, developed by author in previous researches [3], to be used in movement and torque mechanical transmission between two shafts with parallel axis [4], [5].

The shafts are connected by a kinematical linkage with the possibility to have translations in the transversal plane. These translations are named transversal movements. If the shafts are connected to the basis, it will result the associated mechanism, which is a plane mechanism, see also Fig. 1 [1], [2], [6].

II. Parts Modelling

The model parts are (Fig. 1): the semicouplings 1 and 4, the intermediary elements 2 and 3 and the links. All of them are rigid bodies, with masis and inertial properties.

Each semicoupling and the intermediary element result as composite solids after few boolean operations with simple solids as cylinders (Fig. 2, a, b, c). The same procedure will have as result the spring rings (Fig. 2, d). The links will result after simple boolean operations with simple solids as links and cylinders (Fig. 2, e).

For all the mobile bodies, the soft is calculating the masis, the inertial tensor, and masis center position.

The fixed body (ground, 0), without mass properties, is also created by the soft.

For modelling was chosen a transversal mobile coupling, having the follow dimensional characteristics:

1) input shaft diameter d = 32 mm;
2) semi coupling exterior diameter d_e = 60 mm;
3) placement diameter of the links bolts D = 100 mm;
4) semi coupling length l = 50 mm;
5) intermediary element exterior diameter D_e = 120 mm;
6) bolts diameter d_b = 8 mm;
7) intermediary element width g = 10 mm.

III. Restrictions Modelling

For this coupling, all the joints are revolute joints. For each joint are detailed, in Table I, the adiacent bodies, the localisation and the direction. The spring rings are fixed on the bolts using the fixed joints.

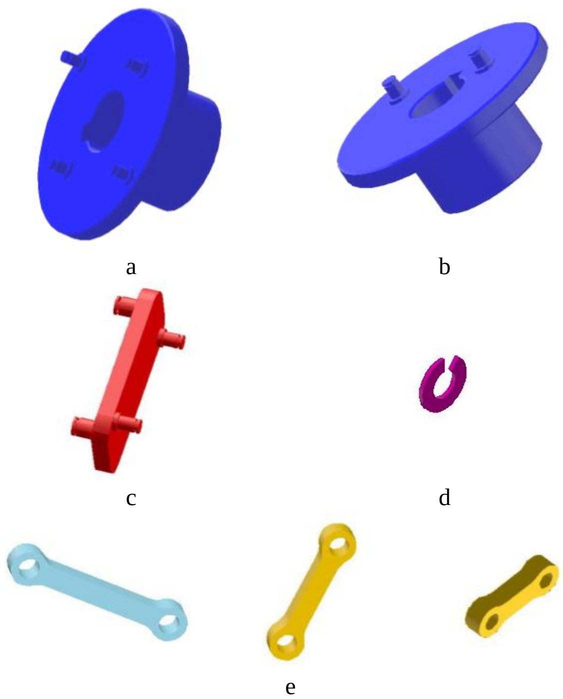

Fig. 2. Model parts

TABLE I
JOINTS DETAILS.

Joint	Adjacent body	Localization	Direction
A	Semi coupling 1 + basis	Semi coupling axis	// z
B	Semi coupling 2 + supplementary cylinder	Semi coupling axis	// z
C, D	Semi coupling 1 + links	Links anchorage points	// z
E, F	Semi coupling 1 + links	Links anchorage points	// z
C',D'	Links + intermediary element	Links anchorage points	// z
E',F'	Links + intermediary element	Links anchorage points	// z
I, J	Intermediary element + intermediary element	Link anchorage points	// z
L, O	Intermediary elements + links	Links anchorage points	// z
M, N	Links + semi coupling 2	Links anchorage points	// z
B'	Supplementary cylinder + basis	Cylinder center	// y

The model construction was made at the transversal eccentricity *e*=0. But, as in reality, the model has to support some different values of the eccentricity. So is necessary to have in the virtual model a suplimentary body (cylinder). This cylinder has a revolute joint with the output semicoupling (B') and a translational joint with the basis (B").

As kinematic restrictions, the model has two motions, as follow:

– a rotational motion at the input semicoupling

$$\varphi_1 = \omega t , \quad (1)$$

where, for the studied case, ω =30 degree/s;

– a translational motion between the suplimentary cylinder and the basis; this motion may have different constant values, for each value of the eccentricity.

The complete model of the coupling is presented in Fig. 3.

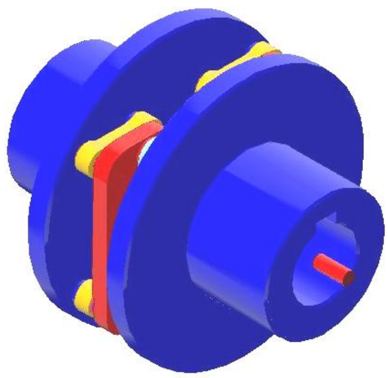
Fig. 3. Coupling virtual model

IV. SIMULATION AND RESULTS

After the model construction, is useful to check the model, to identify possible errors: invalid joints, duplicates, redundant constraints. The degree of freedom (DOF) is calculated by the soft using the Gruebler relation

$$\mathbf{DOF} = \mathbf{6n} - \mathbf{r} , \quad (2)$$

where *n* is the number of the mobile bodies, and *r* is the number of the restrictions [7], [8], [9].

If there are some redundant restrictions, the soft is deleting them, but sometimes, the user cannot know exactly which one was deleted. So, at complicated models is useful to be eliminated by the user, for a correct interpretation of the results.

The model will be simulated for different values of excentricity, from *e* = 0 mm, to the maximum eccentricity for the studied model, *e* = 24 mm. The step size for different eccentricity values is 1 mm.

After simulation, the angular velocity variation diagram in joints A and respectively B (for input semicoupling and also for output semicoupling) is obtained (fig. 4). In this diagram, the angular velocity variations are the same for both semicouplings. That means the studied coupling model is homokinetic (the condition is $\varphi_1 = \varphi_4$, detailed in [1], [3]).

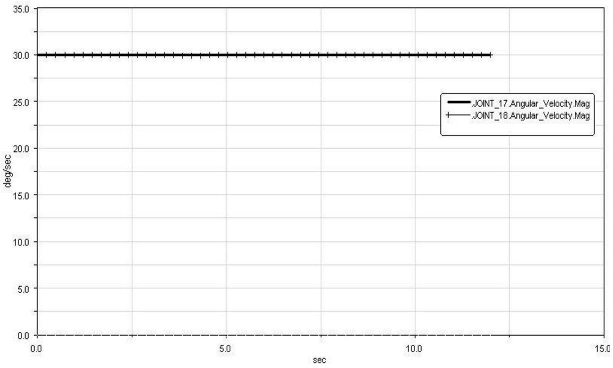

Fig. 4. Angular velocity in joints A and B

As the simulation result, are also the variations of relative motion in each joint, depending of the values of eccentricity *e*, between the input semicoupling, and output semicoupling for one complete rotation.

In ADAMS, the relative motion in a revolute joint (in fact a relative rotation angle) is measured as the relative rotation angle between two markers attached to the joint adiacent elements (Fig. 5). If the angle is trigonometric measured, its values is positive (Fig. 5, a); otherwise, the value is negative (Fig. 5, b) [9].

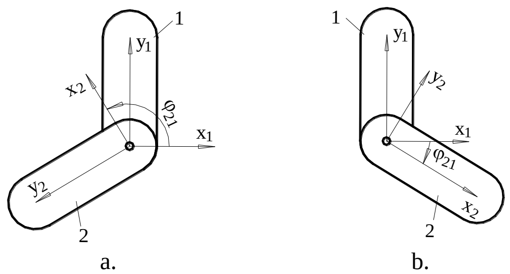

Fig. 5. Joint relative rotation angle measurement

In Fig. 6...14 are presented the relative motion variation diagrams for each link joint, for all the values of eccentricities, from minimum value, e = 0 mm, with the eccentricity step size 1 mm, to the maximum value of the eccentricity for the studied model, e = 24 mm.

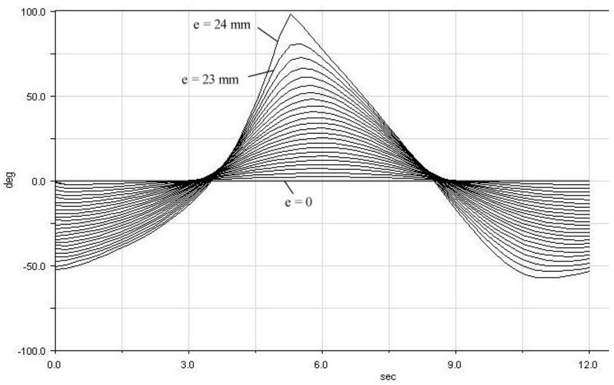

Fig. 6. Relative motion in joints C, D

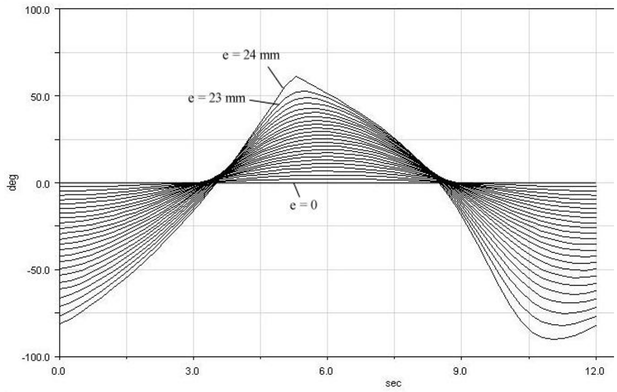

Fig. 7. Relative motion in joints C', D'

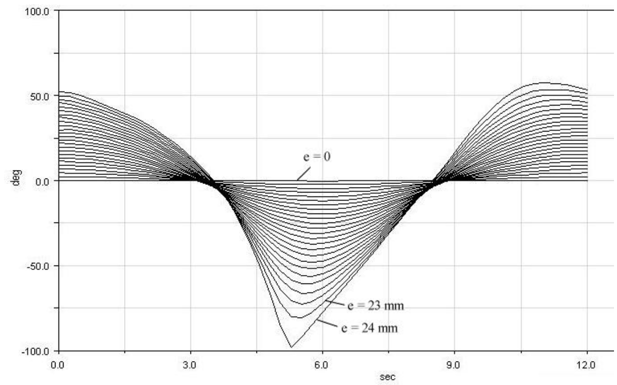

Fig. 8. Relative motion in joints E, F

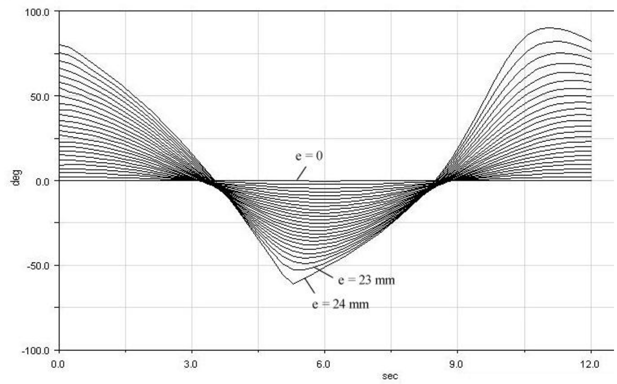

Fig. 9. Relative motion in joints E', F'

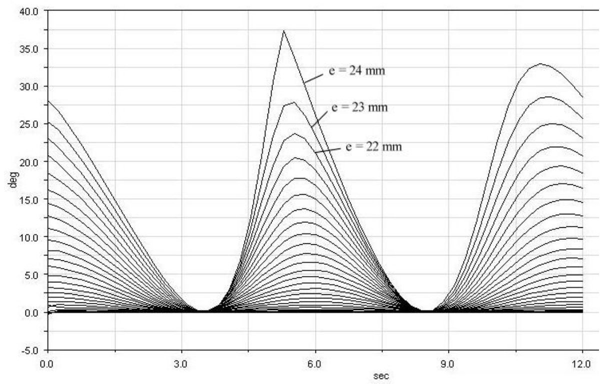

Fig. 10. Relative motion in joint I, J

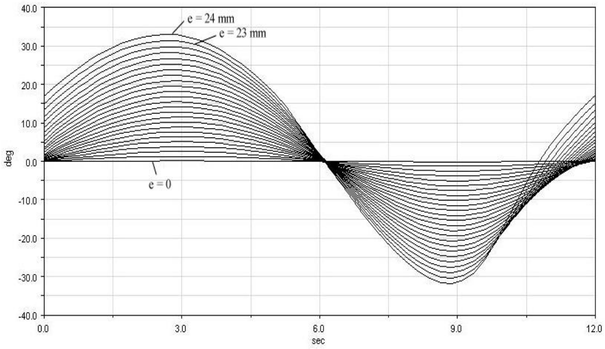

Fig. 11. Relative motion in joints L

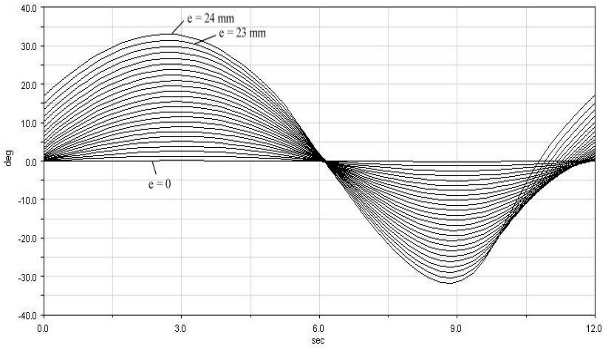

Fig. 12. Relative motion in joints O

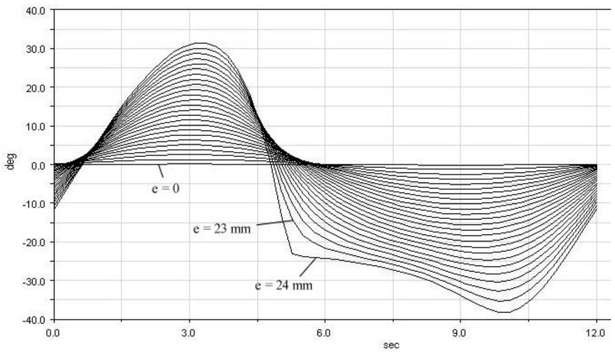

Fig. 13. Relative motion in joints M

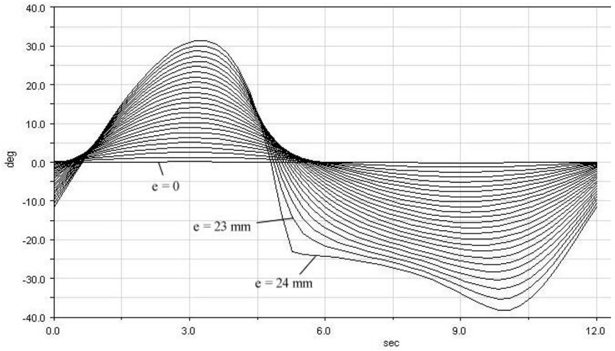

Fig. 14. Relative motion in joints N

V. CONCLUSION

If the excentricity $e = 0$, the relative motion in joints is zero. The relative motion in joints increase with the eccentricity value. The relative motion is maximum for the maximum value of the excentricity for the studied model, $e = 24$ mm. Over this maximum, the the transversal coupling will block itself.

The diagrams, from Fig. 6 to 9, corresponding to the joints C, D, and C' D', respectively E, F, and E', F' have the same pattern, but different values because the corresponding links between the bodies are placed as antiparalelogram configurations.

The diagrams, from Fig. 10 to 14, corresponding to the joints I, and J, L and O, respectively M and O have the same variation, because the corresponding links between the bodies are placed as paralelogram configurations.

Also, these diagrams are useful to know for which values of the eccentricity, the relative motion in joints are good for a construction variant or for another one. For example, if the coupling eccentricity requested during the functioning is low, the intermediary element and links can be replaced with a simplified elastic intermediary element, which includes the links, having a special design; if the requested eccentricity is high, in joints can be placed bearings, to avoid wear.

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