Title

Investigating the speed of pulses along a strectched spring

Objective

This experiment is to measure the speed of pulses along a stretched spring and compare it with the thearetical value.

Apparatus

Long spring x 1
Stop-watch x 1
Newton balance(scale 0-10N) x 1
Slinky spring x 1
Metre rule or measuring tape x 1
Compression balance(scale 0-2kg) x 1

Theory

A wave, which can transfer energy from one point to another, consists of a disturbance moving from a source to sorrounding places.
There are two types of progressive wave: transverse wave and longitudinal wave. The direction associated with the disturbance is at right angles to the direction of travel by the transverse wave. The disturbance is in the same direction as that of the longitudinal wave. The pulses of this two type of waves can be sent along a slinky spring. In this experiment, both the transverse and longitudinal pulses are generated bt\y the hand, and the speed of the transvers pulses along the spring c can be found by: $c = \sqrt{\frac{T}{\mu}}$ whereT is the tension of the spring and μ is the mass per unit length of the spring.

Procedure

1. A long spring was stretched on the floor over a distance of about 10m. The two ends of the long spring was marked with chalk.
2. A long spring along the spring was sent and the time of travel from one end to the other and back again was measured. Then the pulse was calculated.
3. The tension T of the sping was measured by using a Newton balance. The mass m of the spring was measured. The mass per unit length μ of the spring was found.
4. The theoretical value of the pulse speed was calculated by using the formula

$$c = \sqrt{\frac{T}{\mu}}.$$

5. The above steps serveral times was repeated by using different lengths of the spring.
6. The experment was repeated for longitudinal pulses along a slinky spring.

Results

Tabulate the results for transverse pulses as follows:

Stretched length/m	9.5	11.2	12.7	13.4	14.8	16.0
Time of travel/s	2.6	2.3	2.2	2.1	2.1	2.1
Measured pulse speed/m s^{-1}	7.308	9.739	11.545	12.762	14.095	15.238
Tension T/N	6.5	10.0	12.5	15.0	17.5	20.0
Mass per unit length μ/kg m^{-1}	0.130	0.110	0.097	0.092	0.083	0.077
Theoretical pulse speed $c = \sqrt{\frac{T}{\mu}}$ /m s^{-1}	7.071	9.535	11.352	12.769	14.520	16.116
% difference between the measured and theoretical pulse speeds	3.243	2.095	1.672	0.05485	3.0153	5.762

Mass of spring = 1.23 kg

Conclution

The theoretical value of $c = \sqrt{\frac{T}{\mu}}$ is nearly the same with the measured of the pulse speed. Hence, we can conclude the formula $c = \sqrt{\frac{T}{\mu}}$ is established.

Discussion

The result of measured and theorectical transverse pulse speeds are very close. There are only a few percent difference between them..
Due to the medium of the wave is remain unchange, the speed should be remain constant when the pulse travel along the spring.

Source of error

First, the reaction time is presenced as we use the stop watch to count the time of travel. It would be affect the calculation of the measured pulse speeed as the time taken is not exactly accurate.
Second, the spring may not be evently distributed. This would affect the calculation of the mass and the length. Thus, μ may not be accurately calculated.
Third, there is a measurement error because of we correct the answers to 3 or 4 decimal places. It would affect the calculation.
Lastly, there is a systematic error as the scaler of the equipment is not enough to show the more accurate result. It would affect the counting of the length and the weight of the spring.

Improvement

1. Use another electronic equipment to count the time to low the error of time taken.
2. Repeat the experiment more time to reduce radom error.
3. To change a new spring to make the result μ more accurate.
4. To change the equipment that can reduce the systematic error.