Differentials - General Information

Most differentials are the “open” type. These diffs do not contain a limited slip or lockup mechanism. The result is that power goes to the tire with the least traction. For example: If one tire is on ice and the other on dry pavement, the tire on the ice will spin and the one on dry pavement will not. You can test whether you have an open diff by jacking up one side of the car. If you can spin the wheel by hand the diff is an open type. If both sides are off the ground, spinning one wheel will cause the other wheel to move in the opposite direction. Open diffs are ok for most applications

Limited slip differentials have a mechanism that ties the two wheels together for better traction but still allow the wheels to move independently under certain conditions. There are a number of different designs. All BMW’s (except some of the newest models) use a ZF clutch design. This design, stated in it simplest form, uses peloaded clutch plates to tie the wheels together. At some set amount of torque the clutches will begin to slip. For some strange reason this is often expressed as a percentage. Percentage of what? The answer is engine torque. For example: The commonly available 320I LS diff is said to be a “25%” limited slip. It’s actual breakaway torque is 30 ft/lb., which is 25% of the approximately 120 ft/lb. the engine produced. So a 25% LS diff in a later 6 cyl car will have a higher breakaway torque. To add more confusion, diffs were not always custom tailored by the factory to every application so the percentage thing is not strictly accurate. In any case, referring to limited slip by percentage is somewhat usefully for comparing similar diffs; but actual breakaway torque is more correct.

So why do we all seem to want a limited slip differential? We want better and more consistent traction. First the bad news-- In slippery conditions it will cause the car to oversteer or want to “come around”. This is because both tires will lose traction at the same time, but with an open diff only one tire loses traction and the other will still resist oversteer. This is usually not a problem for a skilled driver but can be difficult for the average driver. Now the good news-- Limited slip will allow you to get the power down both in a straight line and around corners. At autocross or track events an open diff will result in inside wheel spin on tight corners. For these applications a limited slip diff is pretty much required. Even on the street at legal speeds, you can notice the improvement in traction.

For street use the normal factory 25% limited slips are appropriate. For dual use street/track or serious autocross increasing breakaway torque to about 40% is a good choice. For a dedicated track car something more like 60-70% is better. For you track junkies, the slipping action of a limited slip generates heat, and the higher the lockup the more heat. So plan on changing the diff oil more often. If you don’t you can plan on rebuilding your diff soon. On my race car I never go more than 2 events without changing the oil.

Now let's talk about the dreaded and much maligned welded differential. First, you do not want to try to run a welded diff on the street. However, the race track is a different matter. Contrary to some opinions a properly welded diff is nearly bullet proof. I have welded many with zero failures. I have also repaired some with broken welds. In all cases the welding was simply insufficient and/or of poor quality. The welding must be done outside of the case and the bearings should be replaced. The part must be preheated and should be TIG welded. A welded diff is inexpensive and low maintenance. Because a welded diff is a no slip unit it can cause understeer or push on slow or medium speed corners. On simple 90 degree corners this is not much of a problem but on low/medium speed sweepers it's definitely noticeable. For this reason a welded diff is usually not the best choice for autocross. On most road racing courses, a welded diff is not much of a handicap. Drivers usually say it takes some getting used to but end up liking the positive feel. I should say that welded diffs are strictly amateur stuff. No "professional" race teams use them.