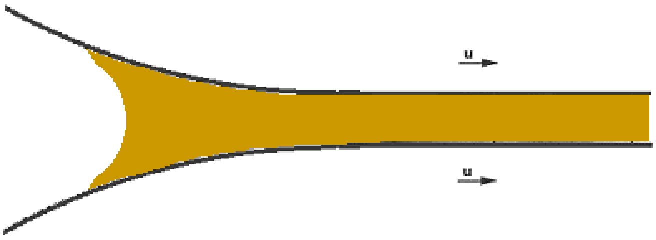
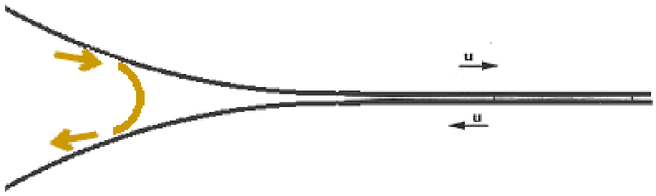
Slide-Roll Ratio versus Slip





Slide/Roll Ratio – Two Roller Machines

Slide/Roll Ratio = **Sliding Velocity / Rolling Velocity**

Where:

Sliding Velocity = $|U_1 - U_2|$

Rolling Velocity = $\frac{1}{2}(U_1 + U_2)$

For lubricated tests in a two roller machine, where the axes of rotation are fixed, the **Rolling Velocity** is the same as the lubricant **Entrainment Velocity**.

Hence:

Slide/Roll Ratio% = $200 \times |U_1 - U_2| / (U_1 + U_2)$

This is the "preferred" definition of Slide/Roll Ratio and it means that for "pure sliding", in other words, for $U_2 = 0$, the **Slide/Roll Ratio = 200%**.

Slide/Roll Ratio – General Solution

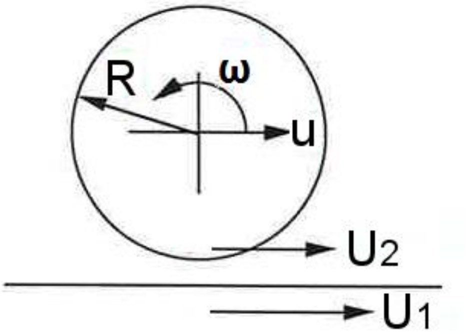
Slide/Roll Ratio = Sliding Velocity / Entrainment Velocity

In some circumstances, it is useful consciously to use the entrainment velocity as opposed to the rolling velocity, when analysing more complicated systems.

Entrainment Velocity = $\mathbf{\frac{1}{2}\{(U_1 - u_c) + (U_2 - u_c)\}}$

Where $\mathbf{u_c}$ is the speed of the contact patch, such that the Entrainment Velocity is the mean speed relative to the contact patch, as opposed to Rolling Velocity = $\frac{1}{2}(U_1 + U_2)$.

Consider rolling and sliding along a plane:



Where:

$u_c = u$

$U_2 = u + R\omega$

Entrainment Velocity $= \frac{1}{2}\{(U_1 - u_c) + (U_2 - u_c)\}$

$= \frac{1}{2}\{(U_1 - u) + (u + R\omega - u)\}$

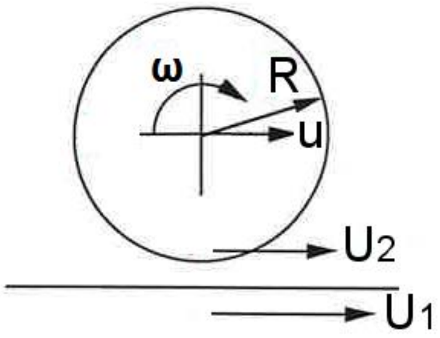
$= \frac{1}{2}\{U_1 - u + R\omega\}$

Hence:

Slide/Roll Ratio% = $200 \times (U_1 - u - R\omega) / (U_1 - u + R\omega)$

If $\omega = 0$ then Slide/Roll% = 200%, hence pure sliding.

If $U_1 = u + R\omega$ then Slide/Roll% = 0%, hence pure rolling.



Reversing ω direction:

Slide/Roll Ratio% = $200 \times (U_1 - u + R\omega) / (U_1 - u - R\omega)$

If $\omega = 0$ then Slide/Roll% = 200%, hence pure sliding.

If $U_1 = 0$:

Slide/Roll Ratio% = $200 \times (- u + R\omega) / (- u - R\omega)$

= $200 \times (u - R\omega) / (u + R\omega)$

Slip Ratio

Slip Ratio% is usually defined as:

Slip Ratio% = 100 x (Vehicle Speed - Wheel Speed) / Vehicle Speed

Slip Ratio% = $100 \times |U_1 - U_2| / U_1$

Hence, for “pure sliding”, in other words, for $U_2 = 0$, the **Slip Ratio = 100%**.

Slip Ratio = Sliding Velocity / Velocity of Larger Roller

Nominate U_1 to be the larger roller:

Slip Ratio = $(U_1 - U_2) / U_1$

Note:

Slip Ratio is a term that appears, as the definition might suggest, to be used mostly in the automotive industry, in particular with regard to traction control and anti-lock braking systems.

Creepage

Creep occurs when one or other of the materials in contact undergo some tangential deformation. If, for example, a thin 'tyre' on the wheel stretches a bit as a result of the application of the normal pressure then in making one revolution the wheel will have advanced a bit more than $2\pi R$. Creepage is that extra bit as a percentage and there are regions of 'stick' and 'slip' within the contact.

There appears to be an alternative definition of Creep% used in the rail industry, which may be at odds with the above definition. This term is derived from the Slide/Roll equation:

$$\begin{aligned} \text{Slide/Roll Ratio\%} &= 100 \times (\text{Sliding Velocity}) / (\text{Rolling Velocity}) \\ &= 100 \times (V - R\omega) / 0.5 \times (V + R\omega) \\ &= 200 \times (V - R\omega) / (V + R\omega) \end{aligned}$$

Now, if $R\omega$ is small, this is sometimes simplified to:

$$\text{Slide/Roll Ratio\%} = 200 \times (V - R\omega) / (V)$$

Hence Slide/Roll Ratio at low rates of sliding, sometimes (possibly) referred to as Creep%, is 2 x Slip Ratio%.