Wheel Alignment

2011 Automobile Maintenance Advanced Course for the Industrial Technical Instructors

No. : ________________________________

Name : ________________________________

Instructor : Li,Kai-Shiung

2011/11/01~ 2011/11/02
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Abstract

A. Six items for wheel alignment
B. Other factors to influence wheel alignment
Introduction

Inaccurate wheel alignment can cause:
① difficult steering
② poor steering stability
③ poor reciprocation on hairpin corner
④ shorten the tire life span
...etc.

Six items for wheel alignment

1. 懸吊高度 (Suspension Height)
2. 外傾角 (Camber)
3. 內傾角 (Steering-axis Inclination，SAI)
   or (King Pin Inclination，KPI)
4. 後傾角 (Caster)
5. 前束 (Toe in)
6. 迴轉半徑 (Turning Radius)
1. 懸吊高度 (Suspension Height)

☆ The distance between the vehicle body, frame or any suspension point to the ground.
2. 外傾角 (Camber)

☆ The angle between the center line of the wheel viewed from the front and the vertical axis used for steering.

1. The center line of the wheel inclines outward is called positive camber.
2. Overlapping center line of the wheel and the vertical axis is called zero camber.
3. The center line of the wheel inclines inward is called negative camber.

☆ camber is normally between $-1.5^\circ \sim +1.5^\circ$
Force on spindle

Non-slip force for wheels
3. Turning radius of the tire

Steering-axis Inclination (SAI) or King Pin Inclination (KPI)

☆ The angle between vertical axis and King Pin center line or steering axle center line viewed from the front usually falls between $6^\circ \sim 9^\circ$. 
包容角（Included Angle）

☆The sum of KPI and camber is called Included Angle. The cross point is under the ground (positive steering offset). It makes steering easier and tires more durable.

☆Incorrect included angle indicates steering column or spindle are twisted.

→ the included angles of left and right wheels should be equal, or it means the parts are distorted.

☆Different contact position of included angle vertex and the ground will affect its tendency to roll inward or outward.
The angle between the vertical axis and King Pin centerline or steering axle centerline viewed from the side.

Incline backward is called positive caster, incline frontward is called negative caster. Normally caster falls between $-1^\circ \sim +3^\circ$ for ordinary vehicles.

The distance between the cross point of steering axle centerline and the ground to the contact surface center of the tire and ground is called backward inclination drag distance.
Caster

Straight driving guidance of positive caster
Positive backward inclination drag distance assist in steering reciprocation

Influence of different suspension level
5. 前束（Toe in）

☆ Viewed from the top, if the distance between front part of the two wheels is smaller than the rear part of the two wheels is called Toe in.
☆ The unit for toe in can be represented by distance or degree, and distance (mm) is more commonly used.
☆ when the distance between front part of the two wheels is bigger than the rear part of the two wheels is called Toe out.
6. Turning Radius

☆ When making a turn, the steering angle of left and right front wheels are different, and to reach the preferable turning radius.

☆ The angle difference between inner and outer wheels is also called Toe out on Turns or Turning Angle.

☆ The angle difference between inner and outer wheels is around $2^\circ \sim 4^\circ$.

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Unequal steering angle

Inner wheel steering angle

Outer wheel steering angle

Rear axle centerline

The angle difference between inner and outer wheels is called Toe out on Turns.

Turning Radius
Other factors to influence wheel alignment

1. 轉向偏位（Steering Offset）
or（Scrub Radius）
2. 軸距差（Setback）
3. 推力角度（Thrust Angle）
The distance of the cross point of King pin or Steering axis centerline with ground to the cross point of wheel centerline with ground is called steering offset.

→ If the cross point of steering axis centerline with ground is at the inside of cross point of wheel centerline with ground then steering offset is positive.

→ If the cross point is at outside then steering offset is negative.

→ If they cross on same spot on ground then steering offset is zero.

Negative Steering Offset
When the wheelbase of two sides of the vehicle are different, it is called setback.

→ When right wheelbase is smaller than left wheelbase, it is called positive setback
→ When right wheelbase is bigger than left wheelbase, it is called negative setback

Setback (Positive setback)
推力角度（Thrust Angle）

☆ When four wheels are correctly positioned, the vehicle can run straight steadily.

☆ When rear wheels are incorrectly positioned or the setback is too big, the vehicle might deviate. The moving direction depends on Vehicle Centerline, Geometric Centerline and Thrust Line.

☆ For FR type vehicles, incorrect rear axle position or damaged chassis will generate thrust angle.

☆ For vehicles with rear wheel independent suspension system, it can also generate thrust angle when there is uneven toe in adjustment for rear wheels, causing rapid wear and tear of the tires.

Thrust Angle
Conclusion

☆ As the growing development of vehicle suspension and steering system structure, the demand for wheel alignment angle is getting stronger.

☆ Wheel alignment equipment is not for adjusting or changing alignment angle but a reference for mechanics. Mechanics compared the original angle with measured angle. If it exceeds tolerable range then they may adjust or replace the parts for keeping it at original angle.

☆ Advanced equipments required experienced and skilled mechanics.
Bubble Meter Operation

1. Place the two front wheels on the turntable. Lift the two rear wheels to the same level as front wheels.
2. Reset the level bubble to zero
   → Read Camber
3. Pull out the turntable pin
4. Reset the Caster to zero by adjustment screw
5. Turn 20° outward
   → Read Caster
6. Reset the KPI to zero by adjustment screw
7. Turn 40° inward
   → Read KPI / SAI
   → Check the turning angle of the other front wheel.
# Wheel Alignment Work Sheet

## 2011 Automobile Maintenance Advanced Course for the Industrial Technical Instructors

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Instructor: Li, Kai-Shiung</th>
</tr>
</thead>
</table>

### Vehicle type:

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<thead>
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<th>Item</th>
<th>Alignment</th>
<th>Measurement</th>
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<td>01</td>
<td>Camber</td>
<td>Left: -4.0</td>
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<tr>
<td></td>
<td></td>
<td>Right: -0.5</td>
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<tr>
<td>02</td>
<td>KPI/SAI</td>
<td>Left: 12</td>
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<tr>
<td></td>
<td></td>
<td>Right: 13</td>
</tr>
<tr>
<td>03</td>
<td>Caster</td>
<td>Left: -2</td>
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<tr>
<td></td>
<td></td>
<td>Right: 2.5</td>
</tr>
<tr>
<td>04</td>
<td>Toe out on Turns</td>
<td>Left: +1°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right: +1°</td>
</tr>
</tbody>
</table>

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<td>01</td>
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