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APLICATION OF DIGITALIZATION AND SIMULATION TO COINING

SKUNCA, M.; LONCAR, D. & MATH, M.

Abstract: *Coining as metalforming technology is known for its technological complexity and phenomenological problems. Practitioned technicians and engineers in the field of coining are the key to the solution of those problems. Development of 3D scanners and FE codes, have enabled the simulation of coining. This includes simulation of details up to scale where flow related phenomenon is tracable. Modification of coin/medal geometry can be made before tooling has been made. Results is significant savings in tool production, allowing technology approved geometry modification, at the moment of artist creation of coin's vers and avers. Paper demonstrates the simulation of coining, using the appropriate FE numerical background that enables the completion of virtual coining.*
Key words: *Coining, 3D scan, FEM, Metalforming, Metal flow*

1. INTRODUCTION

Papers regarding particular technology like coining or minting are scarce (Ike & Plancak, 1998), (Ike, 2005). Reason to this is highly commercial nature of latter technology. Moreover commemorative medals and coins tend to exhibit increase in price (Ladany, 1981). Therefore monetary institutes keep there technology as secret as possible.

High complexity of medal surface within the hight span of ± 0.05 mm in present case, represents a great challenge to FEM modelling. Therefore a 3D FE coining simulation of the golden medal shown in was performed. (Fig. 1)

In order to reduce details (Buffa et al., 2007) have created a model of simplified coin surface geometry. In this paper no geometry simplification was made and simulation was performed over 1/12 of the coin showed as marked area. (Fig. 2)

2. DIGITALIZATION

Digitalization of coin geometry was performed at FSB Zagreb, using ATOS Standard 3D digitizer manufactured by GOM mbh (http://www.gom.com). ATOS measuring head with two CCIR-50Hz camearas 0,8 MPixel, was used with retro

Fig. 1. Croatian red cross medal. Damir Mataušić - Academic sculptor & medallier.

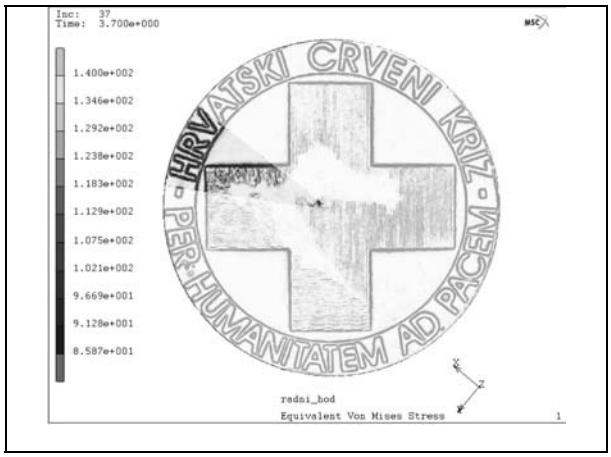

Fig. 2. Digitized medal with 1/12 marked for performing FE simnulation.

reflective illumination. Medal of 37 mm diameter was digitized using available measuring volume of 50x40 mm (one set of lenses: 35 mm projector lens, 50 mm camera lenses, calibration object 50x40 mm).

Implemented photogrametric triangulation technique resulted in high detail scan. Basic steps of digitalisation were as follows; After fixture on base plate, medal was sprayed with penetrant in order to neutralise surface reflection. Calibration and digitalisation were performed in short time. Once point cloud was recorded, ATOS software was used to digitize, process, visualize and export the measured data to Mentat for preprocessing and FE model preparation.

3. PREPROCESSING

3.1 Geometry

Large number of triangles were converted to the geometry of 7e5 surfaces modelling desired geometry. From this number, 3e4 surfaces was chosen to model one twelvth of the coin vers, shown shadowed in Fig. 2. Minimum surface sizes of 0.05 mm were taken as satisfactory modelling of the surface geometry. With a details up to 0.02 mm.

One twelvth of the rigid punch was modelled using 3e4 surfaces. Underneath the punch FE mesh was generated as $1/12^{th}$ of the cylinder of radius 18.3 mm and height 0.68 mm. Divided into mesh of 0.17 mm element size, cylinder is made of 1e5 finite elements. Tip of the cylinder near axis of symmetry was cut off in order to avoid (well known bug) of node penetration trough wedge formed by two intersecting surfaces.

Two wedge plains were used to impose boundary conditions upon 1/12 of the coin.

Flow of the material at the outer edge was restricted by the cylinder surface intersecting wedge planes.

Base plane was modelled as a flat plane, in order to keep the model as small as possible.

In every case of defining rigid surfaces, non-uniform rational B-splines were avoided.