Dynamic Cyclic Bending, Kinetic to Strain Energy, Deceleration Systems.

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Submitted in partial fulfilment of the requirements for the degree of Master of Mechanical Engineering, in the faculty of Engineering, Built Environment and Information Technology, University of Pretoria, Pretoria.

Submitted in July 2004.

Table of Contents

Abstract

During the period of 2001 to 2003 an investigation has been completed at the University of Pretoria, which explored the application of a cyclic plastic bending deceleration system in a dynamic environment. The system consisted of a user-defined number of inline guide rollers, with a metal element threaded in an over and under arrangement. This metal element, when drawn through the rollers, was subjected to bending and reverse bending as the material moved from roller to roller. This action allowed for kinetic energy to be absorbed by means of the kinetic to strain energy transformation mechanism. In the past, this concept and the performance prediction thereof had been proved reliable under quasi-static conditions however, the performance prediction under dynamic conditions remained uncharted.

The study performed at the University of Pretoria produced a dynamic performance prediction model. The various predictions were compared to scale experimental simulations, as well as dynamic finite element analyses. The comparison between the predictions, (mathematical prediction, experimental model results and the finite element analyses) proved to be extremely accurate and consistent. A full-scale evaluation would be the next remaining step to evaluate the system's suitability for future application in industry.

Opsomming

Gedurende die periode van 2001 tot 2003 was 'n studie afgehandel by die Universiteit van Pretoria, ten einde die toepassing van sikliese plastiese buigings vertraging sisteme, onder dinamiese toestande. Die sisteme behels n gebruiker-gespesifiseerde hoeveelheid staal rollers wat inlyn langs mekaar gerangskik is. 'n Staal strook word tussen die rollers deur gevleg. Wanneer die strook aan die een punt tussen die rollers deur gesleep word, buig die strook herhaaldelik om die spoor tussen die rollers deur te volg. Hierdie buigings proses absorbeer energie deur middle van omskakeling van kinetiese na vervormings energie. In die verlede is n model ontwikkel om briekkrag lewering onder kwasi-satiese toestande betroubaar te voorspel. 'n Dinamiese lewerings model is nog nie ontwikkel nie.

Tydens die Universiteit van Pretoria se ondersoek is n dinamiese model ontwikkel en wiskundig geprogrammeer, wat dan die briekkrag lewering van die sisteem onder dinamiese toestande voorspel. Hierdie wiskundige voorspellings is dan vergelyk meet 'n afgeskaalde eksperimentele model wat gebou is by die Universiteit van Pretoria, asook 'n dinamiese eindige element analise van die model. Die vergelyking van al drie resultate, (wiskundige model, eksperimentele opstelling en die eindige element analise) was baie goed en herhaalbaar. Die volgende logiese ontwikkelings stadium in voorbereiding vir industriële teopassing van hierdie sisteme, sal dus volskalse toetse wees.

Acknowledgements

I wish to thank SIMRAC who financially supported this study.

I would like to thank all the persons involved in this project. I would especially like to thank my promoter from the University of Pretoria, Mr N.D.L. Burger, for his guidance and advice; Mr R. Ottermann for managing the finances of the project; Mr T. Blom for his assistance and advice in the data capturing section of the project and also his general insight; Mr P.R. de Wet from the University of Pretoria, and Mr C. Stone from MSC Africa, for their expertise and help with the FEM analysis, and Mr A. von Wieliegh who helped with the model building and modifications.

In addition my thanks goes out to all the technical personnel of the University of Pretoria who contributed to the model building and solving of problems, which were encountered. Lastly, I would like to thank all the people who put up with the endless conversation concerning the topic, and patiently offered their valued insights and opinions.

List of symbols

a	Acceleration. (m/s^2)
D	Coefficient in stress strain relation. (Mild steel characteristic)
F	Force applied by deceleration system (N)
FEM	Finite Element Method
FEML	Finite Element Model
FEA	Finite Element Analysis
Gs	Gravitational acceleration. ($9.8m/s^2$)
M	Mass of cage. (kg)
Msec	Millisecond. (0.001sec)
n	Number of rollers in roller assembly.
p	Exponent in stress strain relation.
R	Roller radius (m)
t	Strip thickness (m)
w	Roller width (m)
σ_{yd}	Dynamic yield stress approximation. (Mpa)
σ_{yo}	Static yield stress of material. (Mpa)
ε'	Strain rate at the point of plastic deformation. (/s)
ε_x	Strain at distance y from neutral plane.
y	Distance from neutral plane. (m)
ρ	Curvature radius of neutral plane. (m)

List of Figures

List of Equations

List of Tables