The Calibration of Instrumented Dies for Powder Compaction

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Abstract

The correct computer simulation of the powder compaction stage requires the determination of the elastoplastic parameters which characterize its mechanical behavour. Instrumented dies are frequently used to monitor the longitudinal and radial stress occurring during powder compaction. When strain gages are employed a previous calibration is needed. Many sources of error exist that can lead to the incorrect calibration of the instrumented die. By means of a FEM simulation some of these problems are analysed. The effect of die wall thickness, compression length, and strain location are studied.

Keywords : Instrumented die, strain gage, compaction, FEM simulation

1. Introduction

The characterization of the mechanical behaviour of powder compacts is highly dependent on the knowledge of the elastoplastic parameters. This objective can be obtained by measuring the die tensional stress during powder compaction. In order to measure the radial and circumferential stresses dies are instrumented by means of strain gages. In order to obtain reliable results a good calibration of the system is of a paramount importance. A frequently employed method is the one described by Mosbah [1] in which a coefficient relating radial stress with circumferential deformation is used. In this work the method is checked by means of FEM simulation.

2. Experimental and Results

The circumferential deformation ($\varepsilon_{\theta calibr}$) at the mid height of the die wall is measured under a known radial pressure distribution. ($P_{r calibr}$), what allows to determine the coefficient ($C_{e_{(H)}}$).

$$C_{e_{(H)}} = \frac{P_{r\,calibr}}{\varepsilon_{\theta\,calibr}} \qquad (1)$$

Now, the radial pressure ($P_{r compac.}$) during a compaction can be obtained by multiplying the coefficient by the deformation measured ($\varepsilon_{\theta compac.}$).

$$P_{r\,compac.} = C_{e_{(H)}} \cdot \varepsilon_{\theta\,compac.}$$

In order to check the validity of this type of calibration a simulation by FEM of the circumferential deformation under different types of applied radial pressure has been carried out.

- *Constant:* Uniform pressure; f(x)=60MPa.
- *Linear 1:* Linear distributión; f(x)=a·x+49.5MPa.
- *Linear 2:* Linear distributión; f(x)=a·x+20MPa.
- *Quad. 1:* Quadratic distributión; f(x)=a·x^2+49.5MPa.
- *Quad. 2:* Quadratic distributión; f(x)=a·x^2+20MPa.

In which x is the height of the die wall. The coefficient a has been calculated in order to obtain the same total force on the die wall for all distributions. The wall thickness studied has been 5, 10 and 15 mm and a die diameter of 10mm. Fig.1 the results obtained in the simulation.

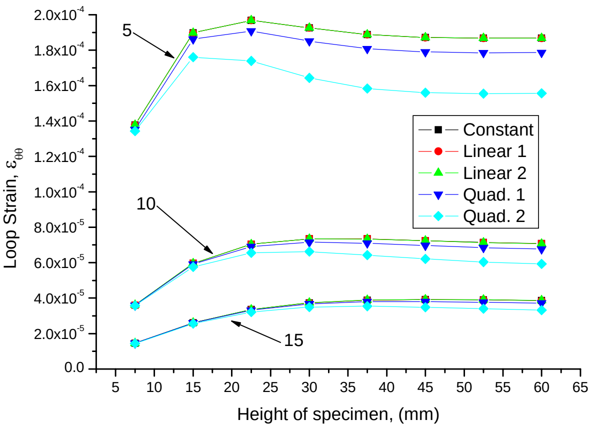

Fig. 1. Loop strain at middle of specimen is caused to several types of radial stress distributions. It is compared to three thickness wall of die.

Fig. 1 shows the strain at the middle of the sample when samples of different height are compacted. This figure also shows the importance of the thickness of the die wall because the sensibility decreases when the thickness increases. But also the dispersion of the deformation increases when the thickness decreases. The deformation at the mid height of the die wall approaches the theoretical value given by Timmoshenko [2] for thick wall tubes. According to these results the calibration method of Mosbah is only valid for linear stress distributions but not when they are quadratic.

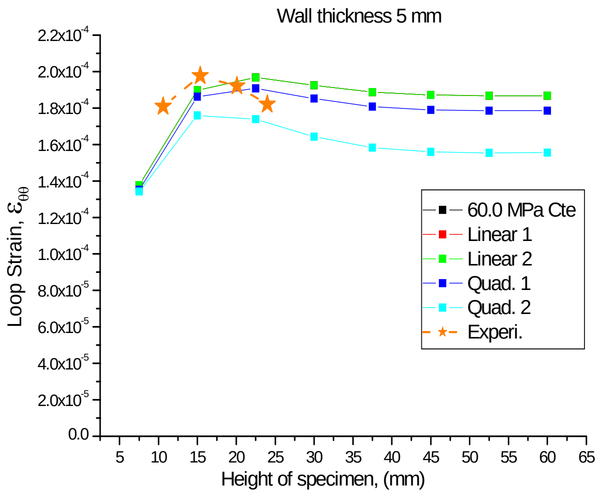

Fig. 2. Loop strain at middle of specimen for several types of radial stress distributions. Experiemental data is also included.

In Fig.2 the results of strain at the middle of samples of different heights for a die of 5mm thick are shown in detail. In this figure the experimental results obtained for the compaction of a zirconia powder are also shown. The agreement between experimental results and FEM simulation are quite good.

3. Summary

Conclusions of this work are:

The wall thickness of the die must be small enough to allow for a good measure sensibility.

Calibration according to the Mosbah method is only reliable if the stress distribution on the die walls is constant or linear.

4. Acknowledgments

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5. References

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