Masonry Experimental Database
－User's Guide－

This user's guide describes in detail the data conversion of masonry experimental database.
Please read this user's guide carefully before using this database.
For details of this database and research results, please refer to Reference[1), 2)].

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Sheet 3	CM	Data table for Before-Cast Framed Masonry Wall
Sheet 4	MI	Data table for After-Cast Framed Masonry Wall
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2. Structure Type of Each Masonry Wall

RMF, RMP, CM, and MI are masonry structural formats. (Table1, Fig.1)

Table1 Type and Construction of Masonry Walls

Reinforced Masonry Wall (RM)	Full-Grout Reinforced Masonry Wall (RMF)	All the masonry elements were grouted with concrete.
	Partial-Grout Reinforced Masonry Wall (RMP)	Only the masonry elements reinforced with reinforcements were grouted.
Framed Masonry Wall (FM)	Confined Masonry (CM) (Before-Cast Framed Masonry Wall)	Masonry walls were placed before constructing the confining RC frame.
	Masonry Infill (MI) (After-Cast Framed Masonry Wall)	Masonry walls were placed after constructing the confining RC frame.

※Before-Cast Framed Masonry Wall (CM) is a widely used name for "Confined Masonry," and After-Cast Framed Masonry Wall (MI) for "Masonry Infill" the abbreviations are CM and MI.

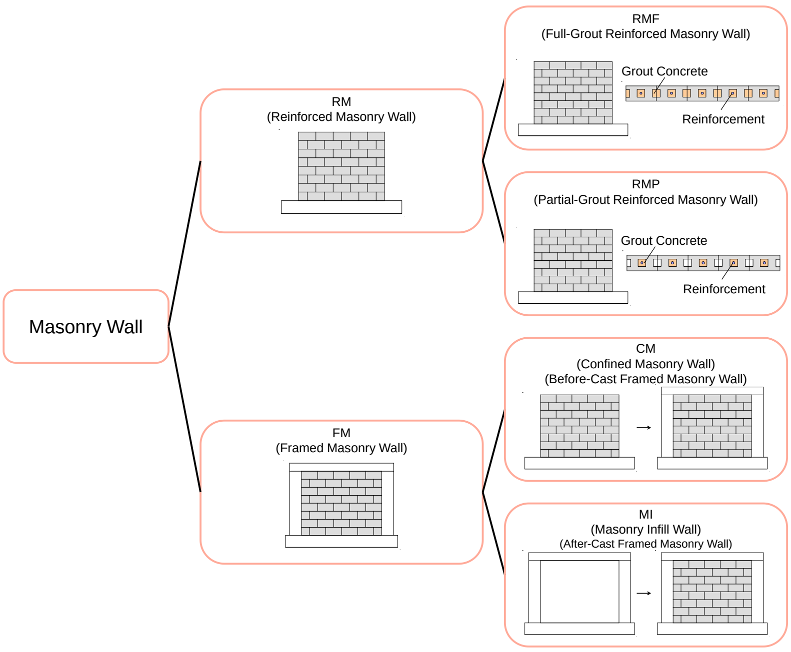
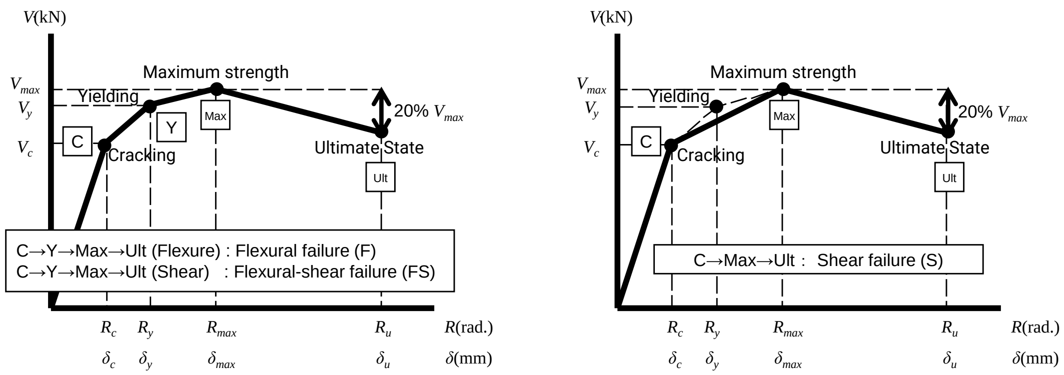


Fig.1 Type and Construction of Masonry Walls

3. Composition of Each Sheet (1)：Column A ~ Column C

Column A	"No."	Paper number. For the article number, refer to "List of Papers" in this database.
Column B	"Specimen"	Specimen name described in the paper
Column C	"Mode"	"Mode of shear failure (S)" "Mode of flexural-shear failur (FS)" "Mode of flexural failure (F)" Fig.2 shows the hysteresis characteristics for each failure type.

※The experimental data classified as " Shear Failure (S)" includes those with yield points, but the author's judgment of the failure type is respected, and the failure type described in the paper is adopted.



(a) Flexural・Flexural-shear (F, FS) Failure

(b) Shear (S) Failure

Fig.2 Failure Model of Masonry Walls

4. Composition of Each Sheet (2)：Column D ~ Column AT

列	No.	記号	説明
D	①	F_m (N/mm^2)	Compressive strength of masonry unit
E	②	F_c (N/mm^2)	Compressive strength of concrete
F	③	L (mm)	Length of wall
G	④	t (mm)	Thickness of wall panel
H	⑤	B (mm)	Width of boundary column
I	⑥	D (mm)	Depth of boundary column
J	⑦	h (mm)	Height of inflection point (Shear span)
K	⑧	A_w (mm^2)	Total section area of wall
L	⑨	N (kN)	Axial force
M	⑩	σ_0 (N/mm^2)	Axial stress
N	⑪	$\sum a_t$ (mm^2)	Total section area of vertical reinforcements in tension (RM) Total section area of longitudinal reinforcements in a tensile column (FM)
O	⑫	p_{te}	Tensile reinforcement ratio (RM) Longitudinal reinforcement ratio in tension (FM)
P	⑬	σ_y (N/mm^2)	Yield strength of tensile reinforcements (RM) Yield strength of longitudinal reinforcements of column in tension (FM)
Q	⑭	$\sum a_v$ (mm^2)	Total section area of vertical reinforcements of wall
R	⑮	σ_{vy} (N/mm^2)	Yield strength of vertical reinforcements of wall
S	⑯	p_{we}	Ratio of lateral reinforcements of wall
T	⑰	σ_{wy} (N/mm^2)	Yield strength of lateral reinforcements of wall
U	⑱	${}_cp_w$	Ratio of lateral reinforcements of column
V	⑲	σ_{cy} (N/mm^2)	Yield strength of lateral reinforcements of boundary column
W	⑳	V_{max} (kN)	Maximum resistant force
X	㉑	τ_{max} (N/mm^2)	Maximum strength
Y	㉒	R_{max} ($\times 10^{-3}$ rad.)	Deformation angle at maximum strength
Z	㉓	R_u ($\times 10^{-3}$ rad.)	Deformation angle at limit state
AA	㉔	V_{cr} (kN)	Resistant force at cracking
AB	㉕	τ_{cr} (N/mm^2)	Strength at cracking

AC	㉖	τ_{cr}/F_m	Normalized strength at cracking
AD	㉗	R_{cr} （$\times 10^{-3}$ rad.）	Deformation angle at cracking
AE	㉘	V_y （kN）	Resistant force at flexural yielding
AF	㉙	τ_y （N/mm^2）	Strength at flexural yielding
AG	㉚	τ_y/F_m	Normalized strength at flexural yielding
AH	㉛	R_y （$\times 10^{-3}$ rad.）	Deformation angle at flexural yielding
AI	㉜	τ_{max}/F_m	Normalized maximum strength
AJ	㉝	$\sqrt{F_m}$	Variable to express tensile strength of masonry unit
AK	㉞	h/L	Shear span ratio
AL	㉟	A_c/A_w	Ratio of section areas of column and wall
AM	㊱	σ_0/F_m	Ratio of axial stress of wall to compressive strengths of masonry unit
AN	㊲	F_c/F_m	Ratio of compressive strengths of concrete and masonry unit
AO	㊳	$p_{te} \cdot \sigma_y/F_m$	Normalized strength of tensile reinforcements
AP	㊴	$p_{we} \cdot \sigma_{wy}/F_m$	Normalized strength of lateral reinforcements
AQ	㊵	${}_{c}p_w \cdot \sigma_{cy}/F_m$	Normalized strength of lateral reinforcements of column
AR	㊶	V_{su} （kN）	Resistant force at shear failure
AS	㊷	V_{mu} （kN）	Resistant force at flexural failure
AT	㊸	τ_{su}/τ_{mu}	Ratio of calculated strengths of shear to flexure

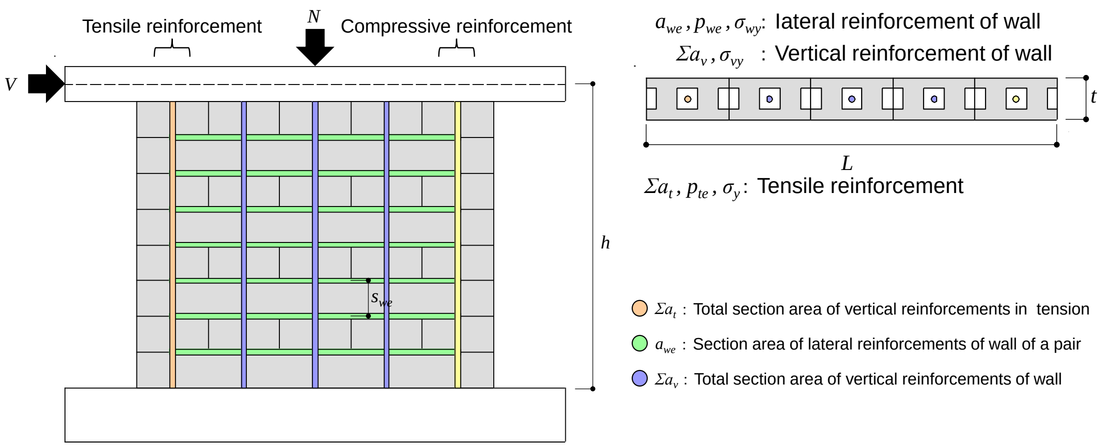
5. Explanation of Items Which Compose a Sheet

The following explains each item that needs to be confirmed, especially the definition and calculation method. Fig.3 shows the symbols of the formula. In addition, as the mechanical unit that expresses the strength of the wall, the unit "kN" is "Resistant force," and the one divided by the area is "Strength". And "Deformation angle " is the deformation angle divided by ⑦Height of inflection point (Shear span) h.

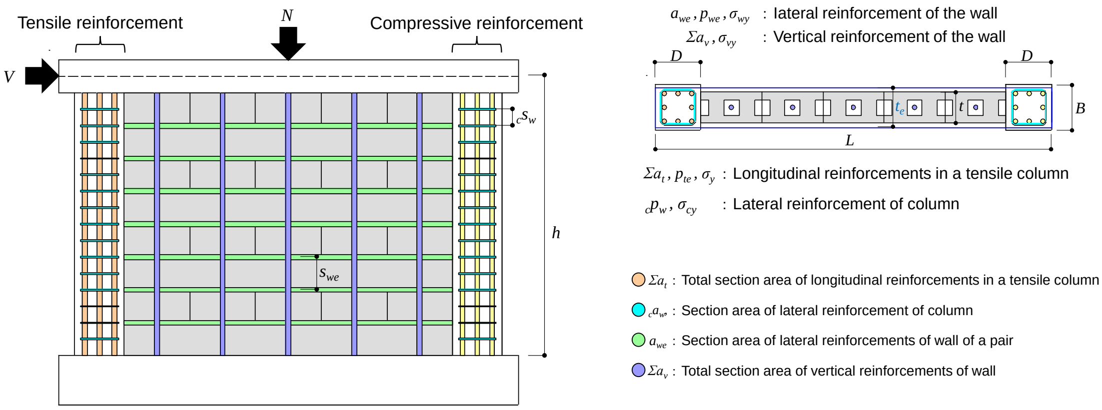
5.1 Materials and dimensions

①	Compressive strength of masonry unit F_m	It refers to an aggregate consisting of bricks and mortar joints that make up a masonry structure.
⑦	Height of inflection point (Shear span) h	The experimental results are two force methods: anti-symmetric loading and cantilever loading. (Fig.4)
⑧	Total section area of wall A_w	[RM] $A_w = L \times t$ [FM] $A_w = (L - 2 \times D) \times t + 2 \times B \times D$ A_w : Total section area of wall (mm^2) L : Length of wall (mm) t : Thickness of wall panel (mm) B : Width of boundary column (mm) D : Depth of boundary column (mm)
⑩	Axial stress σ_0	$\sigma_0 = \dfrac{N \times 10^3}{A_w}$ σ_0 : Axial stress (N/mm^2) N : Axial force (kN)

⑫	Tensile reinforcement ratio (RM) Longitudinal reinforcement ratio in tension (FM) p_{te}	$$p_{te} = \frac{\sum a_t}{A_w}$$ p_{te} : Tensile reinforcement ratio (RM) Longitudinal reinforcement ratio in tension (FM) Σa_t : Total section area of vertical reinforcements in tension (RM) Total section area of longitudinal reinforcements in a tensile column (FM) (mm^2)
⑯	Ratio of lateral reinforcements of wall p_{we}	$$p_{we} = \frac{a_{we}}{t \times s_{we}}$$ p_{we} : Ratio of lateral reinforcements of wall a_{we} : Section area of lateral reinforcements of wall of a pair (mm^2) s_{we} : Space of lateral reinforcement of the wall (mm) ※However, in the case of framed masonry wall (FM), the width t should be read as the equivalent thickness of wall panel t_e. $$t_e = \frac{A_w}{L}$$
⑱	Ratio of lateral reinforcements of column ${}_cp_w$	$${}_cp_w = \frac{{}_ca_w}{B \times {}_cs_w}$$ ${}_cp_w$: Ratio of lateral reinforcements of column ${}_ca_w$: Section area of lateral reinforcement of column (mm^2) ${}_cs_w$: Space of lateral reinforcement of column (mm)

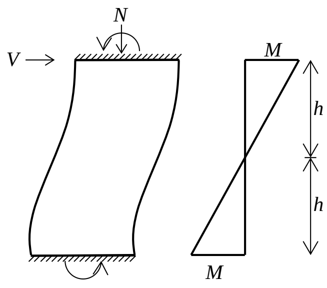


(a) Reinforced Masonry (RM)

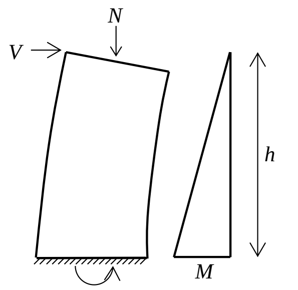


(b) Framed Masonry (FM)

Fig.3 Masonry Wall Sections



(a) Anti-symmetric Loading



(b) Cantilever Loading

Fig.4 Loading Systems

5.2 Calculated Value by Evaluation Formula

㊶	Resistant force at shear failure V_{su}	$V_{su} = \left\{\frac{0.053p_{te}^{0.23}(F_m + 18)}{h/L + 0.12} + 0.85\sqrt{p_{we} \cdot \sigma_{wy}} + 0.1\sigma_0\right\} \times 0.9 \times L \times \frac{A_w}{L}$ Here, the compressive strength of concrete F_c of concrete is read as the compressive strength of masonry unit F_m of the masonry. V_{su} : Resistant force at shear failure (kN) p_{te} : Tensile reinforcement ratio (RM) Longitudinal reinforcement ratio in tension (FM) F_m : Compressive strength of masonry unit (N/mm^2) h/L : Shear span ratio p_{we} : Ratio of lateral reinforcements of wall σ_{wy} : Yield strength of lateral reinforcements of wal (N/mm^2) σ_0 : Axial stress (N/mm^2) L : Length of wall (mm) A_w : Total section area of wall (mm^2)
㊷	Resistant force at flexural failure V_{mu}	$V_{mu} = (\Sigma a_t \cdot \sigma_y + 0.5\Sigma a_v \cdot \sigma_{vy} + 0.5N) \times 0.9 \times L/h$ V_{mu} : Resistant force at flexural failure (kN) Σa_t : Total section area of vertical reinforcements in tension (RM) Total section area of longitudinal reinforcements in a tensile column (FM) (mm^2) σ_y : Y Yield strength of tensile reinforcements (RM) Yield strength of longitudinal reinforcements of column in tension (FM) (N/mm^2) Σa_v : Total section area of vertical reinforcements of wall (mm^2) σ_{vy} : Yield strength of vertical reinforcements of wall (N/mm^2) N : Axial force (kN) L : Length of wall (mm) h : Height of inflection point (Shear span) (mm)

㊸	Ratio of calculated strengths of shear to flexure τ_{su}/τ_{mu}	The ratio of strength at shear failure τ_{su} to bending strength at flexural failure τ_{mu} $\tau_{su} = \left\{\frac{0.053p_{te}^{0.23}(F_m + 18)}{h/L + 0.12} + 0.85\sqrt{p_{we} \cdot \sigma_{wy}} + 0.1\sigma_0\right\} \times 0.9$ $\tau_{mu} = \left(\Sigma a_t \cdot \sigma_y + 0.5\Sigma a_v \cdot \sigma_{vy} + 0.5N\right) \times 0.9/h/t_e$

5.3 Experimental Values

㉔Resistant force at cracking V_{cr}、㉗Deformation angle at cracking R_{cr}、㉘Resistant force at flexural yielding V_y、㉛Deformation angle at cracking R_y、⑳Maximum resistant force V_{max}、㉒Deformation angle at maximum strength R_{max}、㉓Deformation angle at limit state R_u is an experimental value obtained by a structural experiment.

In this database, the hysteresis characteristics of the masonry wall were modeled from the research by Elwood[3)] and Zavala[4)]. (Fig.5) The hysteresis characteristics of the masonry wall are composed of cracking, yielding, maximum strength, and ultimate state, and the stiffness changes at each point. The ultimate state was the strength decreased to 80%.

㉔	Resistant force at cracking V_{cr}	If the value of the experimental result in the papers, that value is adopted. If the value of strength or deformation was in the papers, find the unknown data from the graph. (Fig.6) ※This database and Reference[1), 2)]. is no distinction between the data written in the reference and the read data.
㉗	Deformation angle at cracking R_{cr}	
㉘	Resistant force at flexural yielding V_y	
㉛	Deformation angle at cracking R_y	
⑳	Maximum resistant force V_{max}	If the value of the experimental result in the papers, that value is adopted. If there was no value in the papers, find the value from the graph. When finding the values from the graph, classified them into 4 patterns the experimental results. (Fig.7)。 ※This database and Reference[1), 2)]. is no distinction between the data written in the reference and the read data. And this database and Reference[1), 2)]. is no distinction between the four patterns shown in Fig.7.
㉒	Deformation angle at maximum strength R_{max}	
㉓	Deformation angle at limit state R_u	

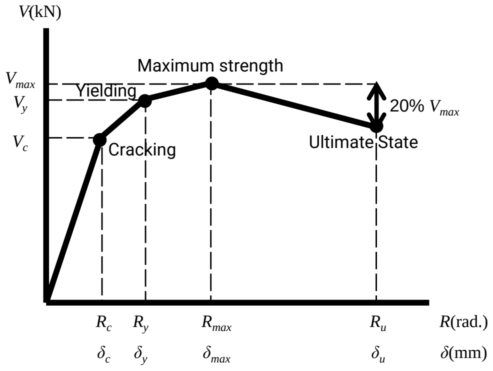


Fig.5 Backbone Model for Masonry Walls[3), 4)]

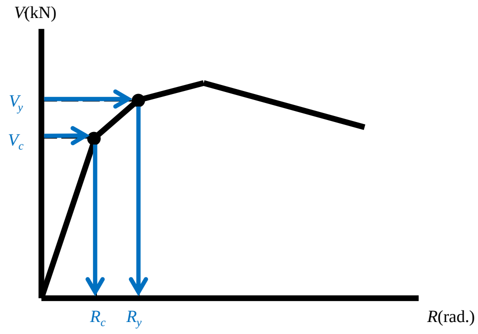
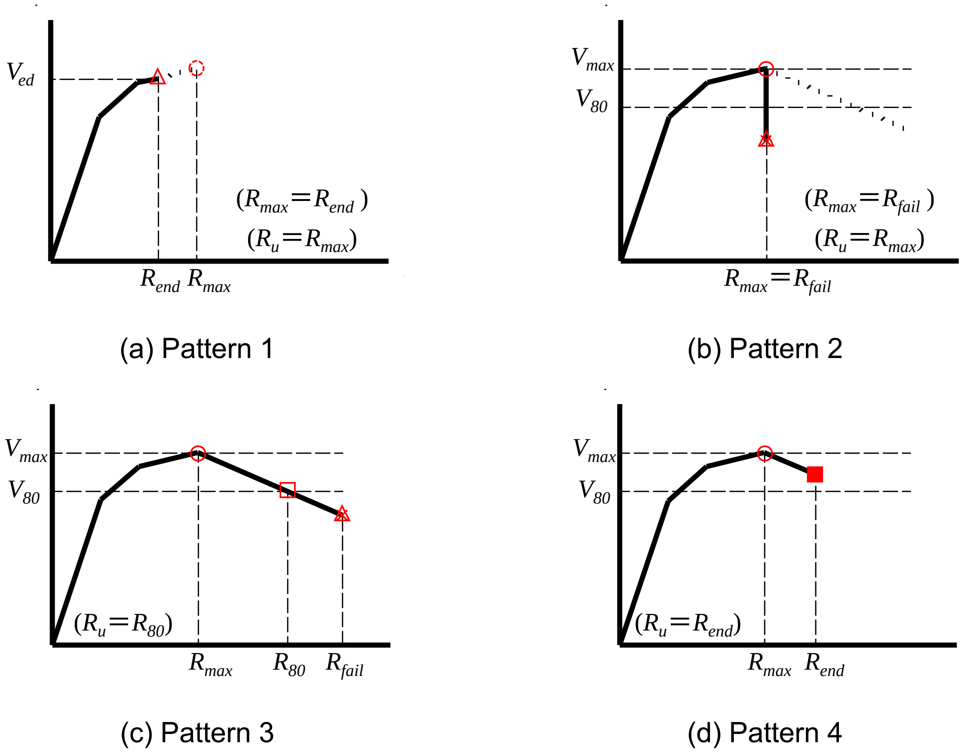


Fig.6 How to read V_{cr}, R_{cr}, V_y, R_y

(Pattern 1)	The experiment was completed without reaching the maximum strength. The maximum strength V_{max} and the deformation at maximum strength R_{max} were the strength and deformation at the end of the experiment. The deformation at the ultimate state R_u was the deformation at maximum strength R_{max}.
(Pattern 2)	After the experiment reached maximum strength, the strength dropped sharply, and the specimen broke. The maximum strength V_{max} and the deformation at maximum strength R_{max} were at the maximum point. The deformation at the ultimate state R_u was the deformation at maximum strength.
(Pattern 3)	After the experiment reached the maximum strength, the strength decreased, and the test specimen broke. The maximum strength V_{max} and the deformation at maximum strength R_{max} were at the maximum point. The deformation at the ultimate state R_u was the strength decreased to 80%.
(Pattern 4)	After the experiment reached the maximum strength, the strength gradually decreased, and the experiment ended or broke before the strength decreased to 80%. The maximum strength V_{max} and the deformation at maximum strength R_{max} were at the maximum point. The deformation at the ultimate state R_u was the value when the experiment was ended or broke.



○	V_{max}
□	V_{80}
×	Failure
△	End of experiment
■	End of experiment or Failure

Fig.7 Experiment Result History Curve Pattern(V_{max}, R_{max}, R_u)

㉕	Strength at cracking τ_{cr}	The value of ㉔Resistant force at cracking V_{cr}, ㉘ Resistant force at flexural yielding V_y, and ⑳ Maximum resistant force V_{max} obtained by papers divided the value of ⑧Total section area of wall A_w.	
㉙	Strength at flexural yielding τ_y		
㉑	Maximum strength τ_{max}		
㉖	Normalized Strength at cracking τ_{cr}/F_m	$\frac{\tau_{cr}}{F_m}=\frac{V_{cr}\cdot 10^3}{A_w\cdot F_m}$	The strength divides by the material strength because it eliminates the effect of the material strength.
㉚	Normalized strength at flexural yielding τ_y/F_m	$\frac{\tau_y}{F_m}=\frac{V_y\cdot 10^3}{A_w\cdot F_m}$	
㉜	Normalized maximum strength τ_{max}/F_m	$\frac{\tau_{max}}{F_m}=\frac{V_{max}\cdot 10^3}{A_w\cdot F_m}$	

References

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