



Norman Hyde plate (left) standard plate (right).
Both have the same outside diameter.

T = Torque - How much engine torque a clutch can transmit without slipping.

Torque = $N \times f \times F_a \times R_m$ Where:

N is the number of friction discs in contact
f is the Coefficient of friction of clutch material
 F_a is the clamping force supplied by clutch springs
 R_m is the Mean Radius of the friction facing

Hidden away in the hostile environment of the primary, bathed in hot engine oil is the motorcycle's clutch. While it is a simple device it can be the source of much aggravation.

Motorcycle clutches transmit engine Torque to the rear wheel. They do this with 4 variables:

- The coefficient of friction (COF) of the clutch facings used,

- The clamping pressure (or Force) supplied by the clutch springs,
- The mean effective radius of the clutch facing surface,
- and the number of friction surfaces.

Don't Let It All Slip Away

by John Healy

You might have noticed that I didn't mention area. In the World of clutches, more area doesn't equal more clutch. So let's look at the 4 things that make your clutch work.

Coefficient of Friction

Friction is "the resistance an object encounters in moving over another."

The coefficient of friction is a number which represents the friction between two surfaces. The assigned number is found through testing.

The material used for clutch facings have different coefficients of friction (COF). Run the clutch dry you will get a high COF. Put it in oil and it drops significantly. This is why you won't find a Nitro Harley dragster's clutch running in oil. The higher the COF the more torque a clutch plate can transmit.

The cork inserts of yesteryear had a high COF, but when used hard, wear was a big problem. Abuse those early cork clutches in those days before cell phones and you were walking.

In our bikes, cork was replaced with cork/rubber blends. These blends gave much longer life, but at the expense of a lower COF. To keep these plates from slipping extra plates were added and we started to see heavier springs.

Cork/rubber blends (referred to as organic) are more than adequate for most street applications where the clutch seldom reaches 100° C (212° F). But use them in a performance application and heat can quickly destroy them. To address the heat problem, modern clutches sport clutch facing materials that will give adequate COF while being able to handle the heat generated when we place more demands on the clutch.

Some modern clutch facings actually have a lower COF than the cork/rubber blends, but continue to work long after organic blends would have "burned-up". Some facing materials, like carbon fiber composites, have a higher COF as they heat up. The loss in the facings ability to transmit engine torque it is made up with higher spring pressures, more plates (more friction surfaces) and a larger mean radius (narrow facing for a given outer clutch diameter).

Because many of these modern facings do not really come into their own until they are used hard and heated up, people who put them in their street bike are often disappointed. For most street riders the old organics can be the better choice.



Sampling various clutch springs using a PT-200 Valve Spring Tester. This is a 57-1830 spring and you can see on the PC screen 42 lb. at 1.325".

Mean Effective Radius

It isn't the surface area of the clutch facing that is important here, but the mean effective radius (MEF) between the inside diameter (i.d.) and outside diameter (o.d.) of the facing material. Increase the mean radius of the clutch facing and you will increase the ability of the facing to transmit engine torque. Take our typical British motorcycle clutch plate and turn off 1/2 of the facing material, increasing the i.d. by 3/8", you have increased the mean radius. Doing this will increase the amount of torque the plate will handle. For those interested the MEF can be calculated:

$$r_m = \frac{D_o^3 - D_i^3}{3(D_o^2 - D_i^2)}$$

Where:

r_m = Mean Effective Radius

D_o = Outside Diameter

D_i = Inside Diameter

Or for those of us who were absent on the days when this was taught, approximately half way between the o.d. and i.d., but not quite. When you pick-up a couple of clutch plates with facings with the same o.d., the one with the smaller i.d. has a larger mean effective radius and will transmit more torque.

Clamping Force

The clamping force is supplied by the clutch springs. The springs come in three strengths: 57-1560 500 twins, 57-1830 650 twins and the 57-4644 used on all T140 clutches.

Number	Free Length	*Fitted Length	Wire Diameter	Coil Bind
57-1560	1.975"	@1.325" = 32 lb	.090"	.790"
57-1560	1.975"	@1.185" = 37 lb	.090"	.790"
57-1830	1.815"	@1.325" = 43 lb	.104"	.900"
57-1830	1.815"	@1.185" = 58 lb	.104"	.900"
57-4644	1.716"	@1.325" = 53 lb	.115"	1.025"
57-4644	1.716"	@1.185" = 76 lb	.115"	1.025"

After Market:

Emgo 88-57493(replaces 57-1830)

1.778" @1.325" = 45 lb. .104" .865"

1.778" @1.185" = 61 lb. .104 .865"

Barnett 501-86-03075 (old # MT-75-3)

1.755" @1.325" = 45 lb. .105" .885"

1.755" @1.185" = 59 lb. .105" .885"

Precision Machine 70-0124 (Triumph 650/750 high performance clutch springs)

1.886" @1.325" = 72 lb. .113" .965"

1.886" @1.185" = 93 lb. .113 .965"

*Fitted length 1.325 nut tightened until spring bolt flush with bottom of screwdriver slot. 1.185" nut tightened until spring bolt flush with the head of clutch nut (Triumph recommendation). Often by going to the next stronger spring is too much. By installing the next heavier spring, but only screwing the nut so the stud is flush with the bottom of the slot you can incrementally increase spring pressure.

Number of Friction Surfaces

The stock Triumph unit construction clutch has six plates giving 11 friction surfaces. The only way to increase this is by adding a plate. This requires thinning the clutch facing. This is just what Norman Hyde did in his 7 plate clutch conversion kit. The stock Triumph plate is 0.150" and Norman's friction plates are thinned to 0.115" allowing for another friction and steel plate to be installed. This gives you 2 more, or 13, friction surfaces. This increases the torque capacity of the clutch about 10%.

The Hyde clutch has a couple of other things that improve its torque handling characteristics. The facing is narrowed increasing the mean effective radius and the friction surface is broken into a series of small pads. The edges of the pads act as a squeegee to remove oil from the steel plate. These modifications greatly increase the capacity of the clutch.

For street use in a 750 twin he recommends using the lighter 650 spring (57-1830) in the 1.185" fitted length or if the stock spring is retained to use the 1.325" fitted length. Because clutch spring pressure is felt directly at the clutch lever this will give an easier pull and retain proper clutch operation.

But wait... Oil Matters -

The coefficient of friction of a clutch plate's friction material is greatly reduced when the plates run in oil. It is further reduced when the oil used has friction modifiers mandated by the Government to be used in modern automobiles. Early Triumphs primary oil was isolated from the engine oil so this wasn't a problem. With later models (1970-on) the clutch shares oil with the engine. This is when you should be considering the affect your oil choice will have on your clutch.

There is a lot of talk about modern oil and zinc, but we should also consider the affect friction modifiers have on our clutches. We are used to looking at the oil's SAE rating checking for an oil that is compatible with our old motorcycles, but we have a new aid to help us find oil that will reduce our clutches ability to transmit engine torque.

It is the JASO standard: JASO-MA has no friction modifiers while the JASO-MB does. You will find the JASO-MA standard on motorcycle oils sold by Morris Lubricants V-Twin 20W/50, Castrol Actevo X-Tra 20W/50, Valvoline® 4-Stroke Motorcycle Oil 20W/50 and others. **Please notice that our engines were designed to be used with 20w/50 oil**, but that is another subject. It is a myth that you cannot use synthetic oil

with a wet clutch. Synthetics blended for use in motorcycles will have a JASO-MA rating (I would recommend using a break-in oil like sold by Morris Lubricants before putting synthetic in the engine).

Stuff Sticks

Another downside of early British clutch designs is their tendency to drag, and in some cases "weld" themselves together. The normal rocking used to free a stuck clutch pack has no affect and the plates have to be removed as a pack and pried apart.

It is believed this is caused by a combination of molecular attraction and the vacuum caused when air is squeezed out between the plates. To achieve molecular attraction the plates must lap themselves perfectly smooth and flat. A clutch facing material used by Barnett in the past was know for this. Today, this is no longer a problem as Barnett. They have change their clutch facing material used on the vintage British plates. Those old plates "worked the treat", just too well when they were used hard!

In modern motorcycle clutches the affects of molecular attraction are greatly reduced by using narrow clutch facing with about 1/3rd the area of friction material of our stock plates. Norman Hyde's 7-plate conversion features this type of plate design (increased mean effective radius, segmented facing pads and additional friction surfaces). You will notice the difference the first time you put your bike into gear. The drag from molecular attraction will be greatly reduced, and reduce, if not eliminate, any grinding going into first gear.

Also by narrowing the face of the friction material you increase the mean effective radius in Hyde's case by about 10%. This, along with the extra 2 friction surfaces, increases the torque capacity of the Triumph clutch approximately 20%.

How narrow you ask? A suitable width of a lining is one that is sufficiently narrow to give the largest mean radius but not so narrow as to allow rapid wear or fade to occur. Also the use of segmented facings allows oil to be cleaned from the steel plate increasing the COF. There is a lot to think about... Now lets talk about the nylon lined clutch cable... Maybe next time.