9. *Zisin ni yoru Torii no Songai.*

Zisin Kenkûsho Matuzawa-Takeo.

(Syôwa 19 n. 6 gt. 20 nt. Happyô.–Sy wa 19 n. 6 gt. 22 nt. Uketori.)

1. *Tottori Tihô no Ozisin de mita Rei.* Syowa 18 nen 9 gatu 10 niti no Tottori Tihô no Oozisin ni oite Isi no Torii no kowareta mono ga kanari aru. Sono uti itiban ue no yoko ni watasita Hari ga otita mono to Nemoto kara oreta mono toga omo na Songai de aru.

Oreta mono ni tuite ginmi siyô. Yoko no Hari wo Omori to kangae Hasira no ue ni Omori wo noseta mono to site toriatukau. Zimen ga yoko ni ugoite oreta mono to suru to Omori ni yoru Tawami oyobi Zure no Hariai no Bubun to Hasira Zitai no Kansei-Situryô ni yoru Tawami oyobi Zure no Hariai no awasatta mono to suru koto ga dekiru. Mazu daiiti no Bubun wo kangaeru. Hasira wa Hankei a no Marubasira, Omori wa Situryô M tosi yoko ni α naru Kasokudo wo uketa Baai to suru. Hasira no Tyusin ni sotte ue-muki ni z-Ziku wo tori suihei ni Kasokudo no Hôkô ni x-Ziku wo toreba Hariai no Seibun wa tugi no yô ni naru.

$$X_x = X_y = Y_y = O$$

$$X_z = \frac{M\alpha}{2(1+\alpha)\mathrm{I}}\left(\frac{3}{4}+\frac{1}{2}\sigma\right)(a^2+y^2-x^2)$$

$$Y_z = -\frac{M\alpha}{2(1+\alpha)\mathrm{I}}\left(\frac{1}{2}+\sigma\right)xy,$$

$$Z_z = -\frac{M\alpha}{\mathrm{I}}(l-z)\,x,$$

tadasi l wa Hasira no Nagasa.

σ wa Poisson no Hi,

I wa Tyokkei no Mawari no Menseki no Kansei-Nôritu sunawati $\frac{\pi}{4}a^4$ de aru.

Hippari no Hariai Z_z no Kyokudai wa

$$(Z_z)_{max} = -\frac{M\alpha}{I}la = -4\frac{M\alpha l}{\pi a^3}$$

Zure no Hariai no Kyokudai wa Men ($y=O$, $z=O$) no Naka de okori sono Heihô wa

$$\tau_{xz}^2 = \frac{(X_x-Z_z)^2}{4}+Z_{xz}^2 = \left(\frac{Z_z}{2}\right)^2+Z_{xz}^2 = \left(\frac{M\alpha}{2I}\right)^2\left\{l^2x^2+\frac{1}{(1+\sigma)^2}\left(\frac{3}{4}+\frac{\sigma}{2}\right)^2(a^2-x^2)^2\right\},$$

sitagatte

$$\frac{\pi a^4}{4(Ma)^2}\tau_m^2=\frac{l^2}{a^2}\left(\frac{x}{a}\right)^2+\left(\frac{\frac{3}{4}+\frac{\sigma}{2}}{1+\sigma}\right)^2\left(1-\frac{x^2}{a^2}\right)^2.$$

Tugi ni x-Hôkô ni $-a$ to iu Kasokudo ga hataraku Baai wa Tan'i Taiseki ni ρa to iu Tikara ga Zissitu ni hataraku Baai to dôyô de aru kara sono toki no Kai wa

$$X_x=\mu\kappa_2\frac{2+\sigma}{24}(x^3+3xy^2)-\frac{1}{3}\mu\sigma\kappa_2(x^3-3xy^2)-\frac{2+\sigma}{24}\mu_1\kappa_2a^2x$$
$$+\mu\sigma\kappa_2x\left(\frac{1}{8}x^2-\frac{5}{8}y^2+\frac{5}{24}a^2\right)+\frac{1}{2}\mu\kappa_2(a^2x-x^3-xy^2),$$
$$Y_y=\mu\kappa_2\frac{2+\sigma}{24}(5x^3+3xy^2)+\frac{1}{4}\mu\sigma\kappa_2(x^3-3xy^2)-\frac{2+\sigma}{8}\mu\kappa_2a^2x$$
$$+\mu\sigma\kappa_2x\left(-\frac{1}{24}x^2+\frac{3}{8}y^2+\frac{3}{8}a^2\right)+\frac{1}{2}\mu\kappa_2(1+\frac{1}{2}\sigma)\ (a^2x-x^3-xy^2),$$
$$Z_z=E\left[-(\kappa_0+\kappa_1z+\kappa_2z^2)x+2\kappa_2\left\{-\left(\frac{3}{4}+\frac{\sigma}{2}\right)a^2x+\frac{1}{4}(x^3-3xy^2)+xy^2\right\}\right]$$
$$+\sigma(X_x+Y_y),$$
$$Y_z=\mu(\kappa_1+2\kappa_2z)\left\{-\frac{3}{4}xy+(2+\sigma)xy\right\},$$
$$Z_x=\mu(\kappa_1+2\kappa_2z)\left\{-\left(\frac{3}{4}+\frac{\sigma}{2}\right)a^2+\frac{3}{4}(x^2-y^2)+\frac{1}{2}\sigma x^2+\left(1-\frac{\sigma}{2}\right)y^2\right\},$$
$$X_y=-\mu\kappa_2\frac{2+\sigma}{24}(y^3+3yx^2)+\frac{2+\sigma}{24}\mu\kappa_2a^2y+\mu\sigma\kappa_2y\left\{-\frac{3}{8}x^2+\frac{5}{24}(y^2-a^2)\right\},$$

Tadasi

$$\kappa_0=\frac{2a\rho}{E}\ \frac{l^2}{a^2}\left(1-\frac{7+12\sigma+4\sigma^2}{6(1+\sigma)}\ \frac{a^2}{l^2}\right),$$
$$\kappa_1=-\frac{\pi a^2a\rho l}{IE},\qquad \kappa_2=\frac{1}{2}\ \frac{\pi a^2a\rho}{IE},$$

E wa Young no Danseiritu.

Soreyueni

$$(Z_z)_{\substack{y=o\\z=o}}=a\rho x\left[-\frac{2l^2}{a^2}\left(1-\frac{7+12\sigma+4\sigma^2}{6(1+\sigma)}\ \frac{a^2}{l^2}\right)-\left(3+\frac{4}{3}\sigma\right)+\frac{2+\sigma}{2(1+\sigma)}\ \frac{x^2}{a^2}\right].$$
$$(Z_x)_{\substack{y=o\\z=o}}=\frac{a\rho l}{2(1+\sigma)}(3+2\sigma)\ \left(1-\frac{x^2}{a^2}\right),$$
$$(X_x)_{\substack{y=o\\z=o}}=\frac{a\rho}{6(1+\sigma)}x\left(\frac{5}{2}+\sigma\right)\left(1-\frac{x^2}{a^2}\right).$$

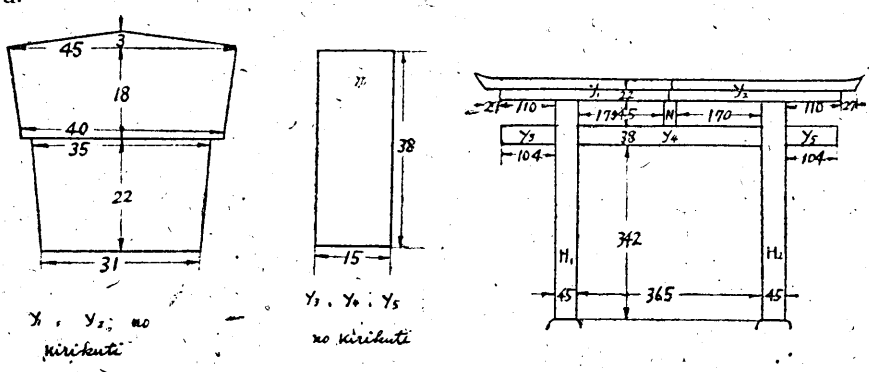
Zure no Hariai no kyokudai τ_m wa

$$\tau_m=\left(\frac{X_x-Z_z}{2}\right)^2+Z_x^2$$

kara motomerareru.

Hama-mura to Sikano-mati tono Aida no Miyakata (宮方) no Nisi ni aru Katine-Zinzya (加知彌神社) no Cotorii wa Kitagawa no Hasira ga Nemoto ka-

ra orete Higasi e taoreta. Kono Torii no Sunpô wo simeseba Zu 1 no yô de aru.



Dai 1 Zu.

Kono Baai ni $a=22.5$ cm, $l=425$ cm, de ari mata $\sigma=1/4$ to sureba

$$\left(\frac{\tau}{a\rho l}\right)^2=\frac{x^2}{a^2}\left(-18.91+.0335\frac{x^2}{a^2}\right)^2+1.96\left(1-\frac{x^2}{a^2}\right)^2$$

to naru. Mata

$$\frac{Z_z}{a\rho l}=\frac{x}{a}\left(-37.82+.0476\frac{x^2}{a^2}\right).$$

Sitagatte yokono Hari kara kuru mono mo Hasira Zitai kara kuru mono mo Z_z, τ wa x/a ni tuite $O\leqq x/a\leqq 1$ no Han'i de sono Zettaiti wa ippô e masu bakari de aru kara Hakwai no Mondai wo kangaeru toki niwa $x/a=1$ no Tokoro wo sirabereba yoi.

Sate Zu 1 ni simesita Torii no onoono no Bubun no Taiseki wo keisan suru to tugi no yô ni naru.

$Y_1=Y_2=5340000\ cm^3$, $Y_3=Y_5=59300\ cm^3$, $Y_4=208000\ cm^3$, $N=16900\ cm^3$, $H_1=H_2=676000\ cm^3$.

Y_1 to H_1, Y_1 to Y_2, Y_2 to H_2, N to Y_4, N to Y_1, matawa Y_2 nado no Hureai wa tan ni Masatu ni yotte hurete iru dake de atta.

Hasira no oreta toki ni, Y_1 (oyobi Y_2) wa suberiotite simatte ita Baai to suberi dasanai uti ni Oreta Baai to subette iru Aida ni oreta Baai toga kangae rareru. Ima kari ni suberi dasanai uti ni oreta mono to site miyô. Yoko nô Hari wa Ryôhô no Hasira ni heikin ni sayôsita to suru. Hasira wa Nemoto de oreta no de atte koko ga mata Tawami oyobi Zure ni taisuru Hariai no Saidai no Tokoro de aru kara koko no mono wo sirabereba yoi.

Mazu Tawami wo kangae yô. Hasira Zitai kara kuru mono wa mae no Keisan ni yotte $x/a=1$ de

$$Z_z=-a\rho\times 425\times 37.76,$$

Mikage-isi no Mitudo wo $\rho=2.65$ to site

$$Z_z = -4.25\times10^4 a.$$

Y_1 kara okoru mono wa

$$Z_z = -\frac{4\times5340000\times2.65\times425}{\pi\times22.5^3}a = -5.50\times10^3 a.$$

Y_3 oyobi Y_4 to N tono Hanbun ga $1=342+19=361$ no Tokoro ni sayôsita to site

$$Z_z = -\frac{4\times1.718\times10^5\times2.65\times361}{\pi\times22.5^3}a = -1.84\times10^4 a.$$

Kono mittu wo awasete

$$Z_z = -61.09\times10^4 a$$

Mikage-isi no Hippari no Tuyosa wa Hon-Mikage de

58.0 Kgr/cm^2 $=5.69\times10^7$ c. g. s.

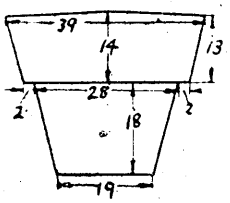
Sitagatte

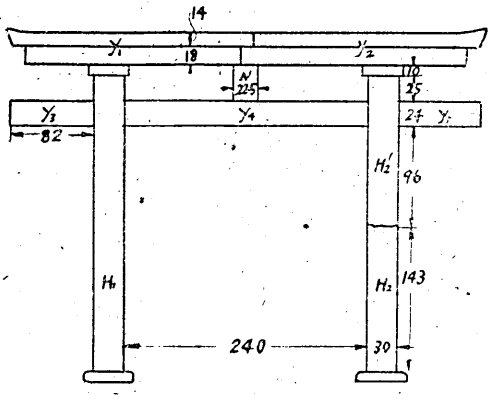
$$a \geqq 5.69\times10^7/6.109\times10^5 = 93 \text{ c. g. s.}$$

Mikage-isi no Hureai no Masatu-Keisû wa 0.3 gurai[1] de aru kara mosi kono 100 gal Teido de kowareta to sureba mada suberi dasanai uti ni kowareta koto ni naru. H_1 ga H_2 yori yowai Tokoro ga atte hazime ni orete Yoko-Hari ga otite simaeba Katahô no Hasira wa nakanaka kowarenai koto ni naru.

Tumari kono Torii wa Atama ga omokatta tame ni kantan ni kowareta mono to omowareru.

2. *Noziri-ko Nanpô no Kyôsin no toki ni mita Rei.* Tugi wa Syôwa 18 nen 10 gatu 14 niti no Nagano-ken Noziri-ko no Nanpô ni omona Higai wo okosita Zisin no toki ni kowareta Hannoki (針ノ木) Buraku no Torii no Rei de aru. (Zu 2)





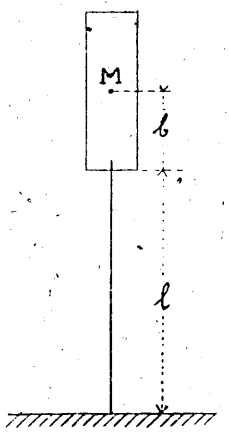
Dai 2 Zu

(1) H. Kawasumi, *Zisin*, 13 (1941), 273.

Korewa Nisigawa no Hasira ga sita kara 143 cm no Tokoro de oreta. Seirikigaku de kangaereba motiron itiban sita ga itiban Hariai no ôkii Tokoro de aru kara sokode oreru Hazu ni naru. Sitagatte kore wa Sindô no Tatiba kara itiô ginmi site miru Hituyô ga aru.

Mondai wo kantan ni suru tame ni Hasira wo hosoi Bô ni okikae sita no Hasi wo kamisime ue ni Kwansei-nôritu wo mootta Situryô wo kamisimete tuketa Baai wo kangaeru. (Zu 3)

Ima M Atama no Situryô,
I 〃 〃 Zyûsin no Mawari no Kwanseinôritu,
l Bô no Nagasa,
b Zyusin to Bô no Tukene no Kyori,
E Bô no Young Danseiritu,
μ Gôseiritu,
k Bô no Kirikuti no Tyokkei no Mawari no Kwaiten-Hankei,
ρ Mitudo,
A Bô no Kirikuti no Menseki,



Dai 3 Zu

to sureba Bô no Yokosindô no Undôhôteisiki wa

$$\rho\frac{\partial^2 y}{\partial t^2}+k^2E\frac{\partial^4 y}{\partial x^4}=0$$

Hasi no Zyôken wa

$x=0$ de $y=a\sin\omega t$ oyobi $dy/dx=0$,

$x=1$ de

$$M\frac{\partial^2 y_x}{\partial t^2}=-EAk^2\frac{\partial^3 y}{\partial x^3},$$

oyobi

$$I\frac{\partial^2\theta}{\partial t^2}=bEAk^2\frac{\partial^3 y}{\partial x^3}-AEk^2\frac{\partial^2 y}{\partial x^2}.$$

$\frac{dy}{dx}=\tan\theta$, kara

$$\frac{\partial^2\theta}{\partial t^2}=\frac{1}{1+\left(\frac{dy}{dx}\right)^2}\frac{\partial^2}{\partial t^2}\left(\frac{dy}{dx}\right)-\frac{2\frac{dy}{dx}}{\left\{1+\left(\frac{dy}{dx}\right)^2\right\}^2}\left(\frac{\partial}{\partial t}\frac{dy}{dx}\right)^2.$$

θ wo tiisai to site

$$\frac{\partial^2\theta}{\partial t^2}\approx\frac{\partial^2}{\partial t^2}\left(\frac{dy}{dx}\right).$$

Undôhôteisiki wo manzoku si korera no Hasi no Zyôken wo mitasu yô na Kai wo daseba yoi.

$$y=\sin\omega t\ (P\cosh\lambda x+Q\sinh\lambda x+R\cos\lambda x+S\sin\lambda x).$$

tadasi $$\lambda=\sqrt[4]{\frac{\rho\omega^2}{k^2E}},$$

to okeba Hasi no Zyôken kara

$$P\qquad +R\qquad =\mathfrak{A}$$
$$Q\qquad +S\qquad =O,$$
$$(EAk^2\lambda^3\sinh\lambda l-\omega^2M\cosh\lambda l)\ P$$
$$+(EAk^2\lambda^3\cosh\lambda l-\omega^2M\sinh\lambda l)\ Q$$
$$+(EAk^2\lambda^3\sin\lambda l-\omega^2M\cos\lambda l)\ R$$
$$+(-EAk^2\lambda^3\cos\lambda l-\omega^2M\sin\lambda l)\ S=O,$$
$$\{(bEAk^2\lambda^2+I\omega^2)\sinh\lambda l-EAk^2\lambda\cosh\lambda l\}\ P$$
$$+\{(bEAk^2\lambda^2+I\omega^2)\cosh\lambda l-EAk^2\lambda\sinh\lambda l\}\ Q$$
$$+\{(bEAk^2\lambda^2-I\omega^2)\sin\lambda l+EAk^2\lambda\cos\lambda l\}\ R$$
$$+\{(-bEAk^2\lambda^2+I\omega^2)\cos\lambda l+EAk^2\lambda\sin\lambda l\}S=O$$

Ima kari ni Syûki 0.1 Byô no Sindô ga attà to sureba ima no Torii no Baai

$E=5\times10^{11}$, $\rho=2.64$ to site $\omega=2\pi\times10$ kara

$\lambda=0.00\ 447.$ ←

Mata

$M=5.658\times10^{}$
$I=2.253\times10^{}$
$A=707$
$l=239$
$b=77.$

sitagatte

$M\omega^2=6.102\times10^{9}$,	$I\omega^2=2.432\times10^{12}$,	$EAk^2\lambda=8.990\times10^{13}$,
$EAk^2\lambda^2=1.776\times10^{9}$,	$EAk^2=1.988\times10^{16}$,	$bEAk^2\lambda^2=3.060\times10^{13}$,
$\lambda l=1.069$,	$\cos\lambda l=0.4810$,	$\sin\lambda l=0.8767$,
$\cosh\lambda l=1.628$,	$\sinh\lambda l=1.285$.	

Korera no Atae kara P, Q, R, S wo daseba

$$y=\mathfrak{A}\sin\omega t\{-0.1212\cosh\lambda x+0.617\sinh\lambda x+1.1212\cos\lambda x-0.617\sin\lambda x\}.$$

$$\therefore\ y''=-\mathfrak{A}\lambda^2\sin\omega t\{-0.1212\cosh\lambda x+0.617\sinh\lambda x+1.1212\cos\lambda x+0.617\sin\lambda x\}$$

Kakko no Naka no Atae f wo x no nisan no Atae ni taisite keisan sureba

x	00	50	100	150	200
f	1.242	0,942	0.593	0.199	0.234

Sunawati Tawami no Nôritu wa kono kurai no Syûki no Sindô ni taisite

wa mada itiban Sita ga itiban ôkii.

Mata

$y''' = \mathfrak{P}\lambda^3 \sin \omega t \{-0.1212 \sinh \lambda x + 0.617 \cosh \lambda x + 1.1212 \sin \lambda x + 0.617 \cos \lambda x\}$

no Kakko no Naka wo g to sureba

x	00	50	100	150	200
g	1.234	1.456	1.684	1.943	2.018

Sitagatte Zure no Hariai wa ue no Hô ga ôkii. Soreyue ni Nobi ni yowai mono nara sita de kowareru Zure ni yowai mono nara ue no hô de kowareru koto ni naru. Ima no Baai wa Mannaka yori sukosi ue de kowarete iru no de aruga korewa sono Atari ni tokubetu yowai Tokoro ga atta to miru yori Hoka wa nai.

9. *Über die Schäden von Torii*[1] *beim Erdbeben.*

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Die grosse Steinsäule von Torii ist manchmal beim Grossbeben gebrochen. Diese Erscheinung ist vom Standpunkt der elastischen Theorie der Balken untersucht worden. Es ist gezeigt, dass das Torii aus Granit trotz des imposanten Aussehens ziemlich schwach beim Erdbeben sei.

1) *Ein Tor vor einem Shinto-Tempel mit eigenartiger Form.*