101年大學部國際交流甄選專題成果展

A Study on the Influence Factors of the Carrier in a Planetary Gear Drive

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Introduction

The carrier in a planetary gear drive with load when the planetary gear works. If the rigidity on input and output of the carrier are different, the carrier will not only get a displacement, but have a different deformation between the both ends at the carrier, and that will cause a distortion on the carrier.

Goal

When the planetary gear system works, there is a load generated and then transfer the load to the carrier by the planetary gear. But there might have many planetary gears in the carrier, these gears withstand the load will not only cause the displacement generated at the gears, but transfer the load to the carrier and cause the carrier deform, the deformation on the carrier will change the relation between all the planetary gears. So there are three kinds of relative deformation in the planetary gear system can be inferred: sun gear to planetary gear, ring gear to planetary and two different planetary gears. The main factor about the interaction between the two planetary gears is the deformation of carrier. Today, it is necessary that investigating the deformation of the carrier first if we want to use the “Influence Coefficient Method” to analyze the relation between the loading and deformation of the planetary gears, hence we can find the relation between the loading and deformation of the carrier by this analysis.

Influence Coefficient Method

“Influence Coefficient Method” is a method of calculation about finding a matrix of influence coefficients from observing the interaction between loading and deformation. Such as Fig.1, the 1 × r matrix of P element stand for stresses, the 1 × r matrix of H element stand for the amount of deformation and the r × r matrix of f element stand for the influence coefficients.

$$\begin{bmatrix} f_{11} & \cdots & f_{1j} & \cdots & f_{1r} \\ \vdots & \ddots & \vdots & \vdots & \vdots \\ f_{k1} & \cdots & f_{kj} & \cdots & f_{kr} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ f_{r1} & \cdots & f_{rj} & \cdots & f_{rr} \end{bmatrix} \begin{bmatrix} P_1 \\ \vdots \\ P_j \\ \vdots \\ P_r \end{bmatrix} = \begin{bmatrix} H_1 \\ \vdots \\ H_j \\ \vdots \\ H_r \end{bmatrix}$$

Fig.1 Influence Coefficient Method

Method

Tab.1

Specification of Carrier	
Radius	820mm
Width	720mm
Center distance with planetary pin	575mm
Radius of pin	110mm
Loading	904721.38N

The model of the carrier we analyze is a assembly of a planetary-gear-reducer entrusted to analyze by the Formosa Heavy Industries Corp, the specification of the carrier is list in Tab.1. In this analysis, the carrier is segmented by triangular mesh, then fix the output end and the bearing, simulating the situation about the real planetary gear works. This analysis does not include investigate the deformation about the gears, so all the gears are remove and put the load on the pins. Then making two loads separated from the original load at the both ends on the pins in order to avoid the pin’s bending. And then we use the analysis software to analyze and observe the deformation, and investigate the relationship between the load and deformation.

Results & Discussion

According to the result, discussing the results of loading put on input end and output end respectively to investigate the deformation of the carrier, then we can find that if there is only a loading exerted at the output end, the pins get a deflection but have no conspicuous different deformation between the front and back of the pin; If there is only a loading exerted at the input end, it will cause a conspicuous different deformation between the front and back of the pin, that means there is conspicuous different deformation between the front and back of the carrier, such as Fig.2 and Fig.3.

List the results systematically into a diagram (Fig.4), it can be find that the slop of the total deformation diagram is almost the same with the deformation diagram only having a loading exerted at input end, besides the loading exert -ed at output end will cause a fixed quantity of deformation on the pins and carrier. By entering different values of loading exerted at both ends (Fig.5), we can find that the deformation of carrier will increase when the input end withstand a larger loading, and the deformation of carrier will decrease if the output end withstand a larger loading ,nevertheless the value of deformation on the output end will get a little increase.

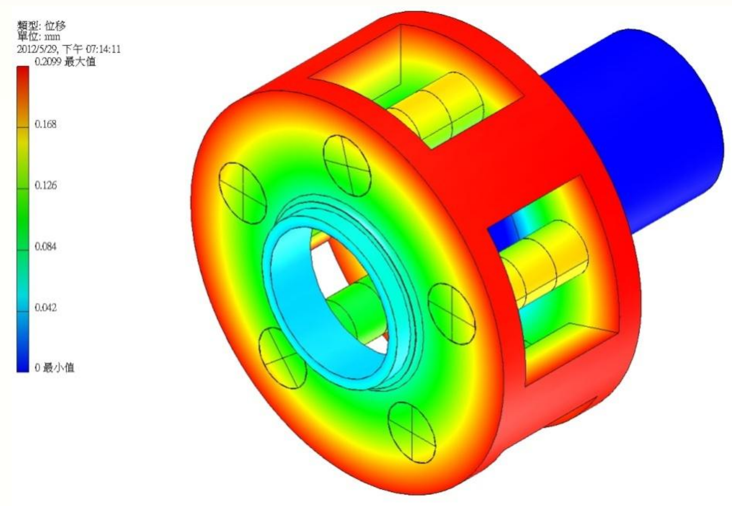

Fig.2 Loading exert at output end

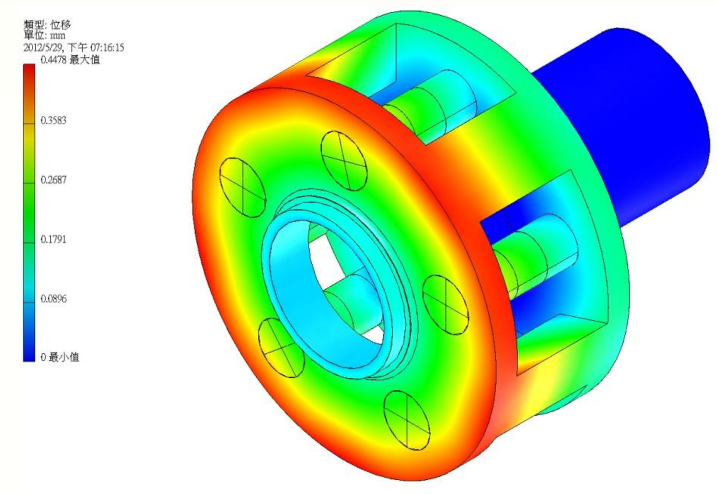

Fig.3 Loading exert at input end

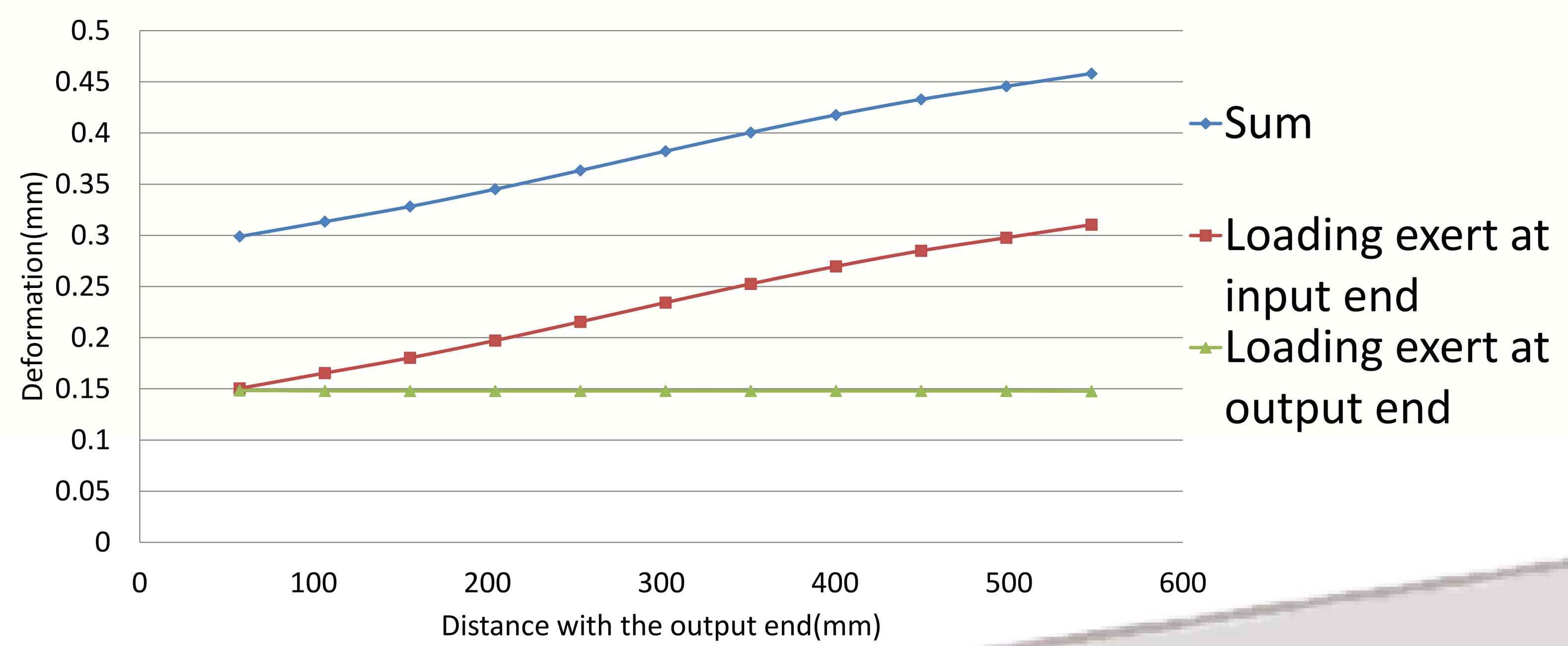

Fig.4

Conclusion

In this analysis, there are two main influence factors of the carrier can be find : the rigidity and the position of the loading.

1. Rigidity : Due to the output end is fixed, the rigidity near the output end is increase, so the amount of deformation decrease after exerting a loading on the output end.
2. Position of the loading : Entering different values of loading exerted at both ends means change the loading position, and that will affect the deformation diagram.

According to the diagram, the deformation curve of carrier will be defined by adding fixed quantity of displacement cause by the loading on the output end.

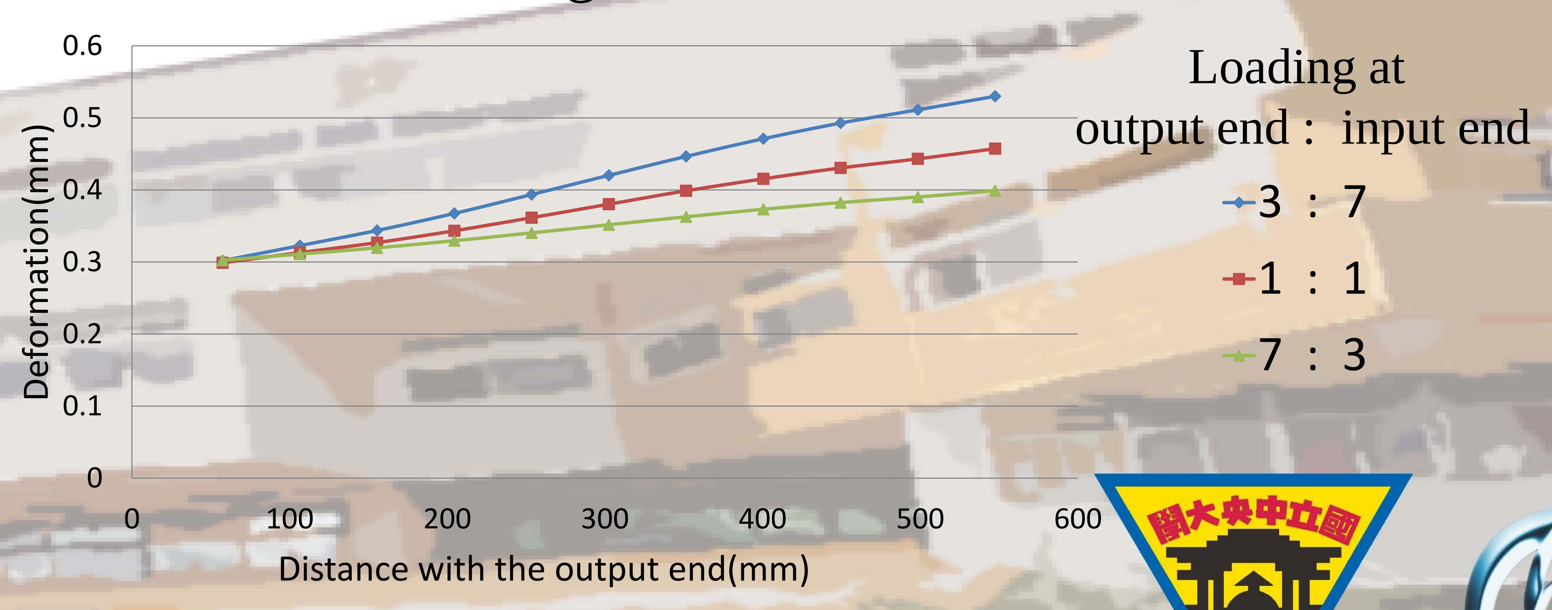

Fig.5