A Number That Barely Moves Across Three Decades of Reynolds Number Sets the Frequency

— the Strouhal number moves by only **1.268766** across a thousandfold change in Reynolds number, so the shedding frequency follows U/D — yet at one and the same Reynolds number of **6667** the frequency is **200.00** Hz in one case and **2.00** Hz in another — [Paper 543]

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— From thinking to syncing. —

Abstract

The shedding frequency behind a cylinder follows from flow speed and diameter.What this paper shows is that the dimensionless combination of the two barely moves across three decades of Reynolds number, and that this is what makes the formula for frequency simple.No new theorem or law is claimed. First, the Strouhal number barely moves ——0.167056 at a Reynolds number of 100, 0.207506 at 1000 and 0.211955 at 100000 (Section 2). **Second, and yet it is not fixed——across a thousandfold change it moves by a factor of 1.268766** (Section 2). **Third, and this is the core.Because it barely moves, the frequency is proportional to U/D——tenfold in U gives tenfold in frequency, tenfold in D gives a tenth** (Section 3). **Fourth, enlarging both leaves the frequency unchanged——$U = 10$ with $D = 0.01$ and $U = 100$ with $D = 0.1$ both give 200.00 Hz** (Section 3). **Fifth, equal Reynolds numbers do not mean equal frequencies——both at 6667, one gives 200.00 Hz and the other 2.00 Hz, a factor of 100** (Section 4). **Sixth, the separator is that there are two dimensionless quantities——one fixes the character of the flow, the other the scale of time** (Section 4). **Keywords**: Karman vortex street, Strouhal number, Reynolds number, vortex shedding, cylinder wake.

Scope of this paper (scope note): **No new theorem or law is claimed——the Karman vortex street, the Strouhal number and Roshko's correlation are standard.The flow is not solved——the Navier--Stokes equations are not solved; values were put into a correlation and compared.Why it is nearly constant is not explained——the mechanism of vortex formation is not entered; only the fact and its consequences.The high-Reynolds transition is not treated——the abrupt change beyond 10^5, the drag crisis, is not entered.One shape only——a circular cylinder; square sections and aerofoils take different values.Agreement with measurement is not claimed——the correlation is itself a fit, and only the properties of the formula were examined.No vibration design is offered——how to avoid resonance is not the subject.Relation to earlier papers**: **Paper 117 showed that scale invariance fixes an exponent in four ways——the near-constancy here belongs to the measured one of those four.Paper 256 showed that the only scale at which dynamic similarity is exact is one——the Strouhal number is nearly constant not because similarity is exact but because the fit is good.Paper 439 showed that judder comes from a gap between two frictions——that paper attributed vibration to a difference; this one shows a quantity that does not move fixing a frequency.Paper 144 showed that an exponent is the signature of what is conserved——what is held here is not an exponent but a ratio itself.Paper 300 showed that sharing a root is decidable——the two dimensionless numbers are separate roots under the criterion of what a quantity carries.**What is added is **measuring the movement of the Strouhal number as a factor of $\mathbf{1.268766}$, confirming proportionality to U/D to 12 digits, exhibiting a factor of $\mathbf{100}$ in frequency at equal Reynolds number**, and **placing the separator on there being two dimensionless quantities**.

1. Notation and the Question

Setting: **a cylinder in a uniform stream sheds vortices alternately from its two sides. With shedding frequency f, speed U and diameter D, the dimensionless number**

$$St = \frac{fD}{U}$$

is the Strouhal number, while the character of the flow is set by the Reynolds number $Re = UD/\nu$.

Observation 1.1

there are two dimensionless numbers.Re and St——in general St should be a function of Re.

Observation 1.2

that function is almost flat.$St \approx 0.2$ over a wide range——and its flatness is what makes the formula for frequency simple.

Question: how flat, and what follows from flatness?

2. How Little It Moves

Computation 2.1: evaluating Roshko's correlation $St = 0.212(1 - 21.2/Re)$.

Re	St
100	**0.167056**
150	**0.182037**
1000	**0.207506**
10000	**0.211551**
100000	**0.211955**

> **Observation 2.2**
>
> a thousandfold change in Re moves St by **1.268766**.From **0.167056** to **0.211955**——that is the content of "barely moves".

> **Observation 2.3**
>
> it is not fixed.It moves by 26.9 per cent——calling it a constant would name a moving quantity a constant. $St \approx 0.2$ is an approximation, not an identity.

> **Observation 2.4**
>
> it saturates on the high side.**0.211551** at 10000 and **0.211955** at 100000——approaching 0.212; most of the motion happens at low Re.

Observation 2.5

the correlation is a fit to measurement.Among the four ways of Paper 117, the measured one——neither an identity nor a consequence of dimensions, so it cannot be carried outside its range.

3. What Flatness Buys

Computation 3.1: **fixing $St = 0.2$ and computing frequencies.**

U (m/s)	D (m)	f (Hz)	Re
1.0	0.01	**20.00**	667
10.0	0.01	**200.00**	6667
10.0	0.1	**20.00**	66667
100.0	0.1	**200.00**	666667

Observation 3.2

this is the core.Tenfold in U gives tenfold in frequency, tenfold in D gives a tenth——holding to 12 digits. A consequence of fixing St, not of solving the flow.

Observation 3.3

enlarging both leaves the frequency unchanged.$U = 10$ with $D = 0.01$ and $U = 100$ with $D = 0.1$ both give 200.00 Hz——while Re has risen a hundredfold from 6667 to 666667.

Observation 3.4

so design can proceed.The frequency follows directly from size and speed——were St to move, one would have to compute Re and correct.

4. The Separator

Computation 4.1: constructing a pair with equal Re and different frequencies. Both $U = 10$ with $D = 0.01$ and $U = 1$ with $D = 0.1$ give $Re = 6667$.

U (m/s)	D (m)	Re	f (Hz)
10	0.01	6667	**200.00**
1	0.1	6667	**2.00**

> **Observation 4.2**
>
> a factor of 100.Same Re, same St, different frequency——Re fixes the character of the flow and not the scale of time.

> **Observation 4.3**
>
> the separator is that there are two dimensionless quantities.Re carries the character, St the timing——speak of frequency from one alone and the answer is off by a hundred.

> **Observation 4.4**
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> separate roots under Paper 300.Re carries viscosity; St does not——two dimensionless numbers containing different quantities.

> **Observation 4.5**
>
> on Paper 256.There, exact dynamic similarity holds only at unit scale——St is nearly constant not because similarity is exact but because the fit is good, and 26.9 per cent does move.

Observation 4.6

what is not said.Why it is nearly constant is not explained——the mechanism is not entered, other shapes are not treated, and the transition beyond 10^5 is left aside.

5. Roll Call and Closing

1. $St = \mathbf{0.167056}$ **at** $Re = 100$ (Computation 2.1): $\mathbf{0.211955}$ **at 100000.**
2. $\mathbf{1.268766}$ **across a thousandfold** (Observation 2.2): **the content of flatness.**
3. **still 26.9 per cent** (Observation 2.3): **not a constant.**
4. **saturating at** 0.212 (Observation 2.4): **motion at low** Re**.**
5. **the correlation is a fit** (Observation 2.5): **not to be carried outside.**
6. **tenfold** U **gives tenfold** f (Computation 3.1): **the core.**
7. **tenfold** D **gives a tenth** (Computation 3.1): **to 12 digits.**
8. **both together leave it unchanged** (Observation 3.3): $\mathbf{200.00}$ **Hz twice.**
9. **a factor of** $\mathbf{100}$ **at equal** Re (Computation 4.1): $\mathbf{200.00}$ **against** $\mathbf{2.00}$ **Hz.**
10. **the separator is two numbers** (Observation 4.3): **character and timing.**
11. Re **carries viscosity** (Observation 4.4): St **does not.**

Closing: **The shedding frequency behind a cylinder follows from flow speed and diameter.The Strouhal number barely moves——Roshko's correlation gives** $\mathbf{0.167056}$ **at** $Re = 100$**,** $\mathbf{0.207506}$ **at 1000 and** $\mathbf{0.211955}$ **at 100000, a factor of** $\mathbf{1.268766}$ **across a thousandfold change. It still moves by 26.9 per cent, so calling it a constant would name a moving quantity a constant:** $St \approx 0.2$ **is an approximation, not an identity. It saturates near** 0.212 **on the high side, with most of the motion at low** Re**. The correlation is a fit to measurement, the measured one of the four ways of Paper 117, and so cannot be carried outside its range.Because it barely moves, the frequency is proportional to** U/D **——fixing** $St = 0.2$**, tenfold in** U **gives tenfold in frequency and tenfold in** D **gives a tenth, holding to 12 digits as a consequence of fixing** St **rather than of solving the flow. Enlarging both leaves the frequency alone:** $U = 10$ **with** $D = 0.01$ **and** $U = 100$ **with** $D = 0.1$ **both give** $\mathbf{200.00}$ **Hz, while** Re **rises a hundredfold. So size and speed give the frequency directly, and were** St **to move one would have to compute** Re **and correct.The separator is that there are two dimensionless quantities——**$U = 10$ **with** $D = 0.01$ **and** $U = 1$ **with** $D = 0.1$ **both give** $Re = 6667$**, and yet the frequencies are** $\mathbf{200.00}$ **Hz and** $\mathbf{2.00}$ **Hz, a factor of** $\mathbf{100}$**.** Re **fixes the character of the flow and not the scale of time, so speaking of frequency from it alone is off by a hundred. Under Paper 300,** Re **carries viscosity and** St **does not, so two dimensionless numbers contain different quantities. Paper 256 found exact similarity only at unit scale, and** St **is nearly constant because the fit is good rather than because similarity is exact.To be honest——the flow was not**

solved; values were put into a correlation and compared. Why the number is nearly constant was not explained, and the mechanism of vortex formation was not entered. Only a circular cylinder was treated, so square sections and aerofoils take different values, and the abrupt change beyond 10^5 was left aside. Agreement with measurement was not claimed, since the correlation is itself a fit, and no advice on avoiding resonance was given. What can be said is that one nearly fixed dimensionless number makes the frequency formula simple, and that reading only the other one is wrong by a hundred, and no further.

References

1. Roshko, A. (1954). *On the Development of Turbulent Wakes from Vortex Streets*. NACA Report 1191.
2. Strouhal, V. (1878). *Uber eine besondere Art der Tonerregung*. Annalen der Physik.
3. von Karman, T. (1911). *Uber den Mechanismus des Widerstandes, den ein bewegter Korper in einer Flussigkeit erfahrt*. Nachrichten von der Gesellschaft der Wissenschaften zu Gottingen.
4. Williamson, C. H. K. (1996). *Vortex Dynamics in the Cylinder Wake*. Annual Review of Fluid Mechanics.
5. Yamagishi, Y. (2026). *Scale Invariance Fixes an Exponent — in Four Different Ways* [Paper 117]. Zenodo. 10.5281/zenodo.22005515
6. Yamagishi, Y. (2026). *The Exponent Is the Signature of What Is Conserved* [Paper 144]. Zenodo. 10.5281/zenodo.22082585
7. Yamagishi, Y. (2026). *The Only Scale at Which Dynamic Similarity Is Exact Is One* [Paper 256]. Zenodo. 10.5281/zenodo.22168919
8. Yamagishi, Y. (2026). *The Three Hundredth Census: Whether Two Things Share a Root Is Decidable* [Paper 300]. Zenodo. 10.5281/zenodo.22171914
9. Yamagishi, Y. (2026). *What Makes It Judder Is Not the Size of the Friction but the Gap Between Two* [Paper 439]. Zenodo. 10.5281/zenodo.22732357

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