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RECENT DEVELOPMENT OF FOUR WHEEL STEERING SYSTEM

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ABSTRACT

In city life, the driving circumstances of the vehicle with higher Wheelbase and track breadth face problems of turning as space is captive, the same problem is faced in low speed to gain control over Four wheel steering is a method developed in the automobile industry for the effective turning of the vehicle and to increase the flexibility. For a vehicle, working on all wheel drive (AWD) it is necessary to achieve adjustability. This calls for a continuous need and demand of a car to attain flexibility. With this attribute, handling and operating at the minimum speed achieved is till 6.2 mph. The main aim is to come up with effective steering response resulting increase in vehicle adjustability while manoeuvring at high speed and to decrease turning radius at low speed with keeping up as less weight as possible of the vehicle.

KEYWORDS: flexibility, Turning radius, Four wheel steering, Stability, Over steer and under steer

I. INTRODUCTION:

Steering is the mechanism by which the user can operate the navigation of travel of the vehicle. It makes the vehicle to follow the wanted path. The objective of this paper is to study the recent steering system being used in four wheelers. The four wheel steering is used to minimize the turning radius of the vehicle as compared to the traditional steering mechanism. The traditional steering mechanism involves the use of Ackerman steering mechanism. Using these steering systems the main disadvantage is that it's more. For eliminating this, it is suggested to employ four wheel steering system. This helps in easily moving of the vehicle in crowded spaces such as parking lots. Flexibility of the turning radius of wheel can be achieved only at low speed. The front wheel and the back wheel turn in the same direction at high speed as it facilitates lane changing. A front wheel does most of the steering while the rear wheel's turning is limited to half during an opposite direction.

II. BACKGROUND THEORY:

The condition for perfect steering is that all the four wheels must turn about the same instantaneous center. While negotiating a curve, the inner wheel makes a larger turning angle θ than the angle φ subtended by the axis of the outer wheel.

In the fig.2.1, a = wheel track, L = wheel base, w = distance between the pivots of front axles.

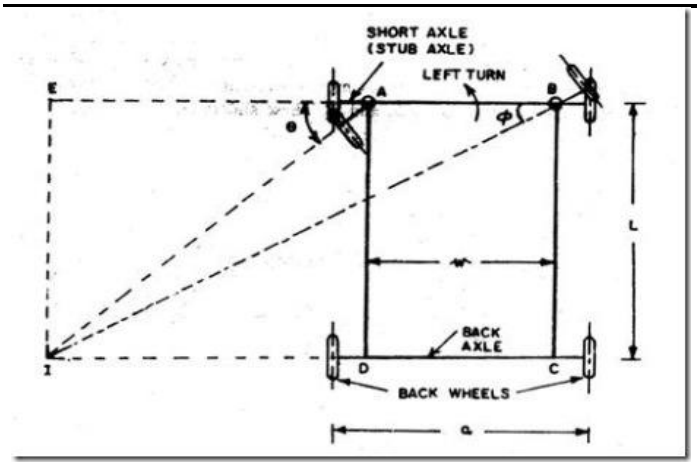

Fig.2.1: Condition for perfect steering

This is the fundamental equation for correct steering. If this experimental condition is fulfilled, there will be no skidding of the wheels when the vehicle takes a turn.

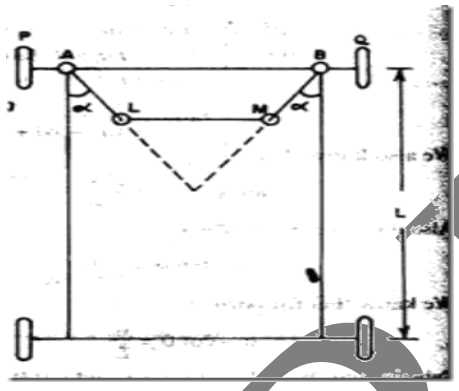

Fig2.2: Ackermann steering gear mechanism

This mechanism gives correct steering in only three positions. Firstly, when θ = 0 and rest of the two corresponding to the turn to right or left (at a fixed turning angle, as determined by equation [1]).The difference between φc and φa will reduce the life of tires because of greater wear on account of slipping.Except for larger values of θ, the vehicle must take a sharp turn; hence it will be moving at a slow speed. At lower speeds, wear of the tires is less. Therefore, the major difference between φc and φa larger values of θ won't matter..As this mechanism employs only turning pairs, friction and wear in the mechanism will be less. Hence its sustenance will be better and is commonly used in automobiles.

III. RECENT STEERING MECHANISAMS FOR FOUR WHEELER:

3.1 CRAB STEERING:

It was developed in 1990's, along with four wheel steering. With Crab steering the wheels can turn in the same direction by the same amount so that the vehicle can move sideways.[10] It is mainly used in construction equipment such as backhoes and forklifts. This is especially helpful in tight quarters on the job, where there is not enough space to move a conventional forklift back and forth several times in order to line up at the exact spot in front of the loading location. [2]

Fig.3.1 Crab steering mechanism

3.2 ARTICULATED STEERING:

Articulated steering separates the vehicle into two sections, a front and a back half with the pivot point directly in the middle. With respect to structure, the articulation of the joint allows the front frame turning at an angle relative to the rear frame in the horizontal plane to obtain the steering function. Hydraulic piston oscillates from the front or the back section about the pivot point directly in the middle of the vehicle. Since the entire body rotates along with the front wheel, the load on the front axle is reduced and con take heavier loads. As they are mobile, flexible, versatile, economic, they are used widely in the forestry, construction, agriculture, and mining industries. [3]

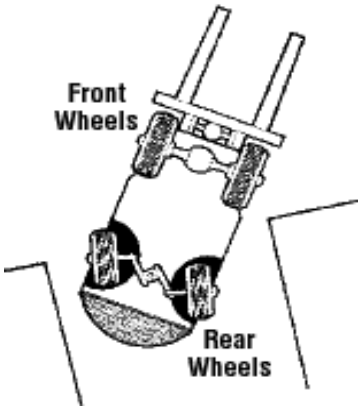

Fig.3.2

3.3 REAR STEERING SYSTEM:

Types of vehicle which are of use only for rear wheel steering, especially fork lift trucks, camera dollies, early pay loaders, Buckminster Fuller's Dymaxion car, and the Thrust SSC. Rear wheel steering swings the rear wheels outside of the front wheel tracks. The prime advantage is greater effectiveness in handling off-centre loads at either front or rear. This type of steering is used with front-end loaders, as the loaders need to move to turn the cargo in the tightest radius. [4] As explained above, the rear wheel steering can simulate smaller, sharper angle of rotation as compared to front wheel steering. It has its uses in various

long goods vehicles, and since these vehicles seldom go at high speeds, they can make the most of the rear wheel steering system. Rear wheel steering is also be found in motor sports, where drifting is encouraged i.e. the rear wheels swing outside the front wheels. Although the degree to which the wheels turn is less than the front wheels.

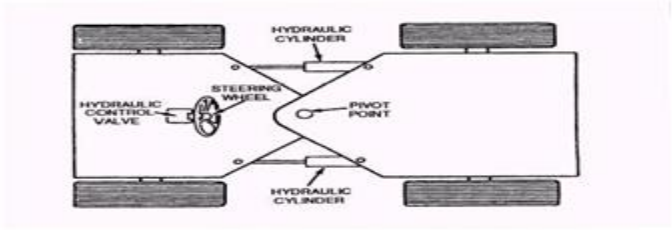

Fig.3.3 Rear steering mechanism

3.4. PASSIVE REAR WHEEL STEERING:

Many modern vehicles offer a form of rear wheel steering known as passive rear wheel steering to counteract normal vehicle tendency to toe in. In many of the vehicles, when cornering, the rear wheels tend to slightly steer to the outside of a turn, which can reduce stability. [5]

3.5 ACTIVE FOUR WHEEL STEERING:

In active four wheel steering, both front and rear wheels can be steered according to the speed of the vehicle and space available for turning. In most active four wheel steering the rear wheels are steered by a computer and an actuator. The rear wheels cannot generally steer as much as front wheels. Conventional two wheel steering mechanism cars tend to under steer or, in few instances over steer. Using 4WS, the car con automatically compensate for an under steer or over steer problem. It improves handling and helps the vehicle make lighter turns. However only a few car manufacturers provide the option for a 4WS system, manufacturers like Honda, which provided a four wheel steering option in their Honda Prelude and, other companies like Mazda, General Motors, Nissan and Renault. However the main objective of these systems was to assist front wheels in steering and not steering itself, and thus the rear wheels could only turn two to three degrees. [6][7]

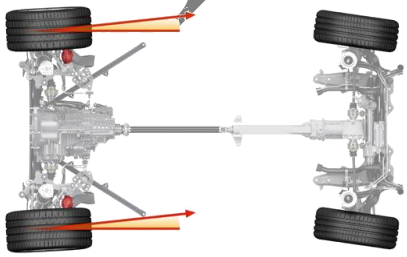

Fig.3.4 Active four wheel steering

3.5.1 WORKING OF AN ACTIVE FOUR WHEEL STEERING SYSTEM:

Four wheel steer steering system works differently during different speed limits. Depending on the speed of the car, the rear wheels may turn in the opposite direction, also known as counter steering, or turn in the same direction, called same-side steering. Operation of this system shows below:

3.5.1.1 LOW SPEED OPERATION:

At low speeds of about 10 to 40 km/h, the rear wheels move in opposite direction to the front wheels. This is also known as counter-steering. In conventional, two wheel steering during turning, the front wheels immediately begin to pivot and the vehicles forward momentum generates a powerful cornering force. The rear wheels however, take time to generate a corresponding force at the rear end of the vehicle. [5] This is the reason the rear end of a car lags behind the front end. In extreme cases this lag may cause the car to over steer and spiral out of control. But in four wheel steering, at low speeds counter steering helps the driver to make sharper turns and reducing the turning radius by up to 40% [7]. This is especially useful in metro cities, where manoeuvring is difficult.

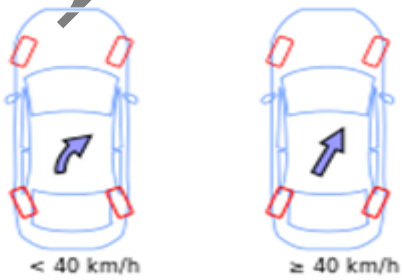

Fig. 3.5 Comparison of high speed and low speed operation

3.5.1.2 HIGH SPEED OPERATION:

Counter steering at high speeds can make the vehicle unstable. So to put this out simply, counter steering at higher speeds would result in an extreme case of over steer where the rear end is pushed away from the centre of rotation of the vehicle making the car more unstable? Same side steering however improves the steering performance of the vehicle by eliminating the high speed sway which is observed in two wheel steering system. This is done by designing of cornering forces on the front and the rear axles simultaneously to eliminate the rear end lag. [5]. However, the degree to which the rear wheels turn with the front wheels depends on the speed of the vehicle. Wheels turn at a lesser angle between speeds of 25 m/h to 50 m/h than at speeds more than 50 m/h.

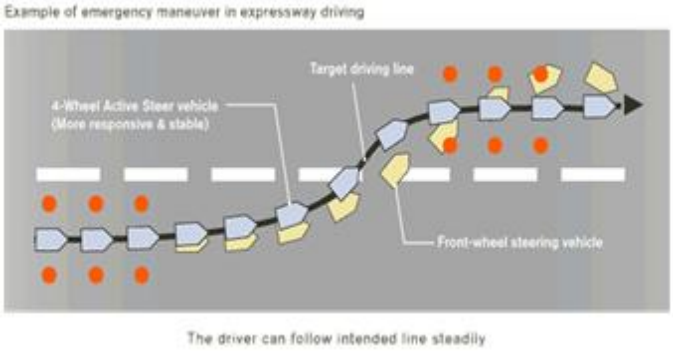

Fig. 3.6: More responsiveness and stability of four wheel steering

IV. CONCLUSION:

The study of various four wheel steering system shows that the flexibility of the vehicle majorly increases at low as well as high speeds. By using electronic steering, the steering response can be further improved. The different types of four wheel steering perform their functions effectively, such as the crab steering improves manoeuvrability in cramped spaces, active four wheel steering improves handling of cars at various speeds and eliminates oversteer and articulated steering reduces effort and improves cornering of segmented vehicles. However, that being said, the four wheel steering system is complex and its implementation is expensive and is yet to be available in all markets. But given the recent advancements in automobile industry, it is safe to assume that the system will become more commonplace.

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