A study on modeling and measuring method of tire weight imbalances and improving reliability (ICCAS 2004)

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Abstract: I propose a modeling of a mechanism for weight fire uniformity measurement of a tire and a way I interpret a Sampling signal by Loadcell through an analysis, and to measure fire uniformity in this study. Correct a weight fire uniformity measurement was possible through the production of conversion and influence factor of a signal with a basis with the model who was an oscillation mechanics enemy.

Keywords: dynamic unbalance, Tire, static & couple, uniformity, load cell

1. INTRODUCTION

A car tire vibrates in a revolution city, but can try to classify it by having obeyed the cause besides a tire like oscillation that the cause poured into a tire oneself and I bend unique oscillation number on a design of etc car.

Tire own oscillation is large, and an oscillation to have been based on weight fire uniformity and a number to divide into An elasticity fire uniformity of the structure of the tire and an oscillation to have obeyed force uniformity are.

Because I am going to measure an oscillation to have been based on tire weight fire uniformity in this study, the cause of an oscillation assumes by appearing by unbalance of the mass which occurred according to the distribution that tire re-question fire uniformity did.

The aquire does the signal to Loadcell Sensor the mass to be distributed lest it should do the homogeneity at the tire FFT analysis and removes DC ingredient. They draw the sine wave to happen according to a rotation vibration. We do Spindle revision with Scale adjustment and calculate an influence Factor. We studied an algorithm development with a system design which measures the discontent of the tire...

2 . OSCILLATION MODEL OF TIRE

2.1 The vibration factor of a car tire

According to an aspect of an oscillation to have been based on weight unbalance of a tire, I can classify it into an oscillation of vertical course and an oscillation of a level direction like Fig.1

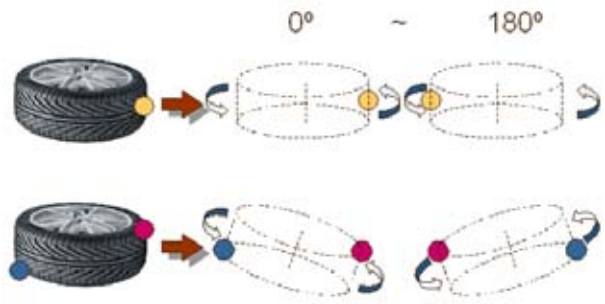


Fig.1 An oscillation to have obeyed a situation of unbalance

These two oscillation appears by the structure that unbalance mass was arranged at, and a part marked by a conspicuous color in a Fig on the tire face means unbalance mass.

If I am the only, and unbalance mass is at the middle of tire Tread, I have an oscillation of vertical course of a tire and have an oscillation of a level direction if unbalance mass is built over Tread with Diagonal line in the center of a tire.

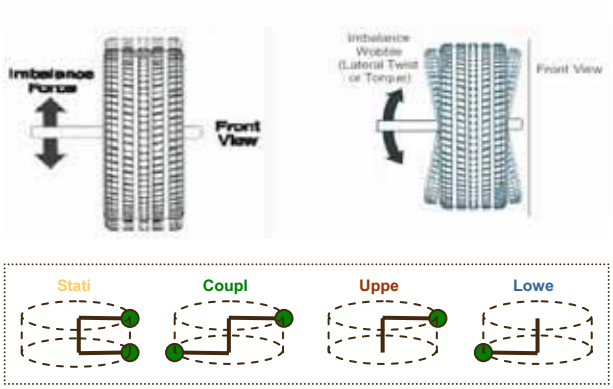


Fig. 2 A bell direction and width direction vibration form

2.2 A vibration modelling of a tire Dynamic characteristic

As for the oscillation of a vertical direction, force S of a straight line direction generates a tire to the center if I mark vertical course and an

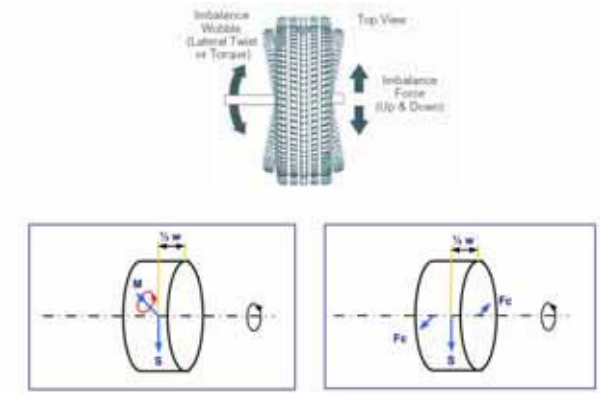


Fig.3 A mechanics enemy modeling of an oscillation

oscillation of a level direction to have been based on mass unbalance of a tire with mechanics a few model, and, as for the oscillation of a level direction, revolution Moment M occurs in the center of a tire
I think here because two force Fc of a straight line direction that size is same as for the Moment M works.
Force S occurs in Fig 3. according to unbalance mass size in a S direction, and it is Static Unbalance (static unbalance), and a tire does it because he force appears in the state that does not turn and it is Couple Unbalnce (couple of forces unbalance) and does it because two force Fc which were based each other on unbalance mass in a diagonal direction achieves a counterpart, and MoMenTeu M occurs in the tire center.
Only a Static Unbalacne component appears in the state that a tire is static (a Black State), but sings this two Dynamic Unbalance (dynamic unbalance) in total because Static and Couple Unbalnce appear in a dynamic state (a revolution state) at the same time.

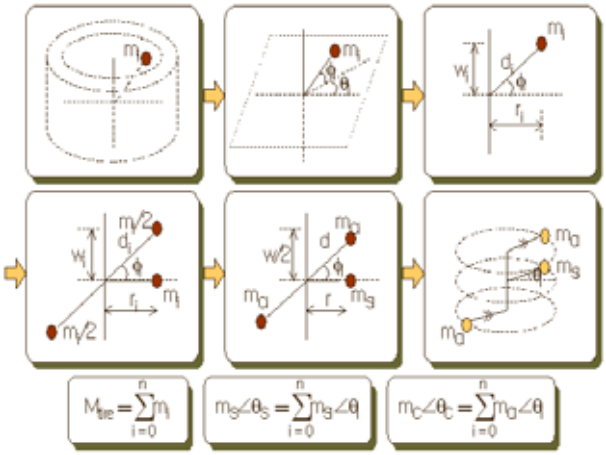


Fig. 4 A mechanics enemy conversion of mass

I can think that it was achieved a tire with a great number of small mass (point mass). An expression is possible with a thing with as if three mass in three circumference quotients if I convert 1m ass in any situation into a way as above (The meaning that an expression was possible results in the result that two cases are physically same)
These three circumference is located in a cylinder quotient doing the upper part and Tire Bead of a base (I am correct, circumference of Rim) to a circumference. If every each circumference merges all mass with a circumference quotient of the all point mass this 3 which a tire is composed of to listen to after a conversion, it is converted into each sweet one point mass on three circumferences. The stomach and the mass Mc which are 2 buildings on the following circumference are Couple unbalance mass, and Ms is Static unbalance mass at this time.

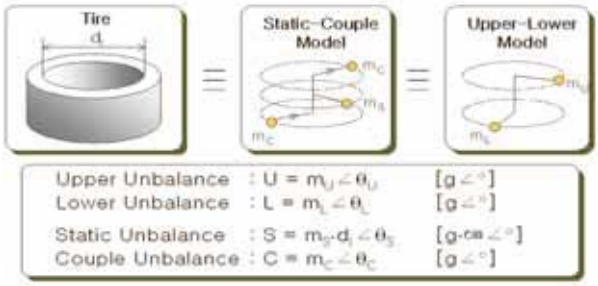


Fig.5 A correlation of each fire uniformity

As the result an indication is possible, and it is a Static-Couple model, and a mass distribution of a tire makes this expression model three mass. A number to express the Upper-Lower model which is too other model of a tire mass distribution is next
This model is a way to express with the stomach and each one point mass on two following circumferences. I use an Upper-Lower style together with a Static-Couple style when I display a measurement result of a tire and can display size and an angle of unbalance mass.
The mass distribution model of a tire knew that an expression was possible with Static-Couple or an Upper-Lower model, but now I leave this and try to know relationship between models.

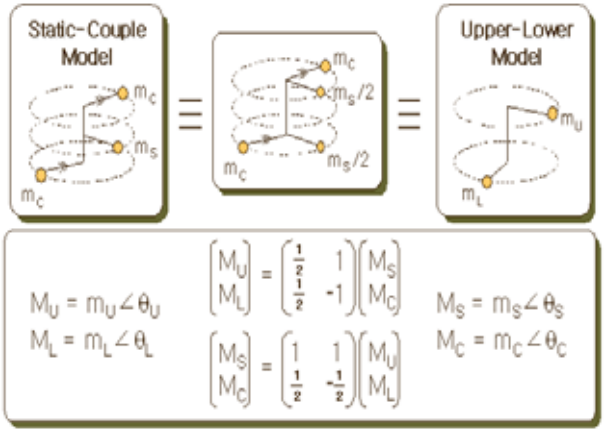


Fig.6 A model conversion

A conversion is possible each other, and, as for these two model, he numerical formula relationship has simple relationship like the stomach through Fig 5. and the same conversion process.
These two model displays unbalance Ryang of the same tire finally, but physical meaning is different.
I know a sheep of an oscillation of vertical course and an oscillation of vertical course in case of Static-Couple model, but I am advantageous, and compare it to this, and a selection does the revision mass which sticks to Rim in order to revise unbalance, but a case of an Upper-Lower model is useful.

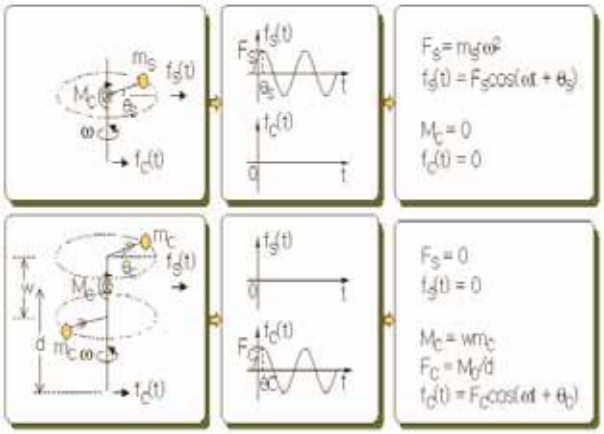


Fig.7 The expression of the unbalance

It is hard, but if a sensor measuring force to have been based on unbalance mass of a Static-Couple model is, a wavelength type of he signal appears with a sine wave shape according to a tire turning, and a frequency of this sine wave is in proportion to a revolution speed, and a seismic amplitude does proportion g in a revolution speed and unbalance mass practically.Fig.7 cover the numerical formula enemy relationship with me.

If there is this measurement way, a measurement analysis is very easy, but, as for this way, it is hard and carries out measurement by a roundabout measurement way in a realistic problem.

3. configuration and measurement algorithm

3.1 Mechanism configuration

As for the measurement mechanism of this system, it is received a wavelength type from two force sensors installed under a tire, and equation of the force (Fc) which force to occur in a tire directly (F and M) and the sensor which are measured indirectly detect seems to be a Fig Lesson 8.

This relationship is different from this in the real as an ideal way, and a calibration process finding out the correct relationship is necessary.The first part includes the paper title, authors' name, abstract, and keywords. All fonts must be in Times New Roman, and the font size of the title, authors' name, affiliation, abstract, and keywords are bold 11pt, 10pt, 9pt, 9pt, and 9pt, respectively.

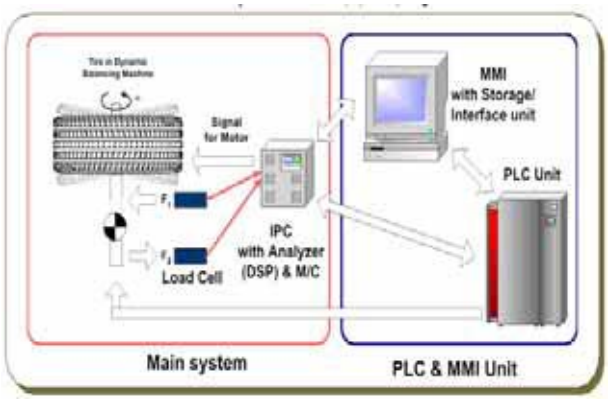


Fig.8 Mechanism configuration

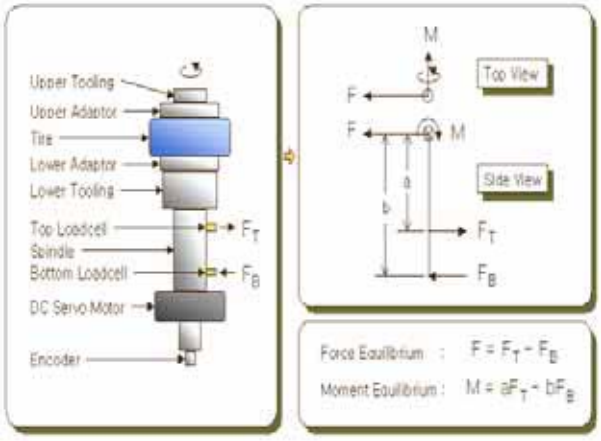


Fig.9 Measurement system configuration

3.2 A production process of weight unbalance

I acquire a signal to have been said on a detection and remove the offset which is a DC component (a Y JeolPyeon price) from the upper part and a force sensor of a base if I express an analysis process of weight unbalance

Apply does the later influence factor that a scale regulation and the spin field where an extraction is later revised the sine wave component which obeyed the revolution oscillation that is the first component through frequency interpretation and calculates unbalance of a tire.

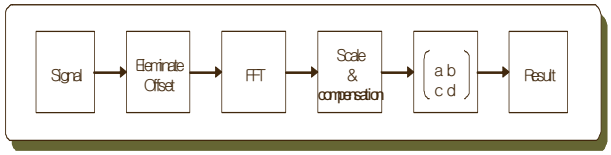


Fig.10 Unbalance interpretation process

3.3 Count influence production of upper and lower Loadcell

Two Loadcell is located in upper and lower with a mechanism enemy in order to measure size of an oscillation. It is transmitted an oscillation of a fixed quantity to the Loadcell which it is not for this means what I classify weight fire uniformity explained in the stomach into Upper and Lower and had to measure, and weight fire uniformity only of upper part side to give an oscillation to only Loadcell of the upper part, and was installed in a base, On the contrary, because nonetheless it is given an oscillation to upper part side, weight fire uniformity of a base side goes bad, and find must do count influence with correlation relationship of an oscillation I do it, and to be happened in Loadcell. Influence factor is to have shown relationship with an ability detected in unbalance mass and a measurement sensor of a tire as count linear proportion.

If unbalance mass and relationship of a detected ability are expressed with linear simultaneous equations, and it is expressed a matrix equation, it seems to be Lesson Fig.11

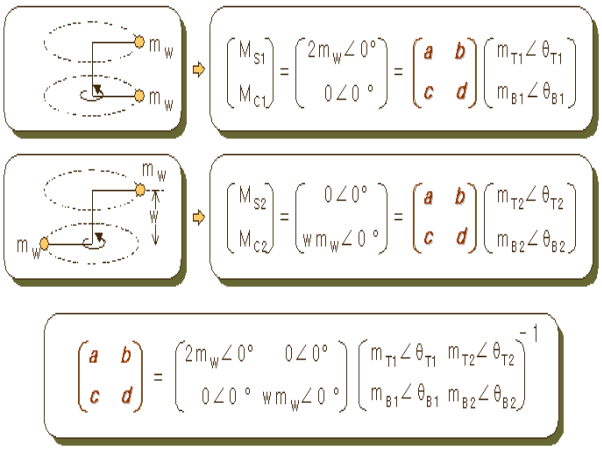


Fig.11 Count influence for signal interpretation of upper and lower Loadcell

3.4 Signal interpretation of weight unbalance

An oscillation to have obeyed dirt happened weight unbalance

for a tire to turn like what was explained at the front is transmitted to Loadcell installed in the upper part and a base with the last enemy.
Because mass fire uniformity is expressed usually to the high-speed data which I let you turn and acquire 1024 sampling data per 1 round per minute, and was acquired with one point with the 200~600 rpm that a number is the revolution speed that there is to generate an oscillation, it is shown regular sine wave.

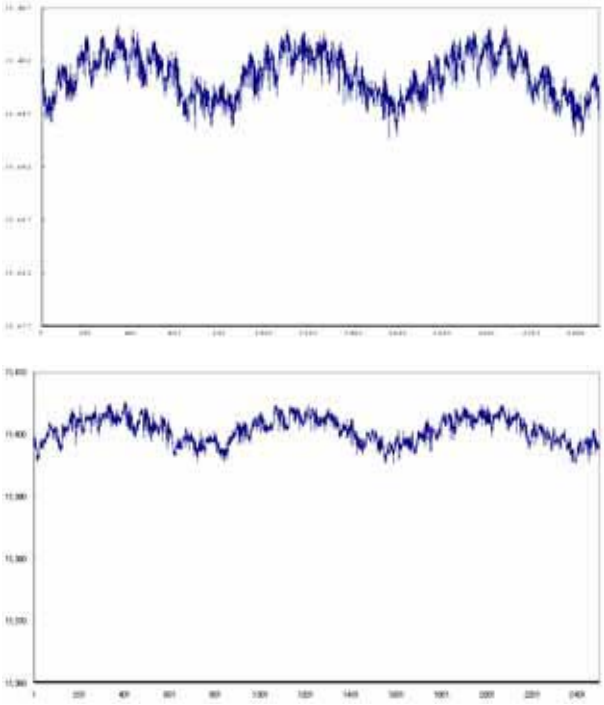
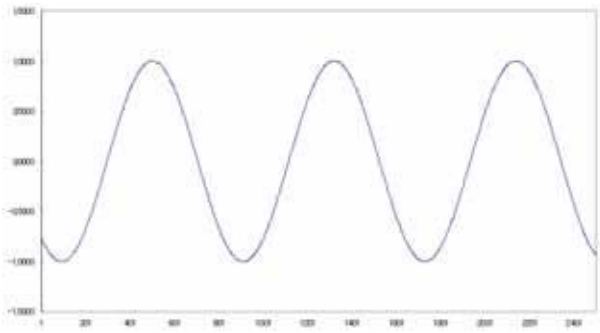


Fig.12 Upper and a lower Loadcell wave form

A DC component elimination and the scale revision that I calculated a high tide group in the first, and was adjusted by actual weight that were a 1 debtor established anger and a quotient did 1024 acquired sampling data by a FFT(Fast Fourier Transfom) formula, and an application calculated count influence in a Loadcell price and calculated the last weight unbalance.

$$X(k) = \sum_{n=0}^{N/2-1} x(2n)\, W_{N/2}^{kn} + W_N^k \sum_{n=0}^{N/2-1} x(2n+1)\, W_{N/2}^{nk},\ k = 0, \ldots, N-1$$



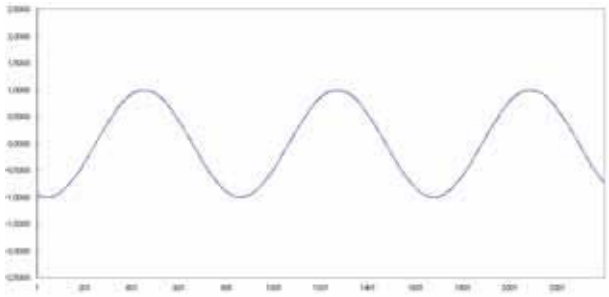


Fig.13 The first harmonic component which was based on FFT

It was not mentioned in this paper, but it is organization enemy configuration besides this, and a dwarf The one-sided mind of the lim extraction and revision algorithm are imperative constructs of correct unbalance measurement, too.

4. CONCLUSION

I knew that an oscillation to have obeyed an oscillation and the mass unbalance which there were two factors on a large scale, and obeyed force uniformity of a tire was in the oscillation occurrence cause of a tire.
Development did the measurement algorithm which a number was to calculate interpretation of an oscillation to have been based on mass unbalance and size of mass unbalance and a system in this study.
Also, I was not inferior, and a number to confirm an important factor was in a performance index of the system that precision of a mechanism read actualization of measurement algorithm.

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