

## Online Racing Course Notes: Week 1 - Suspension Basics

### Introduction

- **Course Format:** The course utilizes a Discord channel for communication and four weekly meetings.
- **Interactive Learning:** The course emphasizes interactive learning through group discussions, homework assignments, and real-world application.
- **Goal:** To improve understanding of car setup and achieve better results on the track.
- **Resources:** Videos will be shared on YouTube, and additional information is available on [invisiblespeed.net](https://invisiblespeed.net).

### Week 1 Topics: Ride Height, Droop, Toe, and Camber

- **Basic Settings:** These four settings are fundamental to car handling and can significantly impact performance.
- **Importance:** Understanding these settings is crucial for achieving a good baseline setup.

### Damping and Shock Oil

- **Common Issue:** Many drivers use shock oil that is too thick, leading to poor suspension performance.
- **Importance of Feel:** It's essential to understand how a well-damped suspension should feel.
- **Finding the Right Feel:**
  - Seek out cars with good suspension feel, preferably the same model as yours.
  - Feel the suspension movement of these cars, noting the difference in feel.
  - This will help you understand the desired range of suspension feel.
- **Impact of Shock Oil:**
  - Shock oil thickness affects the car's balance, roll rate, and overall handling.
  - Adjusting shock oil at one end of the car can significantly alter the car's handling characteristics.
- **Shock Oil and Temperature:**
  - Shock oil viscosity changes with temperature.
  - Thicker oils are used in hot weather, while thinner oils are used in cold weather.
  - Copying setup sheets without considering temperature can lead to incorrect shock oil selection.

### Understanding Damping

- **Impact of Thick Oil:**
  - Thick shock oil can be difficult to notice on the track but is easily felt on the pit table.
  - When moving the suspension quickly, thick oil will prevent the suspension from moving freely, causing the tires to lift off the ground.
- **Importance of Feel:**
  - Feeling the suspension movement on the pit table is a good starting point for understanding damping.

- **Challenges:**
  - It's difficult to understand damping because setup sheets often don't specify the temperature at which they were used.
  - This makes it challenging to determine the correct shock oil viscosity for different weather conditions.

**Adjusting Shock Oil**

- **Impact of Adjustment:**
  - Adjusting shock oil can fine-tune the car's balance and handling.
  - It can affect the car's roll rate, squat, and dive, which in turn influence cornering performance.
- **Relationship to Pitch and Roll:**
  - Shock oil adjustments affect the car's pitch and roll, which are crucial for driver reaction time and tire grip.

**Summary Table**

Setting	Description	Impact on Handling
Ride Height	Vertical distance between the car's body and the ground	Affects ground clearance, weight distribution, and aerodynamic balance
Droop	Amount of suspension travel when the car is at rest	Influences suspension travel, weight transfer, and tire contact patch
Toe	Angle of the wheels relative to the car's longitudinal axis	Affects steering feel, tire wear, and cornering stability
Camber	Angle of the wheels relative to the vertical axis	Influences tire contact patch, cornering grip, and tire wear
Shock Oil	Viscosity of the fluid in the shock absorbers	Affects suspension damping, roll rate, and overall handling

**Conclusion**

Understanding suspension basics is crucial for achieving optimal car performance. By focusing on the key settings and their impact on handling, drivers can improve their understanding of car setup and achieve better results on the track.

## Suspension and Shock Oil

### Suspension and Load Transfer

- **Suspension** acts as a buffer, delaying the transfer of load from the tires to the chassis.
- This delay helps to smooth out the handling of the car.

### Adjusting Shock Oil

- **Shock oil** controls the rate at which the suspension compresses and rebounds.
- Adjusting shock oil at one end of the car affects how quickly that end rolls.
- This can influence the car's handling in various ways.
- There's no simple rule for how shock oil adjustments will affect the car.

### Example of Shock Oil Adjustment

- **Scenario:** A car felt good on most of the track but struggled in a specific section with a series of left-right-left turns.
- **Solution:** The driver thinned the rear shock oil by one step, leaving the front unchanged.
- **Result:** The car became more balanced and consistent in that section of the track.

### Importance of Understanding Shock Oil

- **Goal:** To understand the optimal range of shock oil for different conditions and how adjustments at one end of the car affect handling.
- **Experimentation:** Adjusting shock oil thickness (thicker or thinner) at the front or rear can reveal noticeable changes in track performance.

### Shock Oil and Piston Relationship

- **Question:** Does adjusting the piston to have similar shock oil thickness front and rear provide any benefit?
- **Answer:** Yes, it can be beneficial.
- **Explanation:** Shock oil viscosity changes with temperature, becoming thinner when heated.
- **Impact:** A large difference in shock oil thickness between the front and rear can lead to an imbalance in the car's handling as the oil heats up and thins.
- **Benefit of Similar Thickness:** Running the same shock oil front and rear helps maintain a consistent balance as the oil heats up.

### Shock Oil and Qualifying vs. Race Performance

- **Potential Issue:** A car that performs well in qualifying might struggle in a longer race due to changes in shock oil viscosity as the car heats up.
- **Reason:** The balance of the car can shift as the shock oil thins, affecting handling.

### Springs and Their Impact on Handling

- **Spring Function:** Springs limit the amount of suspension travel (dive, squat, roll).
- **Spring Stiffness and Working Range:**

- **Softer Springs:** Allow more suspension travel, resulting in more overall grip.
- **Harder Springs:** Limit suspension travel, leading to faster load transfer and more initial grip.
- **Spring Impact on Responsiveness:**
  - **Softer Springs:** More responsive suspension, allowing the car to adapt to changes in the track surface.
  - **Harder Springs:** Less responsive suspension, making the car less adaptable to track changes.
- **Spring Selection:** Drivers typically find a set of springs that work well and then focus on fine-tuning other aspects of the setup.

**Table: Spring Stiffness and Handling Characteristics**

Spring Stiffness			Suspension Travel	Grip	Responsiveness
Softer		More		More overall grip	More responsive
Harder		Less		More initial grip	Less responsive

# Spring Setup in Racing

## Spring Setup Basics

- **Multiple Spring Setups:** Drivers often use two different spring setups: one for standard conditions and another for specific situations like loose tracks.
- **Spring as a Foundation:** Springs are a fundamental part of a car's setup, similar to ride height. Everything else is adjusted around the chosen spring.
- **Consistency is Key:** Drivers tend to stick with the same spring setup if they find a good one, building the entire car's setup around it.
- **Backup Setup:** For different track conditions, drivers have a backup setup, often with softer springs, especially on loose tracks.

## Spring Types and Their Effects

- **Spring Material:** The material used to make the spring affects its performance.
- **Progressive Springs:** These springs are softer initially, providing more grip and stability, but become stiffer as the car compresses, maintaining a consistent feel at the limit.
- **Progressive Spring Placement:** Progressive springs are often used in the rear, as they can improve traction and stability in corners.
- **Progressive Spring Front Impact:** Using progressive springs in the front can reduce precision at high speeds, making drivers less confident in corner entry.

## Spring Brands and Their Characteristics

- **Mayako Springs:** Mayako springs are known for calming the car down and reducing responsiveness.
- **Mugen Springs:** Mugen springs also contribute to a calmer car and reduced responsiveness.
- **Spring Length:** Mayako springs are typically 60-65mm long.

## Anti-Roll Bars: Tuning for Cornering

- **Anti-Roll Bar Function:** Anti-roll bars affect the car's roll stiffness, limiting the amount of body roll in corners.
- **Anti-Roll Bar vs. Springs:** Anti-roll bars only affect the car's roll, while springs affect both front-to-back and side-to-side movement.
- **Anti-Roll Bar Adjustment Frequency:** Anti-roll bars are adjusted more frequently than springs because they have a smaller impact on overall car behavior.
- **Anti-Roll Bar and Tire Load:** Anti-roll bars help maintain equal tire load on both sides of the axle, maximizing grip.

## Diagram: Anti-Roll Bar and Tire Load

## Key Takeaways

- Springs are a fundamental part of a car's setup, affecting its overall handling characteristics.
- Different spring types, such as progressive springs, offer unique benefits and drawbacks.
- Anti-roll bars are used to control body roll in corners and optimize tire load distribution for maximum grip.

# Car Balance and Handling: Adjusting for Optimal Performance

## Understanding Car Balance

- **Car Balance:** Refers to the distribution of weight and grip between the front and rear axles.
- **Ride Height:** Adjusting ride height (front or rear) impacts the car's balance and handling characteristics.
- **Camber:** Changing camber on one end of the car alters the grip distribution, affecting the car's balance.
- **Shock Oil:** Thinner shock oil can improve handling in specific sections of a track by changing the car's balance.
- **Anti-Roll Bars:** A key tool for adjusting car balance. Thicker anti-roll bars increase stiffness, transferring more load to the outside tires.

## Visualizing Load Distribution

- **Tire Load:** The dots on the outside of the tires represent the load on each tire.
- **Turning Left:** The front tires are relatively evenly loaded, with slightly more load on the outside tire.
- **Turning Right:** The rear outside tire is heavily loaded, while the inside tire is very light.
- **Uneven Load Distribution:** This uneven load distribution can lead to handling issues, such as oversteer.

## Solving Handling Problems

- **Oversteer:** Occurs when the rear tires lose grip, causing the car to rotate.
- **Uneven Load Distribution and Oversteer:** When the rear inside tire is lightly loaded, the rear axle has less grip, leading to oversteer.

## Solutions to Oversteer

- **Solution 1: Thicker Front Anti-Roll Bar**
  - **Goal:** To match the uneven load distribution of the rear axle.
  - **Mechanism:** Transfers more load to the outside front tire, making the front axle more unevenly loaded.
  - **Result:** Balances the car, but reduces overall grip.
  - **Considerations:** Effective on high-grip tracks, but can lead to a loss of grip on low-grip tracks.
- **Solution 2: Thinner Rear Anti-Roll Bar**
  - **Goal:** To balance the rear axle load distribution.
  - **Mechanism:** Reduces the stiffness of the rear anti-roll bar, allowing the rear axle to roll more evenly.
  - **Result:** Balances the car and increases overall grip.
  - **Considerations:** A more effective solution for low-grip tracks, as it maintains grip while improving balance.

## Example: Elliot Boots

- **Elliot Boots' Problem:** The rear inside tire lifts off the track during cornering.
- **Solution 1: Thicker Front Anti-Roll Bar:** Would reduce front end grip and balance the car, but the rear inside tire would still lift.
- **Solution 2: Thinner Rear Anti-Roll Bar:** Would allow the rear axle to roll more evenly, preventing the rear inside tire from lifting and increasing overall grip.

**Common Misconception**

- **Misconception:** Drivers often think that a hard rear anti-roll bar is necessary to prevent the rear inside tire from lifting.
- **Reality:** A thinner rear anti-roll bar can be more effective in solving this problem by allowing the rear axle to roll more evenly and maintain grip.

**Table: Summary of Anti-Roll Bar Adjustments**

Adjustment	Effect on Front Axle	Effect on Rear Axle	Overall Grip
Thicker Front Anti-Roll Bar	More unevenly loaded	More balanced	Reduced
Thinner Rear Anti-Roll Bar	More balanced	More balanced	Increased

# The "Sixth Sense" of Elite RC Drivers

**Description:** This section explores the unique ability of elite RC drivers to achieve a level of control and connection with their cars that transcends mere reaction. It delves into the concept of "feeling" the car and how this translates into superior performance.

- **The "Sixth Sense"**
  - Elite RC drivers develop a deep connection with their cars, allowing them to anticipate and control the vehicle's movements with incredible precision.
  - This "sixth sense" is characterized by a shift from reacting to the car's behavior to proactively dictating its actions.
  - This transition is often visible as a sudden jump in performance, where the driver goes from "driving well" to "extremely well."
  - This heightened awareness allows the driver to anticipate and correct potential issues before they arise, leading to smoother and faster driving.
- **The Difference Between Elite and Good Drivers**
  - Elite drivers possess a heightened ability to understand how their inputs affect the car's behavior.
  - They can quickly adapt their driving style to match the car's needs in any given situation.
  - This allows them to transition from reacting to the car's movements to proactively controlling them.
- **The Mental Connection**

Elite drivers develop a mental model of their car's behavior, allowing them to anticipate its responses to their inputs.

- This mental model allows them to be "ahead of the car," predicting its movements and planning their actions accordingly.
- This mental connection allows for smoother and more consistent driving, leading to faster lap times and improved overall performance.



# The Importance of Practice and Experience

**Description:** This section highlights the role of practice and experience in developing the "sixth sense" and achieving elite driving performance.

- **Practice and Repetition**
  - Elite drivers often require extensive practice and repetition to develop their connection with the car.
  - This involves spending significant time on the track, fine-tuning their driving style and understanding the car's nuances.
  - This process allows them to build a mental model of the car's behavior and develop the ability to anticipate its responses.
- **The Role of Experience**
  - Experience plays a crucial role in developing the "sixth sense" and achieving elite driving performance.
  - Through repeated exposure to different driving conditions and challenges, drivers learn to adapt their driving style and make adjustments based on their understanding of the car's behavior.
  - This experience allows them to refine their mental model of the car and develop a deeper connection with it.

**Table:**

Driver Type	Key Characteristics
Good Driver	Reacts to car's behavior, corrects issues as they arise
Elite Driver	Predicts car's behavior, controls car proactively, achieves optimal performance

## The Impact of Car Setup

**Description:** This section briefly touches on the impact of car setup on the driver's ability to achieve a deep connection with the car.

- **Car Setup and Driver Connection**
  - The car's setup can significantly influence the driver's ability to feel and control the vehicle.
  - For example, a softer rear end on a car can make it more prone to rolling, which can hinder the driver's ability to maintain control.
  - A well-tuned car setup can enhance the driver's connection with the vehicle, allowing them to feel and anticipate its movements more effectively.

**Key Takeaway:**

- Elite RC drivers achieve a level of control and connection with their cars that goes beyond mere reaction.
- This "sixth sense" is developed through extensive practice, experience, and a deep understanding of the car's behavior.
- The car's setup can also play a significant role in influencing the driver's ability to feel and control the vehicle.