

Widen the Contact a Hundredfold and the Friction Does Not Change

— At 100 mm^2 or 10000 mm^2 of apparent area the friction is **30.0000** N alike — what actually touches is **0.1000** mm^2 , under **0.1** per cent of the apparent area — double the load and the friction doubles exactly —

[Paper 430]

Yuuki YAMAGISHI (山岸 勇輝)

Yamagishi Complexity Torus Lab, Japan

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— *From thinking to syncing.* —

Abstract

A wider contact is expected to rub more. This paper shows that multiplying the apparent area by a hundred leaves the friction unchanged—because the area that actually touches does not depend on the apparent area. No new theorem or law is claimed. First, this is the core of the paper. Taking the apparent area from 100 mm^2 to 10000 mm^2 leaves the friction at **30.0000** N (Section 3). Second, what actually touches is **0.1000** mm^2 , under 0.1 per cent of the apparent area (Section 2). Third, the friction coefficient equals the shear strength over the hardness, namely **0.300000** (Section 2). Fourth, multiplying the apparent area by a hundred divides the touching fraction by exactly a hundred (Section 3). Fifth, doubling the load doubles the friction exactly, by **2.000000**. Area does not move it; load does (Section 3). Sixth, the separator is apparent area against load (Section 4).

Scope of this paper (scope note): No new theorem or law is claimed—Amontons’ law, the real area of contact, and the plastic-contact model are all standard. The mechanisms of friction are not exhausted—separating adhesion, ploughing and intermolecular contributions is not the subject; only the simplest plastic-contact model is used. No material values are asserted—a hardness of 10^9 Pa and a shear strength of 3×10^8 Pa are representative for exposition, not values of any particular material. Elastic contact is not treated—at low pressures a separate argument is needed for why the real area remains nearly proportional to the load. Lubrication is not treated—with an oil film the account changes; only dry contact is treated. Exceptions are not denied—area-dependent friction is known for soft materials and other cases, and this paper does not deny it. Relation to earlier papers: Paper 429 showed that a round trip over the same height does not return the same temperature—there apparently identical operations gave different results; here apparently different settings give identical ones. Paper 300 showed that common root and distinct root can be decided—“apparent area” and “real area of contact” are distinct roots by that criterion. Paper 419 showed that the same material differs in strength by orientation—there a quantity absent from the drawing acted; here a quantity written on it does not. Paper 424 showed that dividing turns a move in the denominator into an event—here too a fraction is the quotient of two independent quantities. What is added is showing the friction constant across three apparent areas, giving the real area as 0.1000 mm^2 , confirming by inversion that the coefficient equals shear over hardness, showing the touching fraction inversely proportional to the apparent area, placing the load dependence as the other side of the boundary, and placing the separator at “area or load”.

1. Notation and the Question

Setting: Under a load W , the asperities of a material of hardness H yield and spread until they can carry it.

$$A_{\text{real}} = \frac{W}{H}$$

The force needed to shear that area at a shear strength s is the friction.

$$F = s A_{\text{real}} = \frac{s}{H} W \quad \implies \quad \mu = \frac{F}{W} = \frac{s}{H}$$

Below, $W = 100 \text{ N}$, $H = 10^9 \text{ Pa}$ and $s = 3 \times 10^8 \text{ Pa}$.

Observation 1.1

A wider contact is expected to rub more. More places touching, more resistance—a natural thought.

Observation 1.2

But experiment says the area does not matter. Rest the same body on a different face and the friction is the same—as has been known for a long time.

Question: Why does it not matter.

2. What Actually Touches Is 0.1000 mm^2

Computation 2.1: Take the real area from load and hardness.

$$A_{\text{real}} = 100/10^9 = 10^{-7} \text{ m}^2, \text{ that is } \mathbf{0.1000 \text{ mm}^2}.$$

Observation 2.2

A square about 0.3 mm on a side. However large the body, no more than this is touching—every surface has asperities, and only their summits meet.

Computation 2.3: Take the friction and its coefficient.

$$F = 3 \times 10^8 \times 10^{-7} = \mathbf{30.0000 \text{ N}} \text{ and } \mu = \mathbf{0.300000}.$$

Observation 2.4

μ equals $s/H \cdot 3 \times 10^8/10^9 = 0.300000$ —and inversion returns the same value.

Observation 2.5

No area appears in that expression. μ is fixed by the ratio of two strengths of the material—shape and size have vanished.

3. A Hundredfold Apparent Area, the Same Friction

Computation 3.1: Hold the load and vary only the apparent area.

Apparent [mm ²]	Real [mm ²]	Touching fraction	Friction [N]
100	0.1000	0.001000	30.0000
1000	0.1000	0.000100	30.0000
10000	0.1000	0.000010	30.0000

Observation 3.2

The friction is **30.0000** N in all three. A hundredfold apparent area moves nothing—because the real area is fixed by W/H , which does not contain the apparent area.

Observation 3.3

What changes instead is the touching fraction, by exactly 1/100. From 0.001000 to 0.000010—the contact does not spread thinner over the wider face; the number of touching places stays and the gaps increase.

Observation 3.4

At most 0.1 per cent is touching. A thousandth of the apparent area—the picture of “contact over a surface” is itself wrong.

Computation 3.5: Now double only the load.

The friction doubles exactly, by **2.000000**.

Observation 3.6

Area does not move it; load does. Two ways of “pressing harder” give different results—and that is the separator.

4. The Separator

The separator: apparent area or load.

Observation 4.1

Moving the apparent area does not move the real area. No area appears in W/H —so the friction does not move either.

Observation 4.2

Moving the load moves the real area proportionally. The asperities yield and spread—so the friction is proportional too.

Observation 4.3

These are distinct roots by the criterion of Paper 300. Both are called “the area of contact”—one is set by shape, the other by force.

Observation 4.4

This is why the coefficient looks like a property of the material. $\mu = s/H$ is a ratio of two strengths, with shape and size gone—not gone, but cancelled in the division.

Observation 4.5

Spreading the load over a wider face does not reduce the friction. The real area is the same—to lower the contact pressure one must lower the load.

Observation 4.6

To be honest—the simplest plastic-contact model is used here. Elastic contact and lubrication need separate arguments—area-dependent friction is known in some cases, and this paper does not deny it.

Observation 4.7

One last thing—the figure of 0.1 per cent is fixed by load and hardness alone. Polishing or flattening does not change it—what changes is only how that area is divided between the number of touching points and the size of each.

5. Roll Call and Closing

1. The real area is 0.1000 mm^2 (Computation 2.1): that is W/H .
2. The friction is 30.0000 N (Computation 2.3): that is sA .
3. The coefficient is 0.300000 (Observation 2.4): equal to s/H .
4. No area appears in μ (Observation 2.5): shape and size vanish.
5. 30.0000 N at a hundredfold area (Computation 3.1): the core.
6. The touching fraction falls by $1/100$ (Observation 3.3): inversely.
7. At most 0.1% touches (Observation 3.4): a thousandth.
8. Doubling the load gives 2.000000 (Computation 3.5): the other side of the boundary.
9. Area does not move it, load does (Observation 3.6): the separator.
10. The separator is area or load (Observation 4.3): distinct roots by Paper 300.

Closing: A wider contact is expected to rub more—more places touching, more resistance—but experiment says otherwise: rest the same body on a different face and the friction is the same. The reason is that the area actually touching does not depend on the apparent area—under a load of 100 N on a material of hardness 10^9 Pa , the asperities yield until $A = W/H = 0.1000 \text{ mm}^2$, a square about 0.3 mm on a side. Shearing that area gives a friction of 30.0000 N and a coefficient of 0.300000 . That coefficient equals s/H , and no area appears in the expression—shape and size have vanished. So a hundredfold apparent area moves nothing—at 100 , 1000 and 10000 mm^2 the friction is 30.0000 N alike. What changes instead is the touching fraction, from 0.001000 to 0.000010 , exactly $1/100$ —the contact does not spread thinner over the wider face; the touching places stay and the gaps increase. At most 0.1% per cent, a thousandth of the apparent area, is touching, so the picture of “contact over a surface” is itself wrong. One thing separates them—apparent area or load. Moving the apparent area does not move W/H , which contains no area; moving the load makes the asperities yield and spread proportionally. Double the load and the friction doubles exactly, by 2.000000 . They are distinct roots by the criterion of Paper 300: both are called the area of contact, but one is set by shape and one by force. So spreading the load over a wider face does not reduce the friction—the real area is the same, and to lower the contact pressure one must lower the load. To be honest—the simplest plastic-contact model is used here; elastic contact and lubrication need separate arguments,

and area-dependent friction is known in some cases, which this paper does not deny. One last thing—the figure of 0.1 per cent is fixed by load and hardness alone. Polishing or flattening does not change it; what changes is only how that area is divided between the number of touching points and the size of each.

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Yuuki YAMAGISHI (山岸 勇輝)

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