of the workaround we had to implement. It's better to lose power than to run with the engine over-revving, risking failure. He managed the long trail without any problems, and I'm waiting for him to bring me the bike and new torque so we can regain all the power that engine can deliver.

Chapter 5 – Cylinder Head

The squish band we call Squish has many functions as we will see below:

CRUSHING BAND

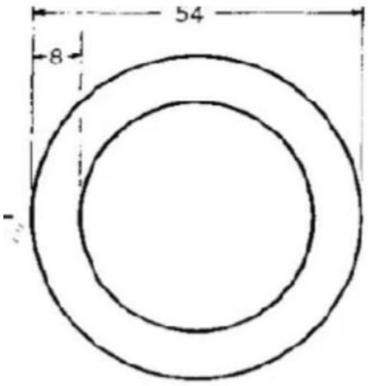
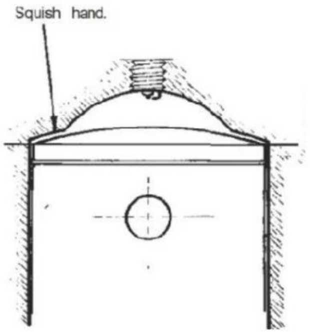


Fig. 2.4 A 50% squish band.



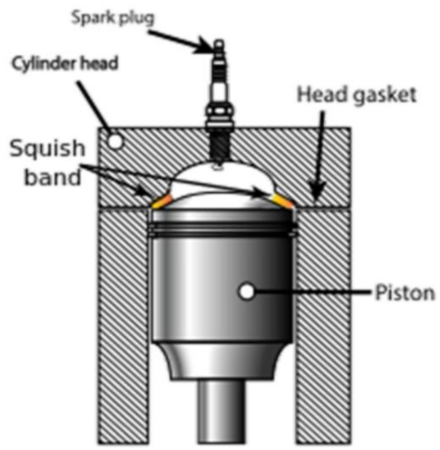
5.1 Prevents detonation

The highest incidence of detonation will always occur near the piston rim. This is because the rim, in the gas flow path, overheats. When the piston compresses the mixture, the tendency for this area near the piston to heat up can cause the mixture to self-ignite.

One way to avoid this is to create a band that partially isolates the mixture from the compression zone of the chamber and prevents this phenomenon.

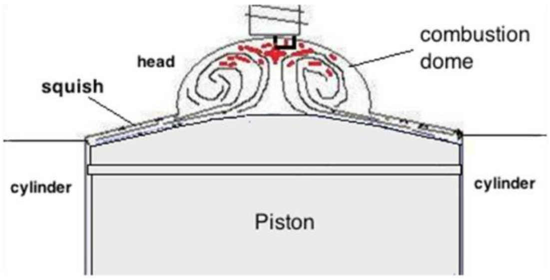
The crush band compresses the mixture into a narrow area and forces the mixture into contact with the cylinder head, cooling it in that area. Consequently, the piston crown is also cooled.

On the other hand, accelerating the mixture too much can cause detonation, so there is a limit to this.



5.3 Combustion Improvement

As the piston rises, it compresses part of the mixture against the cylinder head's squeezing band and accelerates it toward the center. Because the entire rim is compressed, the entire 360-degree circumference of the cylinder heads toward the center, which collides with and rises toward the spark plug. This effect agitates the mixture and vaporizes any liquids still in droplet form, which benefits combustion.



Note in the illustration above that the mixture passes through the candle, which initiates the flame front and spreads it throughout the chamber.

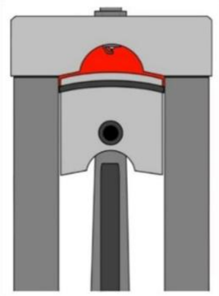
5.4 Reduction of ignition time

Compared to a conventional combustion chamber or a 4-stroke engine chamber, which has valves that prevent squish, the adjacent chamber is smaller, concentrating the mixture closer to the spark plug.

We know that the ignition point always occurs before TDC precisely so that the flame front fills the entire chamber and creates maximum pressure. If the chamber is more compact, we need less ignition advance for the flame front to occupy the entire area.

Compared to a 4-stroke engine, which requires more advance for maximum torque, a 2-stroke engine will have around 15 degrees of advance in the engine's best power range when using gasoline. We'll learn more about advance in the ignition module.

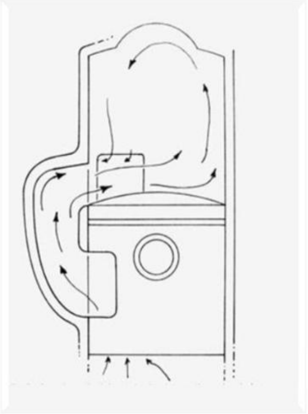
Using less advance benefits engine efficiency in the sense that the piston does not need to fight the pressure initiated by the flame front and generates less heat in the chamber, which reduces the risk of detonation.



5.5 Helps with cylinder cleaning

If we remember the stepping tower (we'll talk more about this in the transfer chapter) that directs the mixture upward at a 100-degree angle towards the combustion chamber, it makes sense to think that this upward-directed mixture needs to be redirected somewhere.

squish chamber has a hemispherical geometry, which redirects the flow from below toward the exhaust port. This effect fills the entire cylinder area and positively directs the burned gases out of the cylinder.



5.6 Crushing band width

squish band width dictates the rpm range where we want maximum power. For engines where we want more torque, we'll use wider bandwidths, and for higher RPMs, we'll use narrower bandwidths.

This is because the higher the RPM, the more we accelerate the mixture. Therefore, we need to narrow the band to avoid excessively high speeds.

We will normally use crushing bands with 55 to 40% area.

55 to 50% for engines with torque zone at lower RPM.

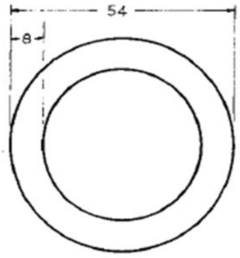
45 to 40% for engines with higher RPM torque zone.

What actually defines the band width is the need your engine has depending on the use it will make, and the height of the band defines the appropriate squish speed which, if accelerated too much, generates detonation.

5.7 How to calculate the area:

In the photo below, we can see the squish band of a 54mm piston at 50%. In this case, the squish band is 8mm wide, and, although it may not seem like it, the inner and outer areas are equal.

We can actually calculate the area or use already known patterns like the example to the side and, with the rule of three, find out the width of the band for any diameter.



For educational purposes, let's calculate the area of the squish shown. To calculate the area of a circle, we'll use the following formula:

$$A = \pi . r^2$$

= 휋. 푟^{2}

0 diãm The outer diameter is 54mm, so its radius is 27mm

Therefore 3.14 x 27^2 = 2,289mm^2

Now let's calculate the area of the inner circle that is 54 -8 -8 which would then be 38mm. Its radius would then be 19mm. We will then have the equation 3.14 x 19^2 = 1133mm^2.

To find out what percentage of area the larger circle has to the smaller one, simply divide one area by the other.

Therefore 1133 / 2289 = 0.49.

This way we find out the crush band percentage for any head.

If we want to use 45% of the area in the band, for example, we can increase the internal area and redo the calculation. For example: 1260 / 2289 = 0.55.

Note that we increased the central area here, which made the band smaller. Therefore, the value found was 55% for the central area, leaving 45% for the crushing band.

Finding the central area of 1260, we can use this value in the formula.

Where: $1260 = 3.14 \times r^2$

$r^2 = 1260/3.14$

$r^2 = 401$

$r = \sqrt[2]{401} = 20$

Therefore, converting to diameter, we'll have 40mm at the central circle. So 54 - 40, leaving 14, which dividing by two, will give us a width of 7mm. Our squish with a 7mm crush band results in a 45% band.

5.8 Crushing height

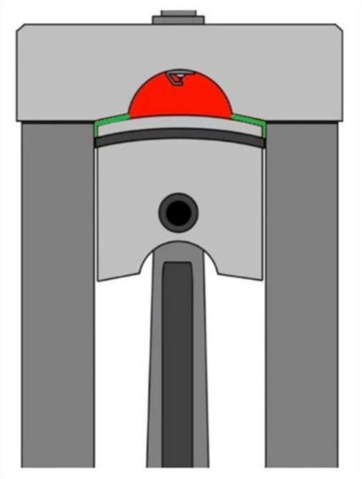
The height together with the length of the band dictates the speed of the squish, that is, they dictate the speed at which the mixture will be compressed and accelerated towards the center of the piston.

We prefer a small height, precisely because the mixture trapped in the band will burn after the piston is traveling downwards and does little to generate chamber pressure.

Let's use the example of the previous combustion chamber, which had 54mm of clearance and 8mm of squeezing band. Let's assume the crankshaft stroke is also 54mm. The literature suggests (without any calculations) using 1.25% of the stroke for squeezing height. In this case, we'll have a 0.67mm height.

We had calculated that the square area of the crushing band was 1133mm^2. To calculate the area trapped in the band, we can multiply the 1133mm^2 area by the band height we calculated.

Note : This calculation, which uses 1.25% of the crankshaft stroke to find the crush height, should only be used in very high-performance engines and with special fuels with a high-octane rating (+100 octane) due to the high risk of detonation. However, we will use this height here as an example to demonstrate the importance of using the correct crush height.

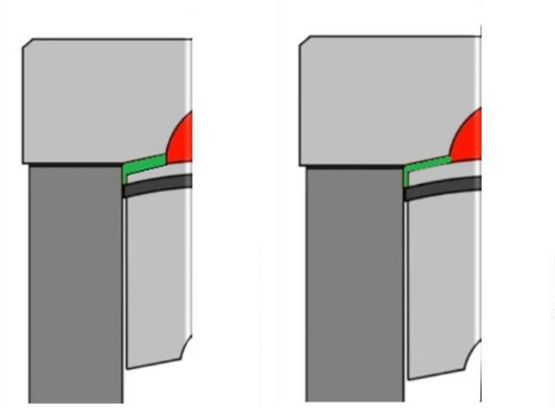


Therefore, we will have 1133 x 0.67 = 759mm^3 of area trapped in the band. Converting to cubic centimeters, let's multiply by 0.001, finding 0.759cc. I want to make you think here: If this engine has a 54mm bore and 54mm stroke, it will then have a total of 123cc.

Well, if we use regular gasoline and want a compression ratio of 10.5:1, we will have a combustion chamber with 13ml.

Using the 0.67 height we calculated, we're trapping 0.7cc of the chamber's total 13ml of mixture. This represents 5% of the total mixture that was compressed. Now let's assume we ignore the squish height and the height is 2mm.

Therefore, 1133 x 2 = 2266 mm^3 of area trapped in the band. Converted to cubic centimeters, we have 2.26 cm^3. This area represents 17% of the total mixture. Therefore, we will have 17% of mixture trapped in the band, which will contribute little to power generation. Ignoring the squish height can take a lot of power away from the engine.



However, this effect isn't a bad thing if we want to lengthen the power curve in engines that require a more spread-out power curve. The mixture stored in the band serves as reserve fuel to burn after the entire mixture has ignited, creating a final "breath" to lengthen the power band after the maximum peak.However, when we want a steeper power curve, we want the mixture to ignite as quickly as possible so that we have maximum pressure in the chamber pushing the piston down.

5.8 Case studies

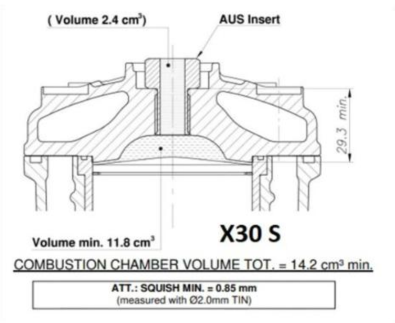
Let's analyze the combustion chambers of the two engines we've already studied. Above, the combustion chamber of the X30 Super and below, the Super Shifter.

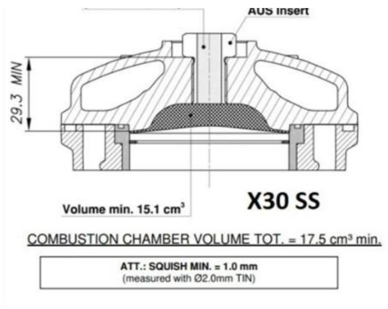
As we've already discussed, the S has a direct-shift transmission and the SS has a paddle-shift transmission. What's clear between them is the width of the squish band. In the S we see a wider band, certainly looking for fast squish speeds and more torque at low RPM, since the engine has no gears. In SS we see a narrower band, seeking faster squish speeds at higher revs.

X30 S

X30 SS

Below we see the two combustion chambers from a side perspective. The X30 S has a 14.2cc chamber and a 0.85mm squish height. The overall ratio is 13.3:1. This higher ratio allows the engine to produce more torque at lower RPM. The X30 SS has a 17.5cc chamber displacement and a 1mm squish height. The compression ratio is 11:1, seeking torque at high RPM.

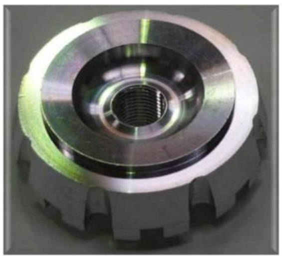




So, here we see the percentage of band and height being utilized in two identical engines, but for different purposes. The X30 Super doesn't have a gearbox, so it needs torque at low RPMs for faster corner exits. The X30 Super Shifter , on the other hand, has a gearbox, which allows it to operate at high RPMs without needing low RPMs, concentrating the power in a narrower band where the gearbox helps.

5.9 Camera formats

Combustion chambers come in various shapes: bell, trapezoidal, toroidal, bell with sinusoidal squish, and bell with elliptical squish. The most common designs used in performance are bell and trapezoidal. We use the bell shape when we want a larger combustion chamber volume and the trapezoidal when we want to further compress the chamber volume. However, in practice and in dynamometer tests, I've noticed minimal differences when changing chamber shapes. Therefore, I disregard chamber geometry and focus more on the ideal compression ratio and squish speed.



Squish speed

Squish speed, so we use programs to calculate the correct height based on the bandwidth. To make things easier, I'll leave below tables created using a program called Squish. Velocity Calculator, by American Michael Forrest, which I acquired a few years ago. Depending on the piston width and squeezing band, you'll know which height to use. Of course, I'm disregarding crankshaft stroke and other parameters here, but I've made sure to keep the speed within a safe range so you don't run into problems. If you prefer to purchase Michael Forrest's program and find the exact speed for your engine, search for Dragon Fly on Google and you'll find it. The price is very affordable and worth the investment.

Base table for 55% crush band

Piston diameter in millimeters	Band width (55% squish) in millimeters	Band height in millimeters
37	6.1	0.62
40	6.59	0.67
42	6.92	0.7
45	7.42	0.75
47	7.75	0.78
50	8.24	0.83
52	8.57	0.87
54	8.9	0.9
56	9.23	0.93
58	9.56	0.97
60	9.89	1
62	10.22	1.03
64	10.55	1.07
66	10.88	1.1
68	11.21	1.13
70	11.54	1.17
72	11.87	1,2
74	12.2	1.23
76	12.53	1.27
78	12.86	1.3

Base table for 50% crush band

Piston diameter in millimeters	Band width (50% squish) in millimeters	Band height in millimeters
37	5.5	0.4
40	5.9	0.4
42	6.2	0.5
45	6.7	0.6
47	7	0.6
50	7.4	0.7
52	7.7	0.8
54	8	0.8
56	8.3	0.9
58	8.6	0.9
60	8.9	1
62	9.2	1
64	9.5	1.1
66	9.8	1.1
68	10	1,2
70	10.4	1,2
72	10.7	1.3
74	11	1.3
76	11.3	1.4
78	11.6	1.4

Base table for 45% crush band

Piston diameter in millimeters	Band width (45% squish) in millimeters	Band height in millimeters
37	4.8	0.48
40	5.19	0.52
42	5.44	0.54
45	5.83	0.58
47	6.09	0.61
50	6.48	0.65
52	6.74	0.67
54	7	0.7
56	7.26	0.73
58	7.52	0.75
60	7.78	0.78
62	8.04	0.8
64	8.3	0.83
66	8.56	0.86
68	8.81	0.88
70	9.07	0.91
72	9.33	0.93
74	9.59	0.96
76	9.85	0.99
78	10,11	1.01

Base table for 40% crush band

Piston diameter in millimeters	Band width (40% squish) in millimeters	Band height in millimeters
37	4.18	0.41
40	4.52	0.44
42	4.74	0.47
45	5.08	0.5
47	5.31	0.52
50	5.65	0.56
52	5.87	0.58
54	6.1	0.6
56	6.33	0.62
58	6.55	0.64
60	6.78	0.67
62	7	0.69
64	7.23	0.71
66	7.46	0.73
68	7.68	0.76
70	7.91	0.78
72	8.13	0.8
74	8.36	0.82
76	8.59	0.84
78	8.81	0.87

5. 11 Squish Velocity (MSV)

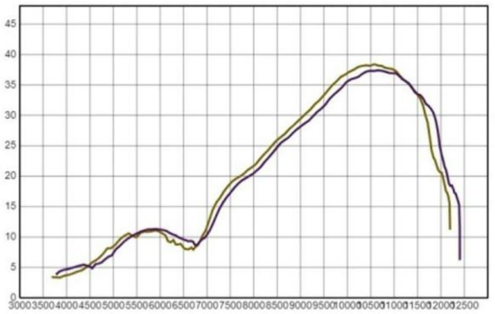
Squish speed is measured in meters per second and can be divided into three levels to match the tuning model we're looking for. The tables I provided work within a medium speed range, which will suit most engines without risk of detonation. But to give you a clear understanding of how to use squish speed in your tuning, follow the classification below.

Classification:

- **Low speed (15–22 m/s):** road engines, slower in response.
- **Medium speed (22–26 m/s):** motocross, balancing acceleration and usable range.
- **High speed (26–30 m/s):** motocross stadiums, with very fast response, but without exceeding high rotation peaks.

5.12 Final considerations

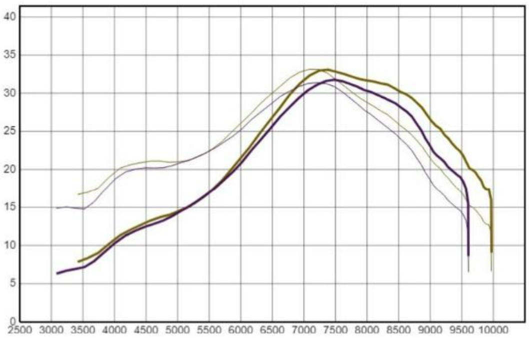
squish band is a powerful ally in directing the type of tuning we want. In the graph below, we can see the practical difference between a 50% squish band in brown and a 45% band in blue. This is an RD135 engine where the only change was the band width, keeping all other parameters the same, including the compression ratio. We see that with 50%, we have an improvement at low RPM and even at peak RPM, and with 45%, the engine reaches higher RPM. Depending on your application, use the squish band to your advantage.



Acerto 1 Puxada 1	Acerto 1 Puxada 1
38.40 Cv em 10572 RPM	37.39 Cv em 10654 RPM
2.70 Kgf.m em 10227 RPM	2.60 Kgf.m em 10407 RPM

Squash band on a Yamaha RD135 engine with 50% squash band in brown and 45% in blue.

Another practical example of what a well-designed cylinder head can do is the graph below, where the crush band was corrected on an off- road motorcycle , and this was the result. The only preparation applied to the engine was the cylinder head correction. Blue before and brown after.



squish speed indicated in the tables.

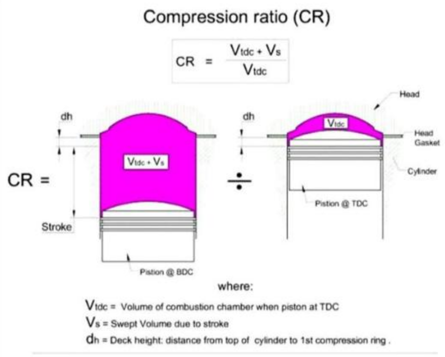
5. 13 Static compression ratio

The static compression ratio is based on two parameters.

The first is the total volume of the engine, considering the entire area above the piston at BDC.

The second is the area remaining in the combustion chamber when the piston is at TDC.

Knowing the volume of both areas, it is possible to calculate the compression ratio of any engine. Remember that 1 ml (milliliter) is equivalent to 1 cc (cubic centimeter), so when we measure a combustion chamber with any liquid, we will find the volume in ml, which is equivalent to a cubic centimeter (cc).



5.1 4 Types of Compression Ratio

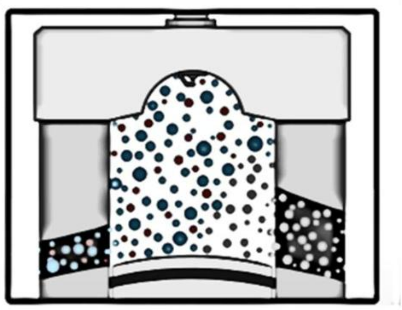
There are two methods of measuring the rate of an engine.

European method: This method of measuring the rate is done in the same way as in four-stroke engines, which considers the entire cylinder volume while the piston is at BDC. To calculate the rate using this method, we will use the crankshaft stroke as a reference.

Japanese method: This method assumes that the cylinder's useful volume extends from the top of the exhaust port to TDC, since the ports prevent the piston from actually compressing. However, I don't use this method, as the literature rarely mentions it . Therefore, we have few references to the use of compression ratios using this method. This is unlike the European method, which is based on examples of four-stroke engines.

Another factor that puts me off this way of measuring the rate is the fact that when we change the graduation of the escape window, it would automatically change the rate.

European method



Calculating the rate is very simple. We simply calculate the engine displacement and measure the combustion chamber volume. As we saw in the introductory module, engine displacement is determined by the piston diameter and crankshaft stroke. Knowing the engine's cubic volume, we need to calculate the combustion chamber volume by measuring it with a syringe and oil. We'll see how to perform this measurement in practice later.

The way to calculate the rate is as follows:

Let's take the DT200 engine as an example. It uses a 66mm piston and a 57mm crankshaft stroke. Therefore: Displacement = r^2 x ϖ x crankshaft stroke. The radius of 66mm is 33mm. Pi is a constant of 3.14, and the crankshaft stroke is 57mm, therefore:

33 x 33 x 3.14 x 57 = 194.9cc

To use this engine on gasoline, we will choose a compression ratio of 10.5:1.

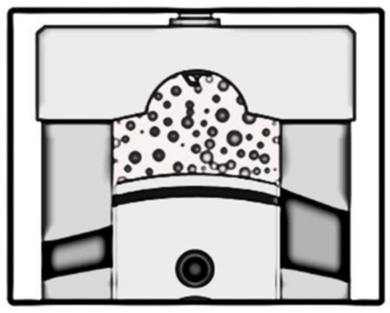
The compression ratio formula is simple, and in this case, we'll estimate any volume to arrive at the correct one. Let's estimate a volume of 20ml and calculate: TX = total engine displacement plus chamber volume, divided by chamber volume.

So: 194.9 + 20 / 20 = 10.74:1. In this case, we exceeded the required volume. If the ratio was above, we need to increase the chamber volume and recalculate. Therefore: 194.9 + 20.5 / 20.5 = 10.50:1. Our goal then is to find 20.5ml inside the combustion chamber with the DT200 piston at top dead center.

Now let's assume I already have an engine assembled and want to measure its compression ratio. We'll first measure the displacement and chamber volume.

In this case, simply apply the same formula to find the displacement. Let's assume we measure a 125cc engine and find 13ml of displacement in its combustion chamber. Let's apply the displacement calculation formula as follows: 125 + 13/13 = 10.38:1.

Japanese method



The Japanese method uses essentially the same formula, but considers the cylinder area with the piston flush with the exhaust port opening. In this case, instead of using the crankshaft stroke, it uses the exhaust port height.

Let's go back to the example of the DT200, which has a 30mm exhaust port height and we will calculate its displacement considering this measurement, therefore:

33 x 33 x 3.14 x 30 = 102.5cc

Her service manual states a 5.7:1 compression ratio. Therefore:

102.5 + 21.5 / 21.5 = 5.76:1.

Note that we find 20.5ml in the chamber when we calculate using the European method and that the two, in practice, do not differ much.

5.15 How to measure

We need to define the desired volume in the chamber and choose between a 10ml or 20ml syringe. For a 50cc engine, we'll never use more than 10ml in the combustion chamber. For a 125cc engine, we'll likely need a volume above 10ml, so we'll opt for a 20ml syringe. Therefore, here we're looking at a 10ml syringe.

In this case, I used two-stroke oil for measurement and filled the syringe to the 10ml mark. To make it easier to measure and visualize the volume that entered the chamber, I prefer to use the back of the rubber, so the volume that entered will also be measured from the back of the rubber.

This technique helps to better visualize the amount that entered.

Note that I added the oil to the first spark plug thread. To avoid making a mistake with this amount, I recommend adding it slowly, adding it drop by drop, and noticing when the oil reaches the first spark plug thread.

The biggest mistake we can make is looking at the syringe and thinking that the remaining oil content will be our chamber volume. But we need to observe the amount that entered, and it corresponds exactly to the volume that emptied into the syringe.

In this syringe, we see that for every 1ml, there are 5 dashes. This means that each dash corresponds to 0.2ml. We see that 7ml was entered plus 3 dashes. Therefore, 7ml + 3 x 0.2ml entered, which corresponds to a total of 7.6ml.

First, let's recall how we found the engine's total displacement. Here we have a 47mm piston with a 41.8mm stroke. Therefore, we have the following calculation:

23.5 x 23.5 x 3.14 x 41.8 = 72.48cc

The formula for finding the compression ratio is:

displacement + chamber volume / chamber volume

We then have: 72.48 + 7.6 / 7.6 = **10.53 : 1 rate.**

Therefore, calculating the compression ratio of any engine depends on two parameters: the actual engine displacement and the actual combustion chamber volume. This is how we find the **compression ratio** of any engine.

Never rely on the measurement provided by the manufacturer or seller, as commercially, the cylinder capacity is always rounded off.

When we think about static compression ratio, we can initially think of a fixed compression ratio, which helps us have a starting point in preparation.

Below we have some compression ratio suggestions that are a consensus among most mechanics and accepted as ideal, bringing good efficiency to the engine without compromising the safety of the mechanical assembly.

Fuel	Suggested compression ratio
Gasoline up to 92 octanes	10.5:1
92 octanes to 97 octane gasoline	12.5:1
Gasoline above 100 octanes	14:1
Ethanol	12.5:1
Methanol	14:1
Avgas (+100 octane)	14:1

Note: My suggested values are intended as a reference. You can use a higher compression ratio for better performance, but as we'll see below, the dynamic compression ratio determines how far we can go.

5.16 Dynamic compression ratio

The dynamic compression ratio, as the name suggests, can vary. It's related to the static and volumetric efficiency of the engine, meaning it varies for several reasons, as we'll see below.

Engine volumetric efficiency, as we saw previously, is related to the engine's breathing capacity—that is, the engine's ability to admit a given amount of air/fuel mixture. Therefore, if the dynamic ratio depends on volumetric efficiency, we understand that increasing it will consequently also increase the dynamic compression ratio.

Now let's imagine we select a static ratio X for an engine and know that this ratio is the limit for that configuration. In other words, if we increase the volumetric efficiency, no matter what we do, the engine will detonate. It's important to consider that increasing the engine's volumetric efficiency will result in damage. Therefore, it's always prudent to work with compression ratios within the safety margin for each fuel.

Therefore, considering dynamic compression ratio is smarter than static compression ratio, since we can have a higher compression ratio if the engine's volumetric efficiency is poor. It also helps to consider that when we have a highly tuned engine, we need to reconsider static compression ratio values, since by tuning the engine, we increase its volumetric efficiency and risk detonation.

Dynamic compression ratio is difficult to measure, as it depends on many variables. But it helps us think about our engine strategy. What I want to get you thinking here is that we can use a higher static ratio in engines that are inefficient, or perhaps reduce the compression ratio in a more efficient engine.

For example:

I have two engines with the same displacement and compression ratio.

Engine 01 – uses 10.5:1 static ratio and stock exhaust

Engine 02 – uses 10.5:1 static ratio and dimensioned exhaust

Let's imagine that engine 01 has a volumetric efficiency of 85% and that engine 02, due to exhaust supercharging, reaches 110% volumetric efficiency.

Therefore, it is as if motor 01 was using a static ratio of 8.9:1 (10:5 x 85%) and motor 02 was using a static ratio of 11.55:1 (10.5 x 110%).

This is why in turbocharged engines, a lower static compression ratio is used, since the pressure added to the engine by the turbocharger considerably increases the dynamic ratio.

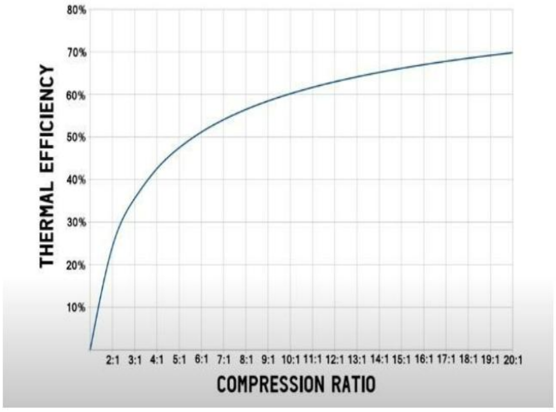
5.17 Thermal efficiency

Thermal efficiency is directly related to compression ratio. The relationship between them forms a parabola that rises rapidly as the ratio increases, starting from 2:1, and begins to curve horizontally at higher compression ratios.

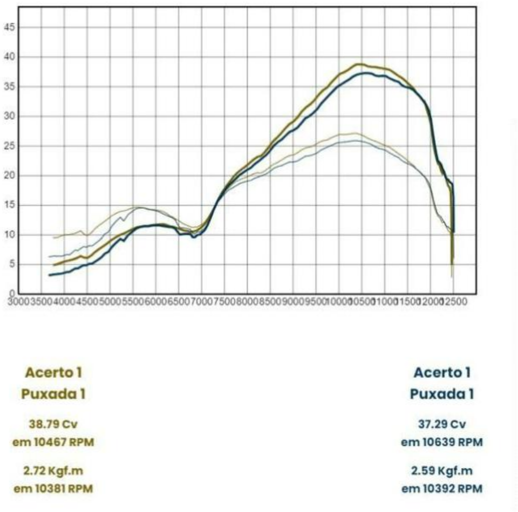
As we can see, we reach a certain compression ratio where efficiency starts to stop growing and trying to increase the ratio exposes the entire mechanical assembly to higher pressures without major gains.

It is assumed that 65% efficiency is a good target for most motors, maintaining safety in terms of mechanical wear due to friction between the bearings and with good thermal efficiency.

Note that increasing the ratio from 14:1 to 16:1 increases efficiency by only 2%. We also need to consider the maximum acceptable ratio for each fuel before considering increasing it.



The graph below shows an example of a test with an RD135 engine with a 16:1 compression ratio in brown and 14:1 in blue. Note that the gain occurred throughout the power curve, and at high revs, it was a draw. Increasing the compression ratio will always be beneficial up to the point where it can no longer withstand the pressure and will detonate. But here again, the advice to never run at the limit applies. If this engine could handle a 16:1 ratio, it's recommended to run at 15:1, for example, to avoid problems, since, as the engine heats up, the chamber temperature could be the trigger for detonation. Other factors, such as lean mixture and poor fuel quality, can also be factors that lead to disaster. Detonation is catastrophic, both in terms of power loss, excessive stress on the connecting rod bearings, and overheating. We want a well-prepared engine, not a ticking time bomb.



5.17 Head preparation

Before starting the head preparation, we need to define three initial parameters.

Desired compression ratio: In the case below, I'll be developing a cylinder head for a 95cc moped big bore . I'll be using methanol, and I'll opt for a static ratio of 16:1.

Crush Band: The piston is 52.5mm, and I want a band with 50% of the area. So, I calculated and found the value of 7.7mm for this area.

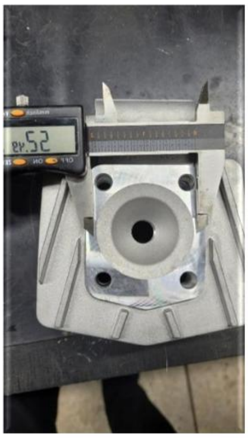
Crush Height: I chose a crush height of 0.72mm, respecting the squish speed of 26 m/s for maximum torque, since in this case the transmission is a CVT. We'll soon learn how to calculate MSV.

Once these parameters have been defined, we can begin work.

Here I'm using a cylinder head with a center spark plug. In this case , I use a spark plug clamped to the lathe to machine the cylinder head. If the cylinder head doesn't have a center spark plug, this work needs to be done on a milling machine.

It's worth noting that this technique works for any cylinder head with a center spark plug. Then, I use the caliper to mark the outside diameter of the squish .

If you look at the piston rim, you'll see that this engine experienced detonation, which is why I'm rebuilding the cylinder head and documenting the entire process for you. The previous cylinder head had a very high cylinder head speed, combined with the high compression ratio, which resulted in detonation.



Next, I clamp the piston in the vise and find out what angle the piston head should be at to replicate the same angle on the cylinder head.

I lock the lathe table and can start machining the crushing part.

In this part, we will open the crushing to the maximum diameter of the cylinder, which here is 52.5mm.

Now we'll create the inner portion of the crush band. We find the inner diameter by subtracting the total diameter of 52.5mm from the crush band on both sides.

That is, 52.5 – 7.7 – 7.7 = 37.1 mm.

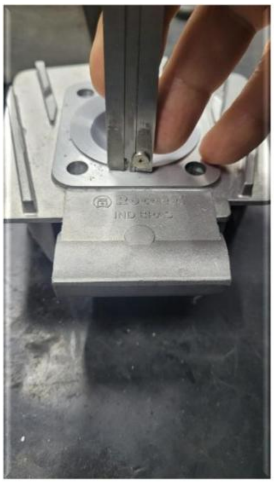
Knowing the central diameter, we will carefully open the head until we reach the measurement found and we will have our 7.7mm crushing band.

So far, we've made the crush band with the correct inner and outer diameter angle. The next step is to determine the crush height. To do this, we'll measure the piston height relative to the cylinder. In this case, the height we found was negative 2.3 mm. Therefore, the cylinder head needs to fit into the cylinder to achieve the 0.72 mm crush we calculated. Back on the lathe, we'll countersink the part that contacts the cylinder to the maximum diameter of 52.4 mm to allow clearance for the squish to enter the cylinder.

The positive height we want the squish to have should be:

2.3 – 0.72 = 1.58mm

Therefore, we must find 1.58mm of squish band above the cylinder head base. Since the cylinder is jacketed, no gasket will be used in this case, so we don't need to consider it in this calculation. However, if a gasket is present, we need to use the following calculation to find the positive squish height : (piston-to-cylinder height + gasket thickness – squish height). Example: 2.3 + 0.5 – 0.72 = 2.08mm.



I recommend that this process be done very calmly and preferably use a height lower than that calculated for machining and carry out tests, assembling the head and testing the height with the tin wire until reaching the desired height.

In this case, I used 1mm tin wire, since the squish height is lower. However, in larger engines where squish heights greater than 1mm are encountered, we'll need 1.5mm or 2mm wire.

After reaching the crush height, the next step is to find the combustion chamber volume for the calculated rate.

Now we will tighten the cylinder head with at least two screws and with a syringe proportional to the volume we want, inject oil into the chamber through the spark plug opening.

The engine must be level to avoid erroneous readings, and the piston must be at TDC. Inject oil until it covers the first thread of the spark plug.

We had set the static ratio to 16:1 and for this we will need:

95cc + 6.4ml / 6.4ml = 15.84:1

In this case, I chose not to change it any further since what is needed to reach the calculated measurement is only 1%.

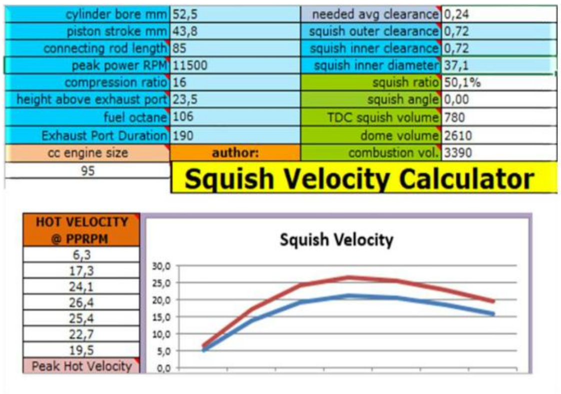
However, it is unlikely that we will find the correct volume and we need to open the combustion chamber bell with a tool similar to the one in the photo alongside.

We must open it until we reach the necessary volume, assembling, measuring and disassembling the head as many times as necessary.

To finish the job, I spin the head and polish the chamber with a piece of steel wool. If the finish is too rough, start with coarse sandpaper, gradually reducing the grit, and then finish with steel wool.

Squish 's velocity , I used the Michael Forrest calculator I bought a while back. By plugging some data into the blue areas, we were able to find the MSV.

Note that the maximum speed reaches 26.4 m/s and that, depending on the crush height, we can adjust this speed. This is how I found the MSV with a 0.72 mm crush.



cylinder bore mm	52,5	needed avg clearance	0,24
piston stroke mm	43,8	squish outer clearance	0,72
connecting rod length	85	squish inner clearance	0,72
peak power RPM	11500	squish inner diameter	37,1
compression ratio	16	squish ratio	50,1%
height above exhaust port	23,5	squish angle	0,00
fuel octane	106	TDC squish volume	780
Exhaust Port Duration	190	dome volume	2610
cc engine size	author:	combustion vol.	3390
95	Squish Velocity Calculator		

HOT VELOCITY @ PPRPM
6,3
17,3
24,1
26,4
25,4
22,7
19,5
Peak Hot Velocity

Text taken from the Bimotion app as previously mentioned. Since the purpose of this engine is a 201-meter sprint, I used the maximum squish speed .

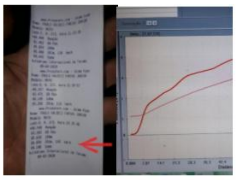
Low-speed MSV 15-22 m/s - for engines that need to spin from the point of maximum torque and beyond the point at which maximum horsepower is delivered. Engine response and acceleration to the point at which maximum torque is delivered are slower. Typically road racing.

Average MSV speed 22-26 m/s - for engines that need to rotate from a point below the maximum torque point to just above the point at which maximum HP is delivered. Typically motocross

High-speed MSV 26-30 m/s - for engines that need to accelerate quickly in slow corners. The engine response is quick. Almost no engine with this MSV rating will exceed its highest peak rpm. Typically, a motocross stadium.

Where MSV means maximum squish velocity.

This engine set a record in 2020 with a time of 8.6 seconds for the 201 meters, reaching 143 km/h. It produced 21.6 hp at the wheel.



Chapter 6 – Cylinder: Graduation

6.1 Introduction

, helps concentrate or spread the powerband, as well as raise or lower the maximum power RPM.

When we define what use will be made of the project, we need to define the heights of the windows, but to know the correct height, we will always base ourselves on the graduation.

The caliper is universal in 2-stroke engines. Regardless of displacement, piston size, or crankshaft stroke, it gives us an idea of how the engine will behave. If we were to base our calculations on port heights, a slight change in crankshaft stroke would significantly alter the engine's behavior, and we would no longer have a logical line of reasoning. Believe me, when you familiarize yourself with the caliper of two-stroke engines, regardless of their size, you'll know how they will behave. That's why I call the caliper universal, because anyone who mentions port angles will be easily understood in a conversation among tuners.

Therefore, avoid talking about port heights; they say very little about any engine. Keep in mind that a 24mm height in an exhaust port on a small-displacement engine creates a relatively low exhaust caliper, but on a large-displacement engine, it can represent a very high exhaust caliper. This is due to the