SULTAN QABOOS UNIVERSITY

College of Engineering

Department of Mechanical and Industrial Engineering

Final Year Project II – MEIE5194

Executive Summary

Design and Fabrication of an Experimental Setup to Investigate Fatigue Failure in Drilling Pipes

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Abstract

This project is aiming to build up an experimental setup that simulates the oil wells drilling mechanisms to investigate fatigue failure of drill-string. The proposed setup is about subjecting the drill-string to torsional and bending loads by rotating it at some given number of revolutions per minute. The rotational mechanism of the tested drilling-string is, in principle, to mimic the rotary drilling operation. In the real case, the drill-string is attached to a drilling bit which cuts through a rock formation. Resistivity of the formation is simulated through designing and building braking mechanism. In order to maintain concentricity and provide adequate stabilization and guiding the drill-string without imposing excessive torque, support mechanism has been designed. Therefore, to have such a robust setup, the design process has been conducted in two main stages: the concept generation and evaluation, and the embodiment design. The embodiment design has done successfully during the first semester. Next, efforts were put to fabricate the set-up during the second semester, where important decisions were taken in terms of manufacturing the setup. Once the setup was assembled, the drill-string specimen was tested and the number of operating cycle was be investigated. A comprehensive finite element modeling and analysis was developed to obtain the natural frequencies of the rotating test specimens, and consequently, their critical speeds.

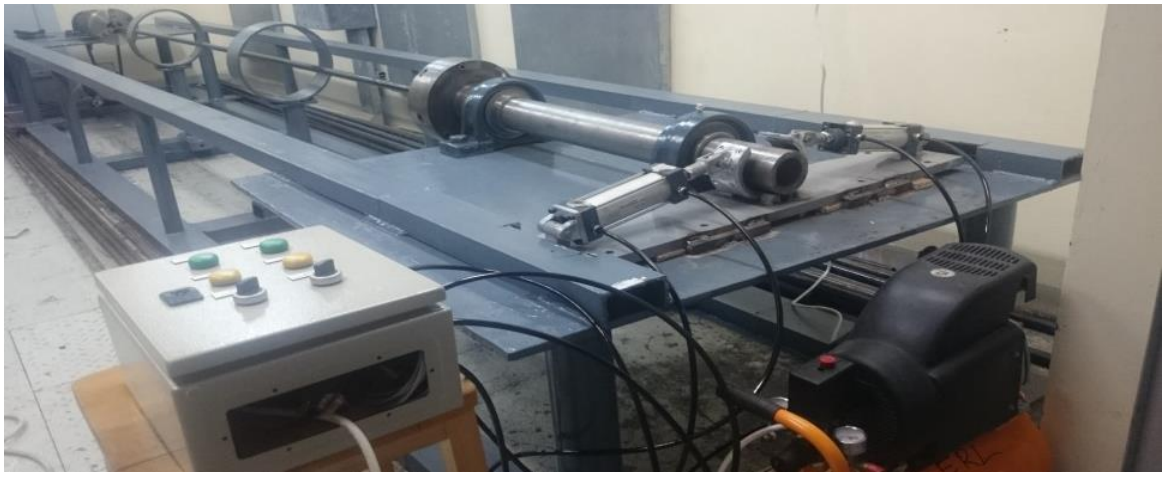

Figure 1: Testing Set-Up

Rotation Mechanism:

Rotation mechanism is a mechanism responsible of rotating the test specimen as well as creating its lateral vibration due to its center of gravity. It consists of housing pipes, flanges, chucks, bearings, motor, pulleys with belts and a controller. The figure below demonstrates each of these components.

A 12-hp motor of a maximum speed of 1200rpm is controlled by a speed regulator and used to provide rotational energy. Rotational energy is transmitted through a pulleys-belts system to the housing pipe. The housing pipe is supported by means of two pillow bearings. At one end of the housing pipe, a flange is connected through threaded fitting, and a chuck is bolted to the flange. Finally, the chuck's jaws are tightened around the test specimen from its both ends, thus, resulting on specimen's rotation.

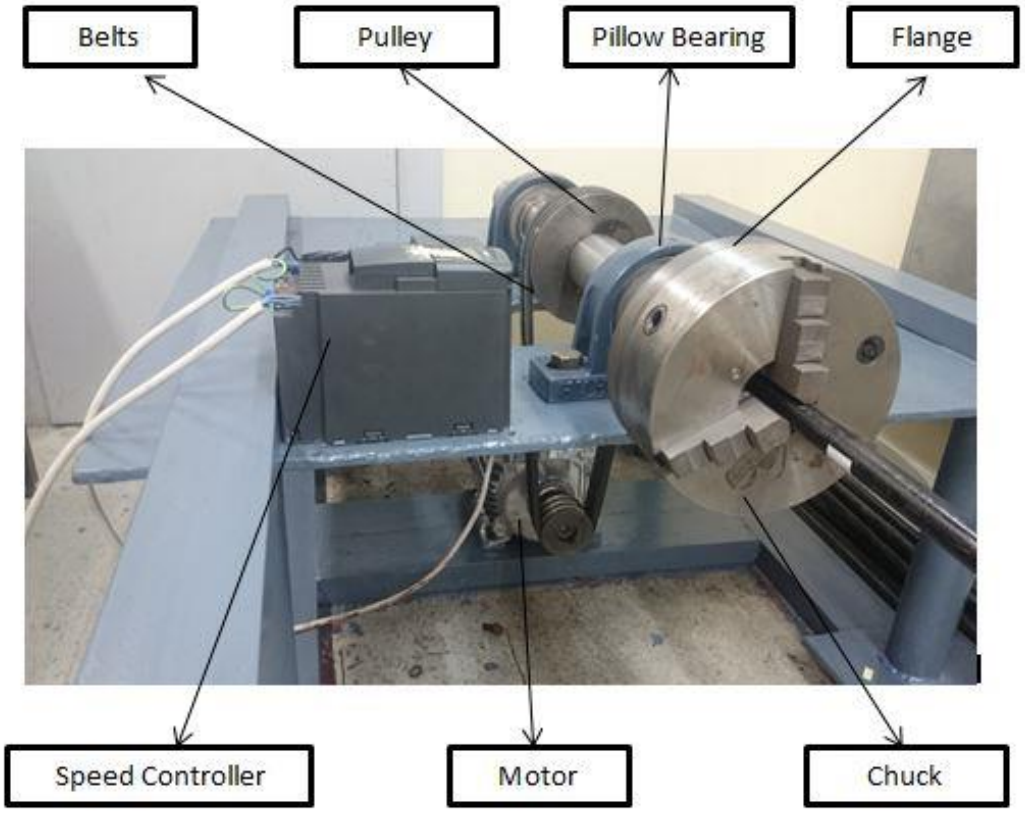

Figure 2: Rotation Mechanism

Braking Mechanism:

The braking mechanism is utilized to simulate the drill bit-rock formation interaction as well as the stick-slip phenomena in drilling pipes, thus, creating torsional vibration to the specimen. The braking mechanism mainly consists of two pneumatic actuators, two breaking pads, compressor and actuator's control unit. The figure below demonstrates each of these components.

Basically, the principle of this mechanism is to apply an alternating resisting torque on the rotating housing pipe such that its speed decreases gradually, and subsequently, reduces the specimen's rotational speed at that end.

A compressor was used to supply pressurized air to the pneumatic actuators. Moreover, the whole mechanism is controlled by the control unit, where the brake can be applied automatically or manually. Beside actuator's valves, the control unit contains a control system which allows the user to specify the desired braking time. Finally, the 10cm stroke pneumatic actuators are used to push the ceramic composites braking pads against the rotating housing pipe with a maximum pressure of 8 bars adjusted as the compressor's output pressure.

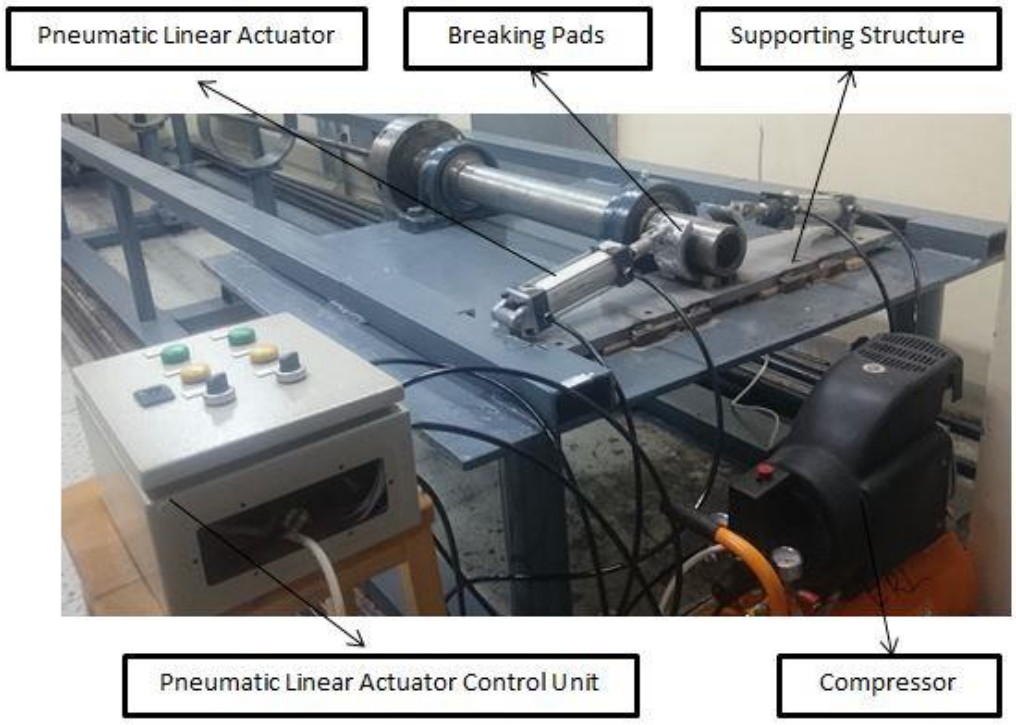

Figure 3: Braking Mechanism