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صفحات بالرسالة

لم ترد بالأصل

Minia University
Faculty of Engineering& Technology

AN INVESTIGATION INTO
THE MECHANICAL PROPERTIES OF METALLIC POWDER COMPACTS

A Thesis

Submitted to the Faculty of Engineering& Technology Minia University, Egypt, for the partial fulfillment of requirements of the M. Sc. Degree in Mechanical Engineering (Production & Design Section)

by

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1994

بسم الله الرحمن الرحيم

TO MY DEAR PARENTS, WIFE, BROTHERS AND SISTERS

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AN INVESTIGATION INTO
THE MECHANICAL PROPERTIES OF METALLIC POWDER COMPACTS

SUMMARY OF THE THESIS

In this work, an investigation of mechanical properties of powder metallurgy (PM) compacts was carried out. As it is well known, deformation and fracture of PM compacts in forming are quite different than these for solid parts. This is due to the presence of pores in the PM compacts, which gives relative density (compact density/theoretical density) less than 100%. The effect of relative density on the behaviour of PM compacts in upsetting was studied.

Two theories characterizing PM compact behaviour during deformation were reviewed :the first developed by Kuhn and Downey (1973) and the second by Hwang and kobayashi (1990). To characterize the deformation of PM compacts, a simple workability index (β_p) is proposed in this study considering the effect of both apparent effective stress of powder material and the hydrostatic (mean) stress components of the powder material proposed index is the same as the stress workability index (β) proposed by Vujovic and Shabaik (1986): more negative value of the index means the addition of a hydrostatic compressive stress to the stress state which leads to a delay fracture; while more positive value of the index means the addition of a hydrostatic

tensile stress to the stress state which leads to speed fracture. When the two theories were applied to the working hypothesis, the Kuhn and Downey theory failed to verify that the effective stress of PM compact having 100% relative density to be the same as that for solid material at the ideal condition ($\mu = 0$, and $\beta = -1$). So, It was suggested that the use of Whang and Kobayashi theory would give more realistic results.

An experimental program was planned and an experimental set up was designed and constructed to carry out the experiments. Compaction in both cold and hot working regimes was carried out to produce PM compacts from Aluminum and Copper powders. Properties of the compacts were measured. Effect of the compaction condition on compact properties was also checked. Then free upsetting of the compacts was preformed between two flat dies and height reduction to fracture were determined.

Hwang and Kobayashi (1990) theory was applied to the experimentally obtained results and constants were calculated. Then workability index (β_p) values were predicted . The results showed a very good agreement with the hypothetical principle and the effect of relative density could be detected with the aid of this parameter. A recommendation of the use of this index for characterizing compsite materials was made.

NOTATIONS

C, n material constants

D_f final specimen diameter

f yield function

H_o initial specimen height

H_f final specimen height

I_2 second invariant of stress deviator

J_1 first invariant of stress tensor

J_2 second invariant of stress tensor

p function of relative density & particle size

P_{cr} critical pressure at density of 100%

R relative density

R_c near-tap density

α function of relative density

β workability index for pore-free materials

σ_t green strength

σ_θ hoop stress component

ε_f strain at fracture

β_p workability index for porous material

ε_{eff} effective strain

ε_r radial strain component

ε_z axial strain component

ε_θ hoop strain component

ν plastic poisson ratio

σ_b yield stress of base material

σ_{eff} effective stress

σ_m hydrostatic stress component

σ_R apparent effective stress of a powder compact

σ_r radial stress component

σ_z axial stress component

P_{D1} compaction pressure