KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

MECHANICAL ENGINEERING LAB IV

GROUP N

EXPERIMENT: WHIRLING SPEED OF AN UNLOADED SHAFT WITH FIXED-FIXED ENDS

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OBJECTIVES

To investigate the whirling speed of an unloaded shaft with fixed-fixed ends.

APPARATUS

1. Control unit
2. Shaft of different lengths and diameters
3. Vernier calipers
4. Whirling apparatus

THEORY

If the speed of an unloaded elastic shaft is gradually increased, it will be observed that at a certain speed the deflection of the shaft becomes very large and a violent instability will occur. The shaft deflects into a single bow and whirls like a skipping rope. If the speed is maintained the deflection will become so large that the shaft will be fractured. However, if this speed is quickly run through, the shaft will again become almost straight. At some other speed the same phenomenon will occur with the difference that, at this speed the shaft will bend into two bows and so son. Such speeds are called whirling or critical speed.

PROCEDURE

1. Obtain a 3mm diameter, 100mm long sample. Check the sample to make sure it is neither bent nor deformed.
2. Ensure you have a pair of the 3mm collets.
3. Set up the unit as outlined by the manufacturer's manual.
4. Once the sample is in place and the guard is closed, turn on the control box ensuring that the speed controller is set to its lowest speed, OFF.
5. Start the motor and test specimen rotating slowly.
6. Gradually turn the motor speed up until the test specimen starts to whirl. Record the 1st whirling speed. The precise point at which the specimen starts to whirl can be difficult to judge.
7. If necessary, reduce the speed and increase it again in order to verify the 1st whirling speed. An approximate value may be taken.
8. Continue increasing the speed of rotation, the sample should straighten out again once the vibrations have stabilized past the whirling range.
9. Speed the sample up further until the 2nd whirling speed is achieved. Record this value. Again, reduce and increase the speed a number of times to verify this whirling speed and take an approximate value.
10. Reduce the speed down to zero and check the sample.
11. Repeat the above procedure for different samples:

Diameter	Length
5mm	100mm
6mm	100mm
3mm	80mm
5mm	80mm
6mm	80mm

12. Calculate average of results to use as a comparison against theoretical values.
13. Once testing is finished ensure that the power to the motor is turned off.

EXPERIMENTAL SETUP

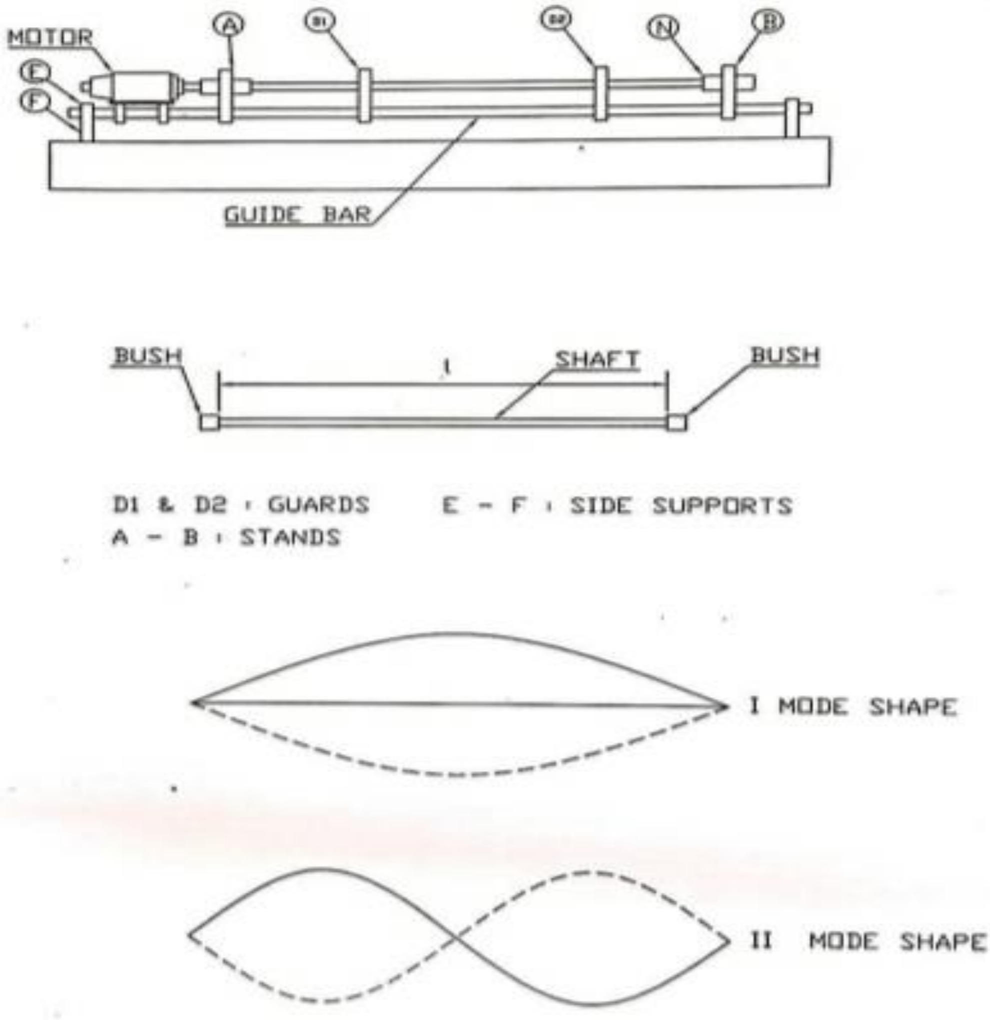

FIGURE-9

RESULTS

Diameter (mm)	Length (mm)	1st Mode (rpm)	2nd Mode (rpm)	Whirl Speed ratio (N2/N1)
3	100	920	2548	2.77
5	100	1184	3780	3.19
6	100	1435	3691	2.57

OBSERVATION

The first and second modes of vibration was observed on 3mm, 5mm and 6mm diameter shafts with lengths of 100cm.

PRECAUTIONS

1. The elastic behaviour of the shaft material changes a little after testing it for a few times and it is therefore advised to use fresh samples for subsequent experiments.

2. Appropriate collets were used for their respective samples to ensure that samples were firmly fixed into the coupling and chuck and the sliding bearing at the tail end.

3. Samples were not tested at speeds beyond the observed 2nd mode of whirl in order not to damage them.

CONCLUSION

The difference between actual speeds and theoretical speeds may have been caused by the following:

1. Presence of damping at the end bearings.

2. The end conditions were not as exact as assumed in theory.

3. Lack of knowledge of the exact properties of the shaft material.