Dynamic Analysis on a Belt Driving Starter and Generator System

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I. Introduction
II. Construction of a BSG System
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IV. Summary

FEAD: front end accessory belt drive
BSG: belt driven starter and generator
I. Introduction

- Environment protection and energy safety

- Literature Review

- Advantage of BSG
  - idling stop
  - braking energy regeneration
  - with small modification to a FEAD
II. Construction of a BSG system

- A FEAD system

- ISG selection

\[ P_1 = \frac{M_Q n_Q}{9550} \]
\[ P_2 = \frac{I_Q \omega^2}{\Delta t} \]
\[ P \geq \max(P_1, P_2) \]

- Twin-Tensioner

- BSG Configuration

![Diagram of BSG Configuration]
III. Modeling and Simulations

- ADAMS/Machinery is employed to build a model for the concept BSG system.

- Modeling

\[
[k] = \frac{AE}{L} \begin{bmatrix}
1 & 0 & 0 & -1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
\end{bmatrix} + \frac{EI}{L^3} \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 6L & 4L^2 & 0 & -6L & 2L^2 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & -12 & -6L & 0 & 12 & -6L \\
0 & 6L & 2L^2 & 0 & -6L & 4L^2 \\
\end{bmatrix}
\]
III. Modeling and Simulations

- Simulation
  - Operational stages: motor cranking, engine cranking and transition
  - A classic sensor and a simulation script is defined, thus to enable one running to cover all the three stages.
  - For each stage, the operational parameters are defined by referring to literature and trial and error.
  - Validations are carried out by repeating an examples given in literature.
Results and discussions

Dynamic behaviors of the BSG system are investigated by checking various performance parameters:
- belt tension force,
- belt vibration,
- tensioners’ motion,
- ……

Observations:
- For quite a few belt spans, belt tension force in the transition stage can be much higher than its counterparts at other two stages.
- For most belt spans, belt tension force at motor cranking is higher than the force at engine cranking. But the situation is different with other belt spans.
During motor cranking, most belt spans suffer from higher transversal vibration than in the engine cranking stage. The difference can be very big.
Results and discussions

- The motion of both tensioner arms is very small, which indicates that the necessity of reducing the torsional spring.
- The two tensioner arms move towards different directions.
Results and discussions

- Both tensioners bear higher torque during motor cranking than during engine cranking.
- For each of the tensioner arm, the torque is more stable during engine cranking than in motor cranking.
Results and discussions

- The angular velocities of the accessory pulleys increase smoothly and slowing with time, except in a very short time adjacent to motor cranking.
- The velocity and its variation of the ISG pulley is bigger than those of others.
IV. Summary

- A twin-tensioner, an ISG motor and a static-tension are chosen or adopted to converse a FEAD system into a BSG system.
- Modeling and simulations are carried out in ADAMS on the concept BSG. Some helpful observations are thus obtained.
- This tentative work is a start of further analysis and optimization design on a BSG.
Thank you!