# Understudy Updates: Compression Ratios

**Description:**

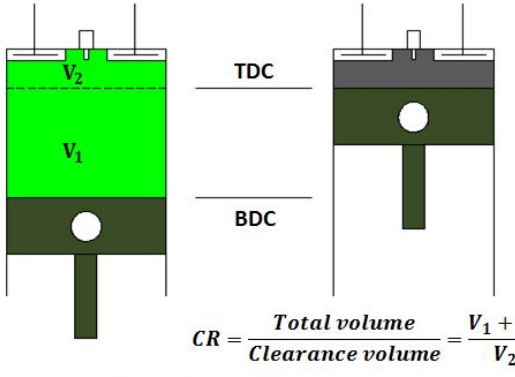
- The compression ratio is the ratio of the volume of an engine cylinder with the piston at the bottom vs. the top.

**Importance to us:**

- Understanding the CR of our engine can better help us decide what changes/things to keep the same in order to improve performance

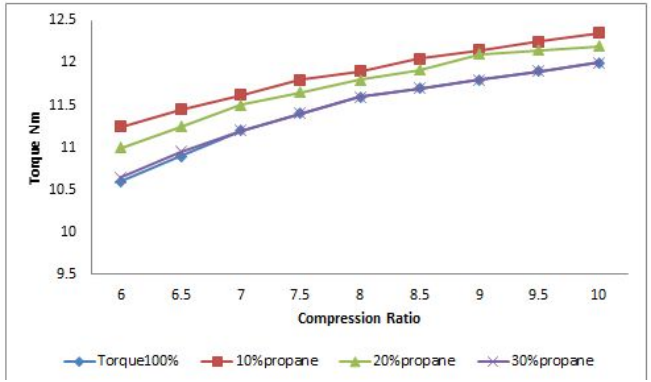
**Questions:**

- Relation between CR and horsepower/torque
- What is the best CR for our uses based on previous data?
- What will changing the CR do to engine performance?




$$CR = \frac{Total\ volume}{Clearance\ volume} = \frac{V_1 + V_2}{V_2}$$

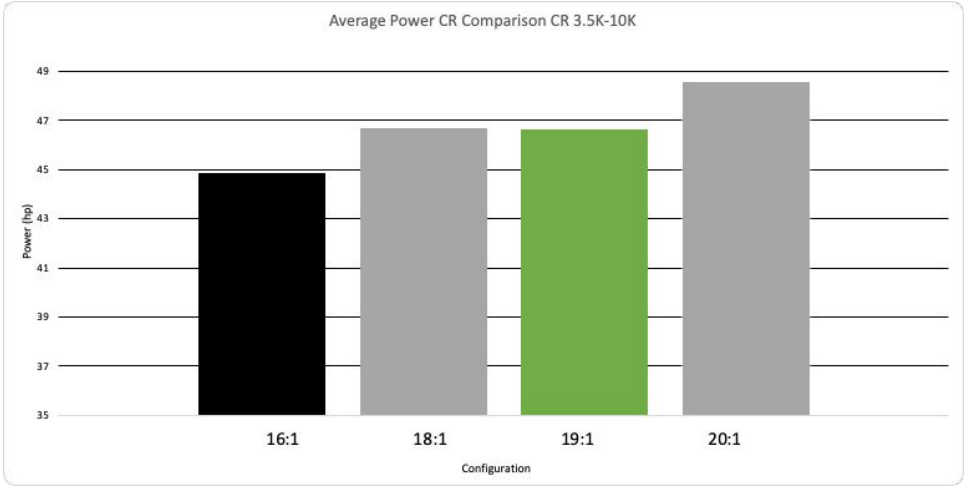




# Understudy Updates: Compression Ratios Cont.

**CR and Horsepower:**

- Based on previous data, the largest average power comes from a CR of 20:1.
- Although this is true, our application may require torque rather than peak HP.
- Looking at the differences when fuel is considered, the 20:1 CR still beats out the others




20:1 CR Average HP 3.5k-10k= 48.57363636

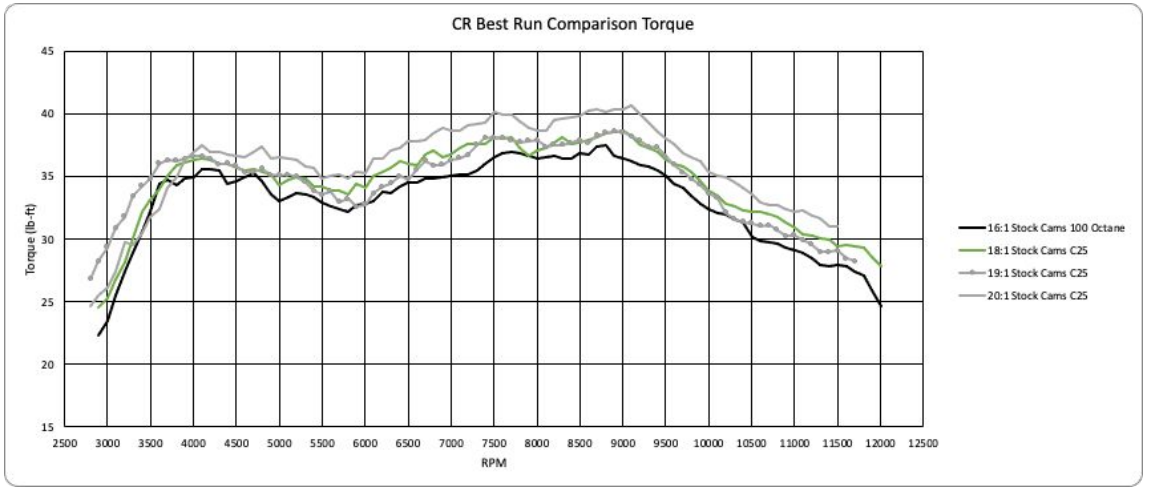
# Understudy Updates: Compression Ratios Cont.

**CR and Torque:**

- If we consider torque as a more important factor than HP, then we can see that the 20:1 ratio is still the winner.

**Limitations:**

- Knock (detonation) is going to be the true defining factor.
- An ideal situation would have a CR of 20:1 winning but more than likely this will be untrue because of limiting factors




| | |
|---|---|
| 20:1 CR Average Torque 3.5k-10k= | 37.57621212 |

# Understudy Updates: Compression Ratios Cont.

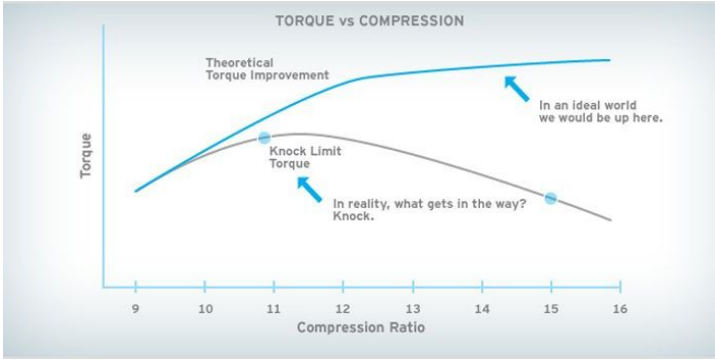
**Knock Characteristics:**

- In theory, torque and HP will increase with an increasing CR, but not realistically.
- The real torque curve will flatten or even drop once the engine becomes knock-limited.

**Knock Prevention/Solution:**

- For higher CR, knock will need to be reduced.
- To reduce knock:
  - Higher octane fuel
  - Better cooling
  - Richer AFR (uses more fuel though)
  - Retard timing when knock appears
- If these precautions are met, a high CR like 20:1 would be possible without a drop in torque.

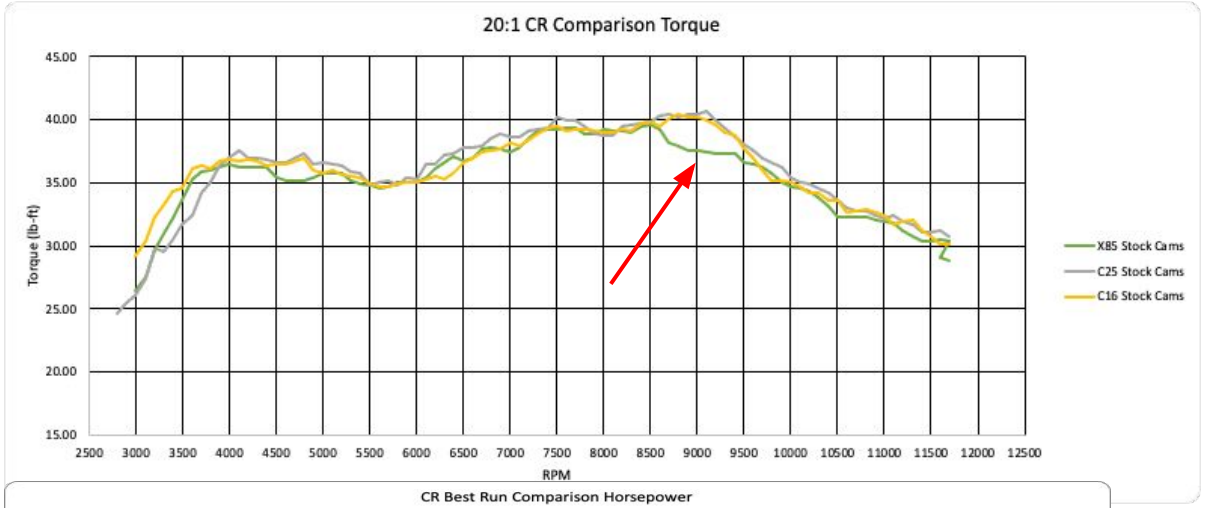
| C25 | | | | X85 | |
|---|---|---|---|---|---|
| (3000 to 12000 RPM) | | | | (3000 to 12000 RPM) | |
| | | | | | |
| | | | | | |
| Average HP = | 49.64622222 | | | Average HP = | 49.74522222 |
| Average Torque = | 35.87922222 | | | Average Torque = | 35.35311111 |

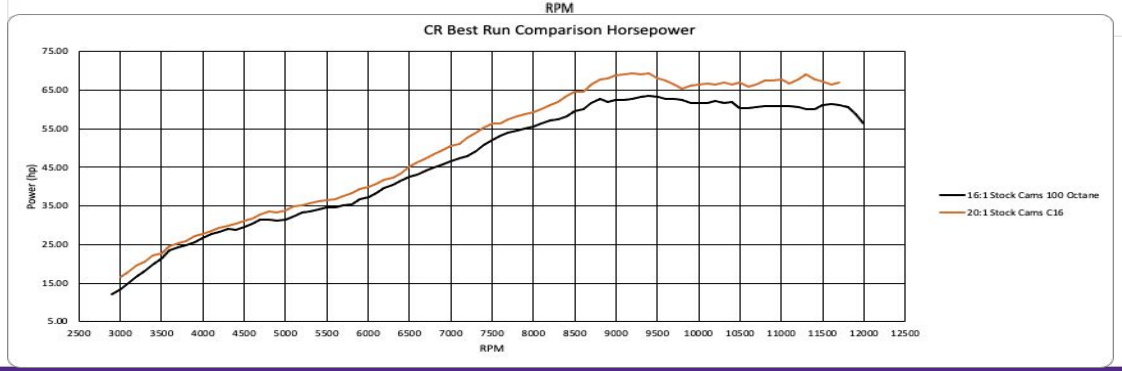


# Understudy Updates: Compression Ratios Cont.

**CR and Torque:**

- Based on the given torque curve, higher octane fuel proves to perform better with the higher compression ratio.
- The X85 shows a slight dip in the torque, which could be a result of knock.



# Understudy Updates: Compression Ratios Cont.

**Overall:**

- The ideal setup would be the highest possible CR and highest octane fuel.
- Although 20:1 is ideal, it will be closer to 16-18 due to physical constraints found by previous tests.

| 18:01 | | |
|---|---|---|
| Volume at TDC | 14.64 | cc |
| Volume at BDC | 239.58 | cc |
| Actual Compression Ratio | **16.36** | **:1** |

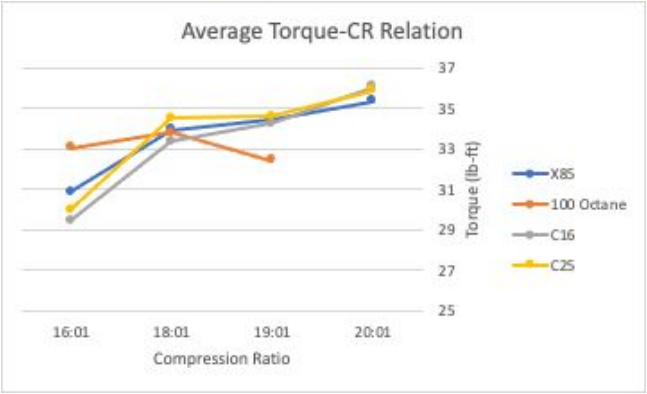
| 19:01 | | |
|---|---|---|
| Volume at TDC | 13.84 | cc |
| Volume at BDC | 238.78 | cc |
| Actual Compression Ratio | **17.25** | **:1** |

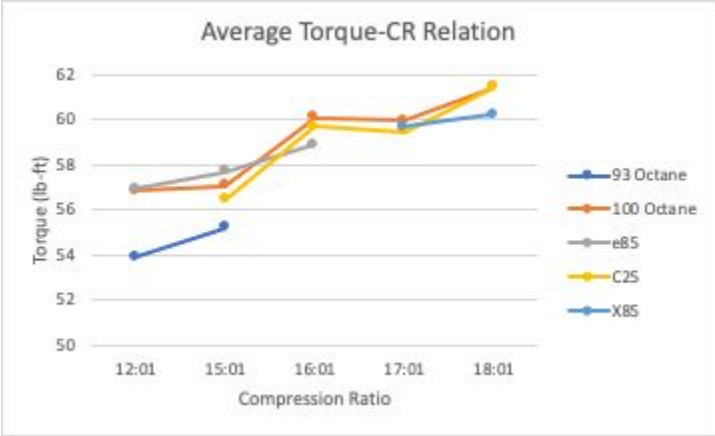
| 20:01 | | |
|---|---|---|
| Volume at TDC | 12.84 | cc |
| Volume at BDC | 237.78 | cc |
| Actual Compression Ratio | **18.52** | **:1** |

# Understudy Updates Compression Ratio

## Torque/CR Relation:

- Graph displays relation between Compression Ratio and Average Torque.
- Top data taken directly from 2018 trials, bottom is more recent
- Each line represents a different fuel
- With this data, it proves the benefit of having a higher octane fuel as well as higher compression ratio for torque gains.



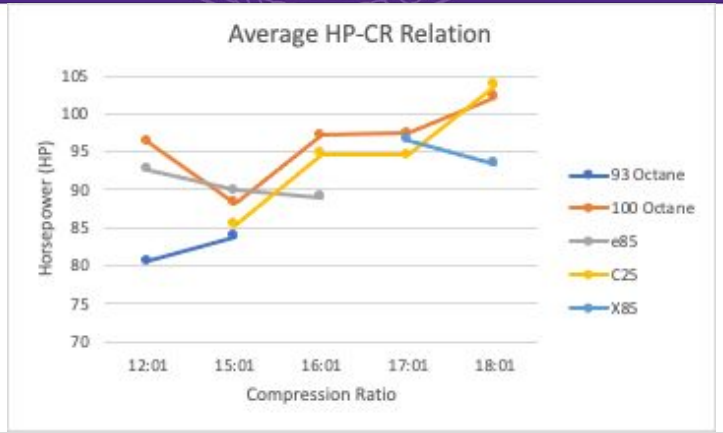
# Understudy Updates Compression Ratio Cont.

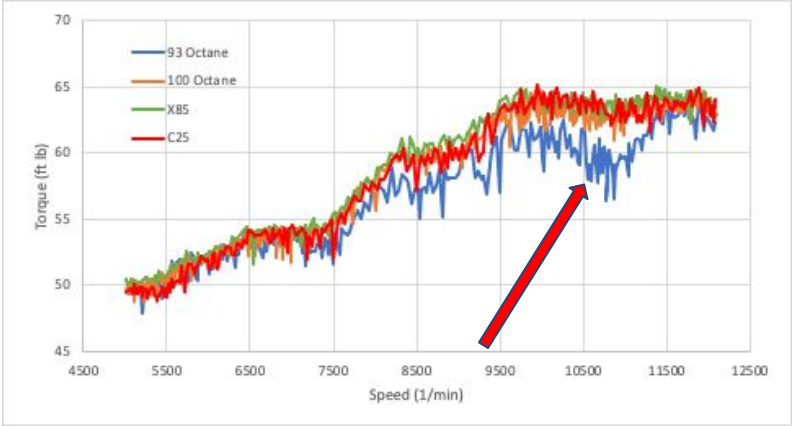
## HP/CR Relation:

- I also made a graph for Horsepower vs Compression Ratio using the same data
- Once again proves that HP should increase with compression ratio theoretically.
- Although, 15:1 seems to have a drop in Horsepower?

## 15:1 Torque Curve:

- I pulled the torque curve from the 15:1 CR data and the lowest Octane fuel (93), appears to show signs of knock, even at 15:1 CR.



# Understudy Updates Compression Ratio Cont.

**Dyno Evidence:**

- According to the Dynos completed in 2017, regardless of CR, 100 Octane and e85 come very close in torque and horsepower