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Author(s)	小出, 房吉; 中島, 廣吉
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演習林研究報告第六號

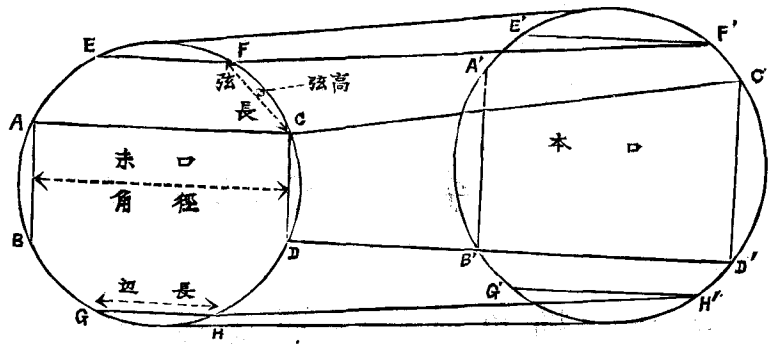
其一、杣角材積ノ新速算法

林學博士　小　出　房　吉

林學士　中　島　廣　吉

I. 通　　論

杣角ハ專ラ建築用材ノ目的ヲ以テ林内伐木地ニ於テ造材セラルヽ角材即四隅ニ幾分ノ丸味ヲ有スル材種ニシテ之ガ求積法ノ精疎ハ當事者ニ直接至大ノ影響ヲ及ボスコト明ナリ而シテ之ガ精疎ノ誘因ヲ爲スモノ頗多ク或ハ原木丸太ノ形狀ノ正否,屈曲,枝節等ノ有無或ハ杣夫ノ技倆ノ巧拙或ハ墨掛法ノ是非等擧ゲテ數フベカラズ故ニ之ガ研究ノ前提トシテ先本道ニ於テ行ハルヽ一般墨掛法及角取法ニ就キテ一言スベシ即從來慣行ノ方法ハ立木ヲ伐倒シ所要ノ長サニ玉切リテ丸太ト爲シ之ヲ適當ノ位置ニ据エ次テ其末口斷面ノ左側ニ於テ與ヘラレタル掛數(角徑=1ニ對スル邊長ノ比)相當ノ尺寸(例ヘバ五掛ノ場合ニハ約一寸)ヲ左方ニ殘シ圖中A點ヨリ墨糸ヲ垂下シABナル垂直線ヲ作リ次ニA點ヨリAB線ニ直角ニAC線ヲ引キC點ヨリAB線ニ平行シテCD線ヲ作リ以テABヲACノ掛數倍(例ヘベ五掛ノ場合ニハ約〇.五倍)ニ相當スル長サト爲スニ在リ若是ガ其倍數ニ相當セザル時ハ再ABヲ移動シテ此法ヲ反覆施行スルモノトス其他EF及GHニ在リテモ同樣夫々ACニ平行ニ引キ以テACノ所定掛數倍ニ等シキ長サト爲スヲ要ス



又本口斷面ニ於テモ末口ノ場合ト同一ノ角徑ニシテ AB ニ相當スル位置ヲ見計ヒ A′B′ナル垂直線ヲ下シ夫々 C′D′,E′F′及 G′H′ヲ作リ次デ弧面 AEA′E′ニ該當スル樹皮ヲ輕ク剝ギ墨糸ヲ以テ AA′及 EE′ノ直線ヲ引キ後所謂刄廣ヲ以テ ABA′B′ノ材部ヲ削取ス順次斯クノ如クシテ枕角ヲ造ルモノトス

以上ハ墨掛法及角取法ノ大要ニシテ事甚簡單ナルカ如シト雖是ニヨリテ造材セラルヽ實地ノ枕角ハ決シテ單純ナル形狀ヲ呈セズ或ハ天然的原因ニヨリ或ハ人爲的原因ニヨリ數學的ニ規則正シキ形狀ヲ爲スモノ極メテ稀ニシテ合理的ニ求積スルコト殆ド不可能ナル場合多シカルガ故ニ從來實地ニハ簡易ヲ旨トシ不合理ナル略算法ヲ以テ甘ンジ掛數ノ如何ヲ顧ズ只末口角徑ノ相乘ニ材長ヲ乘ジ而モ角徑ハ現實ノモノヨリ二分ヲ控除シ寸以下ヲ切リ捨テ又材長ハ延寸三寸ヲ引キ去リ尺以下ヲ切リ捨テ以テ求積スル所ナリ從ヒテ二割以上ノ誤差ヲ生ズルコト決シテ稀ナラズ又其稍精密ナリト稱セラルヽ算法ト雖末口角徑ノ自乘ヨリ角材ノ四隅ニ存スル弧部ヲ均同ノ三角形ト看做シテ引キ去リ之ニ材長ヲ乘ジテ求積スル所ニシテ尙二割近クノ誤差アルヲ見ル左レバ決シテ精密ナリト稱スベカラズ寧ロ常ニ過小ナルノ不利アリトス

斯クノ如キ杜撰ナル求積法ハ本道今日ノ如ク既ニ木材ノ不足ヲ訴ヘ材價ノ暴騰セル時代ニ在リテハ到底許容スベカラザル方法ナリトス是吾人ガ該問題ノ研究ニ着手シタル所以ナリ而シテ枕角ノ形狀ハ既記ノ如ク不規律ニシテ其關係スル因子又多ク而モ數學的ニ支配スベカラザル

モノ加ハリ絶對的完全ナル求積法ヲ見出スルコト固ヨリ至難ノ業ニシテ吾人ノ玆ニ説明セントスル方法ト雖尚且近似法タルヲ免レズ又實驗材料モ漸ク二三ノ針葉樹種ニシテ原木丸太六〇〇本内外ニ過ギズ他日更ニ廣ク材料ヲ蒐集シテ精査スルノ要アリト雖然レドモ尚從來ノ求積法ニ比シテ聊優ルモノアリト信ズルヲ以テ不十分ナルヲ顧ズ此際之ヲ發表スルコトヽセリ

II. 求積法ノ基礎

吾人ノ求積法ハ所謂間接法ニシテ因子トシテ枕角ノ得材率ヲ要スルガ故ニ豫メ之ヲ調査セザルベカラズ因リテ先得材率ノ算法ヲ論ジ次テ求積法ニ及バントス而シテ枕角ノ材積及得材率ハ他ノ要件同一ナルモ尚材長及掛數ノ函數ニシテタトヽ同一樹幹ノ同一部分ヲ造材スルモ材長ノ長短及掛數ノ大小ニヨリテ常ニ不同ナリ左レバ此二者ガ枕角ノ材積及得材率ニ對シ如何ナル影響ヲ及ボスカ其詳細ヲ知悉スルコト最先ノ要務ナリ

1). 材長ト枕角材積及得材率トノ關係

玆ニ材長一八尺末口直徑二尺及本口直徑二尺三寸ヲ有スル普通拋物線体的幹截アリトシ之ヨリ各種材長ノ丸太ヲ造材シ夫々本末兩斷面ヲ使用シテ其材積ヲ算出シ次ニソノ各丸太ヨリ一〇掛($\frac{10}{10}$)ノ枕角即正角材ヲ造出シ其材積ヲ求メ且夫々當該丸太ノ材積ニ對スル百分率即得材率ヲ計算シ以テ材長順ニ列記スルコト左表ノ如シ

材長階 (尺)	丸太材積 (立方尺)	枕角材積 (立方尺)	得材率 (%)	枕角材積差 / 材長差	得材率差 / 材長差
6	19.8627	11.9964	60.40		
8	26.9320	15.9952	59.39	2	0.51
10	34.2905	19.9940	58.41	2	0.50
12	41.7522	23.9928	57.46	2	0.47
14	49.4991	27.9916	56.55	2	0.48
16	57.4704	31.9904	55.66	2	0.47
18	65.6676	35.9892	54.81	2	0.47

即此表ニ就キ數値ノ變化ヲ檢スルニ掛數同一ナル場合ニハ材長ノ增加スルニ從ヒ丸太及枕角共絕對材積ハ增進スルニ反シ得材率ハ漸次ニ減退スルコト明ナリ但各個ノ數値ハ小數完約ノ程度如何ニヨリ多少ノ相違アリ次ノ諸場合ニ於テモ亦同樣トス而シテ枕角材積ノ增程ハ大略一種ノ等差級數ヲ爲シ又材積差ト材長差トノ比即材長六尺ニ屬スル枕角材積ト夫々材長ニ相當スル枕角材積トノ差ヲ夫々相當材長ノ差ヲ以テ除シタル商ハ何レモ同額ニシテ不易ナルヲ以テ此現象ハ材長ノ一次函數ト看做シ得ベク次ニ枕角得材率ノ減程ニ在リテモ大約一種ノ等差級數ヲ爲シ又得材率差ト材長差トノ比即材長六尺ニ屬スル得材率ト夫々材長ニ相當スル得材率トノ差ヲ夫々相當材長ノ差ヲ以テ除シタル商ハ相互粗同値ト看做シ得ベキヲ以テ是又材長ノ一次函數トシテ表出スルモ可ナルガ如シ然ラバ一般ニ前者ニ對シテハ

$$M=\alpha_1+\beta_1 y$$

或ハ

$$M=\beta_1 y$$

ノ形ニテモ可ナルベク又後者ニ對シテハ

$$P=\alpha_2-\beta_2 y$$

ノ關係式ガ成立スベキ理ナリ而シテ實驗ノ事實モ亦此假定ノ通用スベキヲ敎フル所ナリ但M=所要材積, P=所要得材率, y=所定材長, α_1, β_1, α_2, β_2=實驗上求ムベキ常數トス

2). 掛數ト枕角材積及得材率トノ關係

假ニ前項ニ於ケルト同一條件ノ長大幹截アリトシ其上部ニ於テ末口直徑二尺材長六尺ヲ有スル小幹截ヲ切取シ是ヨリ各種掛數ノ枕角ヲ造材シ各其材積ヲ計算シ次デ原木丸太ノ材積ニ對スル夫々ノ得材率ヲ算出シ之ヲ掛數順ニ揭記スレバ次表ノ如シ

掛數階	丸太材積 (立方尺)	枕角材積 (立方尺)	得材率 (%)	枕角材積差 / (掛數差)^2	得材率差 / (掛數差)^2
0.1	19.8627	19.4550	97.95		
0.2	〃	19.3276	97.31	12.74	64.00
0.3	〃	19.0398	95.86	10.38	52.25
0.4	〃	18.4820	93.05	10.81	54.44
0.5	〃	17.6648	88.93	11.19	56.38
0.6	〃	16.7734	84.45	10.73	54.00
0.7	〃	15.6664	78.87	10.52	53.00
0.8	〃	14.4786	72.89	10.16	51.14
0.9	〃	13.2272	66.59	9.94	49.00
1.0	〃	11.9964	60.40	9.21	46.36

即此結果ヲ吟味スルニ材長一定スル場合ニハ枕角ノ材積及得材率ハ共ニ掛數ノ增加スルニ從ヒ漸ク減少ス而シテ其減程ハ各欄ニ就キテ見ル如ク必シモ吾人ノ期待スル如ク嚴密ニ規則正シキ變化ヲ示サズト雖元來掛數ナルモノハ常ニ0.1—1.0ノ範圍ヲ脫スルコトナク而モ實地ニハ多ク0.3—0.8ノ間ニアルヲ以テ之ヲ掛數ノ二次函數ト看做スモ大差ナシトス然ラバ一般ニ絕對材積ニ對シテハ

$$M=\alpha_3-\beta_3 x^2$$

又得材率ニ對シテハ

$$P=\alpha_4-\beta_4 x^2$$

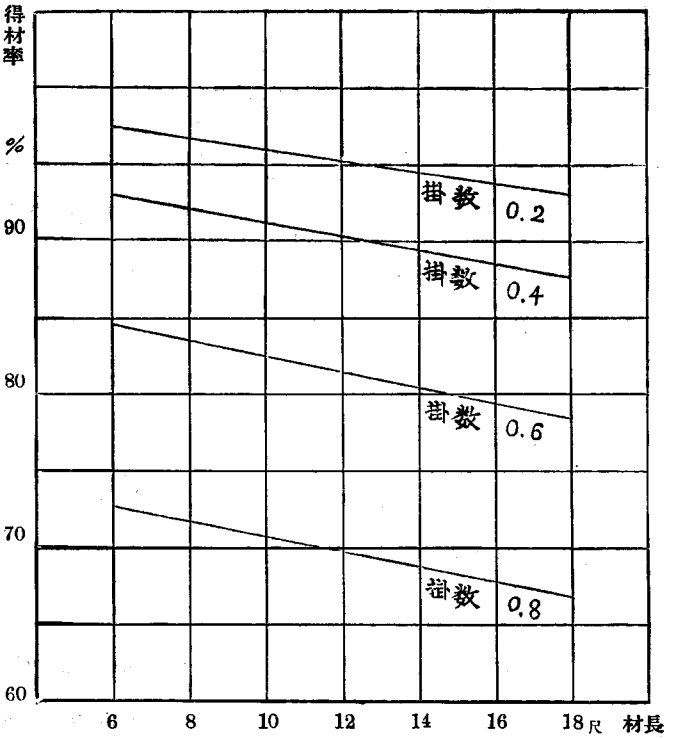
ノ關係式ガ成立スベキ筈ナリ而シテ吾人ノ實驗モ亦略此假定ノ通用スベキヲ證明スル所ナリ　但x=所定掛數其他ノ記號ハ前項ニ於ケルト同意義ノモノトス

3) 材長及掛數ト枕角材積及得材率トノ關係

前記二項ニ於テハ解シ易キタメ材長及掛數ノ各別ニ對スル關係式ニ就キテ論ゼリ因リテ玆ニハ此二者ガ同時ニ關係スル場合ヲ攷究セントス該關係ハ既ニ前項所載ノ事實ヨリ略推斷シ得ベシト雖尙明瞭ナラシメンガ爲1)ノ條下ニ於ケルト同一條件ノ丸太ニ就キ各種掛數每ニ枕角材積及得材率ヲ算出シテ表示スルコト左表ノ如シ

掛數階	材長階（尺）	丸太材積（立方尺）	枌角材積（立方尺）	得材率（%）	掛數階	材長階（尺）	丸太材積（立方尺）	枌角材積（立方尺）	得材率（%
0.2	6	19.8627	19.3276	97.31	0.6	6	19.8627	16.7734	84.45
	8	26.9320	26.0087	96.57		8	26.9320	22.4609	83.40
	10	34.2305	32.8173	95.87		10	34.2305	28.1888	82.35
	12	41.7522	39.7401	95.18		12	41.7522	33.9596	81.34
	14	49.4991	46.7242	94.39		14	49.4991	39.7748	80.35
	16	57.4704	53.8127	93.64		16	57.4704	45.5959	79.34
	18	65.6676	60.9919	92.88		18	65.6676	51.4422	78.34
0.4	6	19.8627	18.4820	93.05	0.8	6	19.8627	14.4786	72.89
	8	26.9320	24.8139	92.14		8	26.9320	19.3411	71.81
	10	34.2305	31.2200	91.21		10	34.2305	24.2132	70.74
	12	41.7522	37.6909	90.27		12	41.7522	29.0917	69.68
	14	49.4991	44.2196	89.33		14	49.4991	33.971[illegible]	68.63
	16	57.4704	50.8229	88.43		16	57.4704	38.8509	67.60
	18	65.6676	57.4800	87.53		18	65.6676	43.7305	66.59

即此表ニヨリ各種數値ノ變化ヲ案ズルニ既記ノ如ク掛數同一ナル場合ニハ材長ノ增大スルニ應ジ枌角材積ハ增加シ得材率ハ減少ス又材長ノ變化一定スル場合ニハ掛數ノ增加スルニ從ヒ兩者共減低ス而シテ其經路ハ此兩者ニヨリ全ク其方向ヲ異ニスト雖掛數每ニ材長順ニ圖示シ此兩者ヲ各別ノ一團トシテ觀察スルトキハ其各團中ニ在リテハ相互或間隔ヲ保チテ略平行線的ニ走行ス殊ニ此關係ハ得材率ノ場合ニ於テ顯著ナリ尙了解ヲ助ケンガ爲掛數每ニ材長順ニ應ジ得材率ノ變化ヲ圖示スルコト次ノ如シ



今此等ノ諸點並前記二項ニ於ケル記事ヲ總合シテ稽査スルトキハ枕角材積ニ對シテハ一般ニ

$$M=a+by-c\,x^2$$

或ハ

$$M=by-c\,x^2$$

ノ如キ關係式ノ成立スベキヲ類推スルニ難カラズ然レドモ此種絶對材積ニ對スル關係式ハ固丸太ノ末口直徑ニ關スル所ニシテ直徑同一ナラザレバ直ニ通用セズ換言スレバ直徑異レバ從ヒテ式中ノ常數モ異リ常ニ一定ノ常數ヲ以テ共通ニ處理スルヲ得ザルノ事情アリ斯クテハ公式トシテノ應用甚狹ク寧ロ直徑ニ關係ナキ得材率ノ場合ヲ採用スルニ若カス左リナガラ此得材率ノ場合ニ在リテモ前記二項ニ於ケル如ク材長ト掛數トヲ各別ニ取扱ヒ二個ノ方程式ヲ併用スルガ如キハ計算煩勞ニシテ實用上ノ不便甚大ナリ故ニ吾人ハ此二者ガ同時ニ關係スル一個ノ

方程式ヲ作成シテ以テ此等ノ缺點ヲ削除セントス是吾人ガ主トシテ玆ニ方程式

$$P=\alpha-\beta y-\gamma x^2$$

ニ就キテ論述スル所以ナリ而シテ之ガ果シテ實際ニ成立スルヤ否ヤ又之ニヨリテ何程ノ誤差ヲ生ズルヤハ左記實驗ノ結果ヲ待チテ決定セントス　但 P= 所要枕角得材率, y= 所定材長, x= 所定掛數, α, β, γ= 夫々實驗上定ムベキ常數トス

III. 實驗ノ成績

今玆ニ實驗ノ結果ヲ表示セントスルニ當リ前提トシテ先供試材料及實驗方法ニ就キテ略述スベシ

1). 供試材料

該研究ニ供用シタル材料ハ**エゾマツ** (Picea ajanensis, Fisch.) 及**アカエゾ** (Picea Glehni, Mast.) ノ二種ニシテ大正六年三月本學附屬天鹽第一演習林ニ於ケル官行斫伐ノ際此等樹種ノ混淆原生林ヨリ採取シタルモノナリ即原木ハ胸高直徑一尺七寸乃至三尺五寸ノ樹幹合計一九三本ニシテ之ヨリ造材シタル枕角五七〇本ナリトス今角徑ト材長トニヨリテ本數ヲ列記スルコト左表ノ如シ

材長階(尺) / 角徑階(尺)	6	8	9	12	14	15	19	計
0.9				2	1			3
1.0			1	9	3			13
1.1		2	2	12	11		4	31
1.2			3	12	30	3	12	60
1.3		5	2		31	3	6	47
1.4		8	6	7	54	1	11	87
1.5		10	4		51		3	68
1.6		18	1	1	44	1	4	69
1.7		12		1	35	1	2	51
1.8	1	11	2	2	28		1	45
1.9		7	1		18	1		27
2.0		8	1	1	14	2	1	27
2.1		1	1		14	1	1	18
2.2		2			2	1		5
2.3		1			5			6
2.4	1	3			3		1	8
2.5		1			1			2
2.6					1			1
2.7							1	1
2.8		1						1
計	2	90	24	47	346	14	47	570

2). 實驗ノ方法

此場合杣角ノ材積ハ所謂 Riecke 式ニ由リテ求ムルヲ穩當トスル所ニシテ之ニ要スル因子ハ材長及三個ノ横斷面ナルヲ以テ先角材ノ本末兩斷面ニ就キ二個ノ角徑,四個ノ邊長,四個ノ弦長及四個ノ弦高ヲ一分迄採讀シ材長ハ寸位迄採用セリ而シテ中央斷面ニ對スル此等因子ハ直接ニ測

定スルコト困難ナリシヲ以テ本末兩斷面ノ各角徑ト邊長トヨリ推算シ又弦長ト弦高トヨリ成ル曲線部ハ普通拋物線体ノモノト看做シテ計算セリ斯クシテ本末中ノ三斷面積ヲ確定シ式

$$V_k=\frac{l}{6}(A_o+4A_m+A_u)$$

ニヨリテ近似的ニ求積シタリ　但 V_k=所要角材材積, l=材長, A_o, A_m, A_u=本末中ノ三斷面積トス

又原木丸太ハ所謂 Smalian 式ニ由リテ求積スル所ニシテ其本末兩斷面ニ就キ無皮ノ直徑ヲ二方向十文字ニ測定シ一分迄採讀セリ材長ハ角材ノ場合ト同大トス即式

$$V_m=\frac{l}{2}(B_o+B_u)$$

ニヨリテ算出シタリ　但 V_m=所要丸太材積, B_o, B_u=本末兩斷面積トス

次ニ斯クシテ得タル二種ノ材積ヲ以テ左式ニヨリ夫々枕角得材率(P)ヲ算定セリ即

$$P=\frac{V_k}{V_m}100$$

最後ニ掛數算定ニ就キテ一言セン既述ノ如ク枕角ノ形狀ハ甚不規律ニシテ同一掛數ト稱スルモ多數角材ノ間ニハ多少ノ相違アルノミナラズ又同一角材ニ在リテモ角徑相互及邊長相互ノ間ニ幾分ノ差異アルヲ常トス故ニ吾人ハ末口斷面ニ就キ邊長四個ノ平均ヲ取リ之ヲ角徑二個ノ平均ニテ除シ得タル商ヲ以テ當該掛數トナシ且一般ノ習慣ニ從ヒ其範圍(0.300—0.399)ヲ三掛ニ編入シ又其範圍(0.400—0.499)ヲ四掛ニ加算セリ以下之ニ準ス

3). 實驗ノ結果

前項記述ノ方法手續ニヨリ實驗シテ得タル結果ヲ掛數每ニ材長順ニ總括表示スレバ次表ノ如シ但表中得材率ハ各掛數ニ就キ夫々材長階每ニ式

$$得材率=\frac{枕角材積合計}{丸太材積合計}\times 100$$

ニヨリ算出シタルモノニシテ所謂總平均値ト知ルベシ而シテ此種ノ數値ハ性質上樹種ニヨリテモ異ルベキモノナレバ樹種每ニ分別スルノ要

アリト雖吾人ノ實驗材料タルエゾマツ及アカエゾノ兩種ニ在リテハ其間殆ド差異ナク敢テ區別スルノ必要ヲ認メザリシヲ以テ之ヲ併算シテ同一ニ處理セリ又材長每ノ階級ヲ作成スルニ當リテモ習慣ニ從ヒ延寸ヲ三寸ト爲シ其範圍一四.三乃至一五.二尺ヲ以テ一四尺物ト爲シ一四尺ノ階級中ニ編入セリ其他モ之ニ準ス

掛數階	材長階（尺）	本數	丸太材積合計（石）	柚角材積合計（石）	得材率
0.3	9	2	3.9160	3.5559	90.80
	12	3	9.4905	8.4143	88.66
	14	1	4.3712	3.9477	90.31
	15	1	2.6575	2.3465	88.30
	19	1	3.4771	2.9748	85.55
0.4	6	1	2.1984	1.9735	89.77
	8	16	44.4106	39.1927	88.25
	9	14	34.3615	30.8323	89.73
	12	16	34.3241	30.3063	88.29
	14	87	381.1171	330.1753	86.63
	15	4	17.4901	15.2155	86.99
	19	13	83.0831	70.5139	84.87
0.5	6	1	4.7591	4.1647	87.51
	8	70	231.2298	196.9141	85.16
	9	6	19.2518	16.4100	85.24
	12	27	69.6429	59.5803	85.55
	14	241	1177.4790	988.5381	83.95
	15	9	31.6832	26.6260	84.04
	19	30	162.0979	133.2066	82.18
0.6	8	4	9.3419	7.7336	82.78
	9	2	3.6553	3.0189	82.59
	12	1	1.7071	1.3638	79.89
	14	17	73.5993	60.9595	82.83
	19	3	13.2692	10.7334	80.93

IV. 結　　論

1) 杣角得材率ノ場合

前掲ノ實驗成績ヲ通覽スルニ杣角ノ得材率ハ既記ノ如ク多少ノ例外アレドモ大体ニ於テ何レノ掛數ニ在リテモ夫々材長ノ增加スルニ從ヒ漸次ニ減少シ且其變化ノ經路ハ材長ノ變化ヲ一定スル時ハ掛數毎ニ或間距ヲ隔テヽ殆ド平行線的ニ走行スルヲ見ル因リテ今既述ノ如ク關係式

$$P=\alpha-\beta y-\gamma x^2$$

ヲ前提シ最小二乘法ニヨリテ常數ヲ求ムルニ

$$\alpha=95.102402\,;\ \beta=0.286678\,;\ \gamma=27.938632$$

ヲ得タリ　但計算ノ場合ニハ各材長階所屬本數ヲ重量トシテ使用セリ

尙材長ハ尺ヲ單位トシ掛數ハ小數ニテ示スモノトス

更ニ此等常數ヲ利用シ式

$$P=95.102402-0.286678\,y-27.938632\,x^2$$

ニヨリテ得材率ヲ算出シ得タル結果ト實測ノ結果トヲ並記シテ誤差關係ヲ明示スルコト次表ノ如シ

掛數階	材長階 (尺)	$\alpha=95.102402$; $\beta=0.286678$; $\gamma=27.938632$					
		本數	實測得材率	算出得材率	誤差 (△)	誤差ノ自乘 (△²)	
0.3	9	2	90.80	90.01	−0.79	0.6241	WF = ±0.855643
	12	3	88.66	89.15	+0.49	0.2401	
	14	1	90.31	88.57	−1.74	3.0276	
	15	1	88.30	88.29	−0.01	0.0001	
	19	1	85.55	87.14	+1.59	2.5281	
0.4	6	1	89.77	88.91	−0.86	0.7396	
	8	16	88.25	88.34	+0.09	0.0081	
	9	14	89.73	88.05	−1.68	2.8224	
	12	16	88.29	87.19	−1.10	1.2100	
	14	87	86.63	86.62	−0.01	0.0001	
	15	4	86.99	86.33	−0.66	0.4356	
	19	13	84.87	85.19	+0.32	0.1024	
0.5	6	1	87.51	86.40	−1.11	1.2321	
	8	70	85.16	85.82	+0.66	0.4356	
	9	6	85.24	85.54	+0.30	0.0900	
	12	27	85.55	84.68	−0.87	0.7569	
	14	241	83.95	84.10	+0.15	0.0225	
	15	9	84.04	83.82	−0.22	0.0484	
	19	30	82.18	82.67	+0.49	0.2401	
0.6	8	4	82.78	82.75	−0.03	0.0009	
	9	2	82.59	82.46	−0.13	0.0169	
	12	1	79.89	81.60	+1.71	2.9241	
	14	17	82.83	81.03	−1.80	3.2400	
	19	3	80.93	79.60	−1.33	1.7689	
						$\Sigma\triangle^2=22.5146$	

今此表ニ就キ誤差關係ヲ吟味スルニ

正負ノ配分及個數ノ關係ハ先順調ト稱シ得ベク且誤差量モ敢テ多額ナラズ又誤差ノ W F (der wahrscheinliche Wert der Fehler) ニ對比シテ出入スル關係モ略順當ト看做シ得ベシ左レバ本式ハ此現象ヲ表出スルニ對シ適合

スルモノト認ムルモ大差ナシト信ズ

2). 枌角材積ノ場合

既ニ該函數ノ成立ヲ承認スルニ於テハ性質上原木丸太ノ直徑ニ關係ナキモノナルヲ以テ何レノ場合ニ於テモ材長及掛數ヲ與フレバ直ニ得材率ヲ求メ得ベシ或ハ之ニ由リテ豫メ得材率表ヲ作成シ置クモ可ナリ既ニ得材率ヲ有スルニ於テハ之ヲ原木丸太ノ材積ニ乘ジ一〇〇ヲ以テ除スレバ又直ニ所要ノ枌角材積ヲ知リ得ベシ即

$$V_k = V_m \frac{P}{100}$$

因リテ今此式ヲ利用シテ算出シタル枌角材積ト實測シタル枌角材積トヲ比較シテ其誤差量及誤差率ヲ列擧スルコト左表ノ如シ

掛數階	材長階 (尺)	丸太材積 (石)	實測枌角材積 (石)	算出枌角材積 (石)	枌角材積誤差 (石)	枌角材積誤差率
0.3	9	P=90.01				
		1.2697	1.1483	1.1429	−0.0054	0.47
		2.6463	2.4076	2.3819	−0.0257	1.07
	12	P=89.15				
		4.7650	4.1375	4.2480	+0.1105	2.67
		2.1334	1.9351	1.9019	−0.0332	1.72
		2.5921	2.3417	2.3109	−0.0308	1.32
	14	P=88.57				
		4.3712	3.9477	3.8716	−0.0761	1.93
	15	P=88.29				
		2.6575	2.3465	2.3463	−0.0002	0.01
	19	P=87.14				
		3.4771	2.9748	3.0299	+0.0551	1.85
0.4	6	P=88.91				
		2.1984	1.9735	1.9546	−0.0189	0.96
	8	P=88.34				
		1.3953	1.2098	1.2326	+0.0228	1.88
		3.0650	2.5927	2.7076	+0.1149	4.43
0.4	8	3.3213	2.8216	2.9340	+0.1124	3.98
		2.8440	2.5171	2.5124	−0.0047	0.19
		2.8959	2.6098	2.5582	−0.0516	1.98
		3.6111	3.2729	3.1900	−0.0829	2.53
		3.2428	3.0059	2.8647	−0.1412	4.70
		2.9238	2.6101	2.5829	−0.0272	1.04
		3.7489	3.0382	3.3118	+0.2436	7.94
		2.9281	2.5947	2.5867	−0.0080	0.31
		2.3443	2.1656	2.0710	−0.0946	4.37
		2.1300	1.9687	1.8816	−0.0871	4.42
		2.8760	2.5190	2.5407	+0.0217	8.61
		2.6680	2.2158	2.3569	+0.1411	6.37
		2.7757	2.4919	2.4521	−0.0398	1.60
		1.6404	1.5289	1.4491	−0.0798	5.22
	9	P=88.05				
		2.5667	2.2852	2.2600	−0.0252	1.10
		1.9681	1.7866	1.7329	−0.0537	3.01
		2.1069	1.8372	1.8551	+0.0179	0.97
		2.4375	2.1505	2.1462	−0.0043	0.20
		1.9718	1.8621	1.7362	−0.1259	6.76
		1.6776	1.5247	1.4771	−0.0476	3.12
		1.7438	1.5627	1.5354	−0.0273	1.75
		1.4489	1.2790	1.2758	−0.0032	0.25

掛數階	材長階 (尺)	丸太材積 (石)	實測 枕角材積 (石)	算出 枕角材積 (石)	枕角材積 誤差 (石)	枕角 材積 誤差率
0.4	9	2.2244	1.9993	1.9586	−0.0407	2.04
		2.2594	1.9381	1.9894	+0.0099	0.51
		2.7716	2.4168	2.4404	+0.0236	0.98
		2.1656	1.9922	1.9068	−0.0854	4.29
		4.9015	4.4203	4.3158	−0.1045	2.36
		4.1177	3.7776	3.6256	−0.1520	4.02
	12	P=87.19				
		1.7022	1.4494	1.4841	+0.0347	2.39
		5.9766	5.4576	5.2110	−0.2466	4.52
		1.7599	1.5664	1.5345	−0.0319	2.04
		2.1540	1.8118	1.8781	+0.0663	3.66
		2.4155	2.1306	2.1061	−0.0245	1.15
		1.8551	1.6618	1.6175	−0.0443	2.67
		1.7518	1.6060	1.5274	−0.0786	4.89
		1.9581	1.7950	1.7073	−0.0877	4.89
		1.7452	1.5612	1.5216	−0.0396	2.54
		2.6495	2.1745	2.3101	+0.1356	6.24
		1.5936	1.3780	1.3895	+0.0115	0.83
		2.1834	1.8521	1.9037	+0.0516	2.79
		1.6307	1.4366	1.4218	−0.0148	1.03
		1.8385	1.6167	1.6030	−0.0137	0.85
		1.3842	1.2089	1.2069	−0.0020	0.17
		1.7258	1.5997	1.5047	−0.0950	5.94
	14	P=86.62				
		4.1222	3.4549	3.5706	+0.1167	3.38
		3.0042	2.7704	2.6022	−0.1682	6.07
		3.1017	2.5796	2.6867	+0.1071	4.15
		4.3574	3.4097	3.7744	+0.3647	10.70
		2.9777	2.5531	2.5793	+0.0262	1.03
		4.5221	3.7291	3.9170	+0.1879	5.04
		2.6222	2.2389	2.2713	+0.0324	1.45
		5.1948	4.4403	4.4997	+0.0594	1.34
		4.0248	3.6718	3.4863	−0.1855	5.05
		6.8759	6.1805	5.9559	−0.2246	3.63
		4.8063	4.1252	4.1632	+0.0380	0.92
		5.1404	4.7164	4.4526	−0.2638	5.59
		4.1683	3.7603	3.6106	−0.1497	3.98
		4.6125	4.0958	3.9953	−0.1005	2.45
		5.3436	4.4308	4.6286	+0.1978	4.46

掛數階	材長階 (尺)	丸太材積 (石)	實測 枕角材積 (石)	算出 枕角材積 (石)	枕角材積 誤差 (石)	枕角 材積 誤差率
0.4	14	4.1145	3.5821	3.5640	−0.0181	0.51
		10.0368	9.0526	8.6939	−0.3587	3.96
		4.6739	4.1647	4.0485	−0.1162	.7
		2.7765	2.4098	2.4050	−0.0048	0.20
		2.4852	2.1601	2.1527	−0.0074	0.34
		2.2521	1.9969	1.9508	−0.0461	2.31
		4.2140	3.3485	3.6502	+0.3017	9.01
		2.9228	2.5604	2.5317	−0.0287	1.12
		3.8505	3.2683	3.3353	+0.0670	2.05
		3.2907	2.8527	2.8504	−0.0023	0.08
		9.0288	7.8359	8.3405	+0.5046	6.44
		3.1034	2.7640	2.6934	−0.0706	2.55
		2.8382	2.4299	2.4584	+0.0285	1.17
		4.7290	4.1323	4.0963	−0.0360	0.87
		4.4266	3.9460	3.8343	−0.7	2.83
		3.0752	2.5893	2.6637	+0.0744	2.87
		5.3620	4.5744	4.6446	+0.0702	1.53
		4.0636	3.5635	3.5199	+0.0436	1.22
		4.1540	3.7619	3.5982	−0.1637	4.35
		3.1673	2.7519	2.7435	−0.0084	0.31
		2.4080	2.0702	2.0858	+0.0156	0.75
		6.0700	5.1953	5.2578	+0.0625	1.20
		4.5325	3.9989	3.9261	−0.0728	1.82
		3.9899	3.3833	3.4561	+0.0728	2.15
		4.1699	3.6109	3.6120	+0.0011	0.03
		2.5342	2.1674	2.1951	+0.0277	1.28
		3.4543	2.8136	2.9921	+0.1785	6.34
		2.3983	2.1720	2.0774	−0.0946	4.36
		2.7782	2.4205	2.4065	−0.0140	0.58
		3.8556	3.2259	3.3397	+0.1138	3.53
		5.4304	4.8229	4.7038	−0.1191	2.47
		4.9894	4.1137	4.3218	+0.2081	5.06
		3.6950	3.2907	3.2006	−0.0901	2.74
		2.8765	2.5405	2.4916	−0.0489	1.92
		10.4975	8.7376	9.0929	+0.3553	4.07
		4.2565	3.4644	3.6870	+0.2226	6.43
		4.5186	3.7533	3.9140	+0.1607	4.28
		4.6784	4.0208	4.0524	+0.0316	0.79
		4.1431	3.6457	3.5888	−0.0569	1.56
		3.5147	3.1298	3.0444	−0.0854	2.73
		2.9593	2.6033	2.5633	−0.0400	1.54

掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角材積 誤差 (石)	柚角 材積 誤差率
0.4	14	7.1945	6.2804	6.2319	−0.0485	0.77
		3.2571	2.7758	2.8213	+0.0455	1.64
		2.4894	2.1885	2.1563	+0.0322	1.47
		7.1546	6.2513	6.1973	−0.0540	0.86
		5.3912	4.8043	4.6699	−0.1344	2.80
		4.2087	3.6641	3.6456	−0.0185	0.50
		2.2134	2.6372	2.7834	+0.1462	5.54
		2.5717	2.3362	2.2276	−0.1086	4.65
		4.2522	3.7095	3.6833	−0.0262	0.71
		3.2149	2.7831	2.7847	+0.0016	0.06
		3.6933	3.1913	3.1991	+0.0078	0.24
		4.1074	3.4790	3.5578	+0.0788	2.27
		3.5335	3.1249	3.0607	−0.0642	2.05
		5.2241	4.5076	4.5251	+0.0175	0.39
		6.3837	5.4463	5.5296	+0.0833	1.53
		2.4516	2.1391	2.1236	−0.0155	0.72
		4.6371	4.1804	4.0167	−0.1637	3.92
		3.9897	3.5843	3.4559	−0.1284	3.58
		4.7640	4.3723	4.7640	+0.3917	8.96
		3.0217	2.5852	2.6174	+0.0322	1.25
		6.4719	5.2217	5.6060	+0.3843	7.36
		3.3876	3.0471	2.9343	−0.1128	3.70
		5.1652	4.4876	4.4741	−0.0135	0.30
		3.5713	3.0420	3.0935	+0.0515	1.69
		2.9724	2.6470	2.5747	−0.0723	2.73
		6.3919	5.7540	5.5367	−0.2173	3.78
		4.6240	3.7637	4.0053	+0.2416	6.42
		3.8350	3.1916	3.3219	+0.1303	4.08
		3.1311	2.7785	2.7122	−0.0663	2.39
		8.5396	7.7100	7.3970	−0.3130	4.06
		10.4778	9.4086	9.0759	−0.3327	3.54
	15	P=86.33				
		2.2112	1.8830	1.9089	+0.0259	1.38
		2.3233	2.0455	2.0057	−0.0398	1.95
		6.4492	5.6975	5.5676	−0.1299	2.28
		6.5064	5.5895	5.6170	+0.0275	0.49
	19	P=85.19				
		4.1557	3.4207	3.5402	+0.1195	3.49
		4.2387	3.4727	3.6109	+0.1382	3.98

掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角 材積誤差 (石)	柚角 材積 誤差率
0.4	19	4.1160	3.4977	3.5064	+0.0087	0.25
		4.4659	3.7910	3.8045	+0.0135	0.36
		3.7520	3.2022	3.1963	−0.0059	0.18
		4.3708	3.7326	3.7235	−0.0091	0.24
		2.7508	2.4694	2.3434	−0.1260	5.10
		3.4929	3.1425	2.9756	−0.1669	5.31
		3.7313	3.2749	3.1787	−0.0962	2.94
		12.4698	9.8578	10.6230	+0.7652	7.76
		5.0361	4.4403	4.2903	−0.1500	3.38
		18.2289	14.9196	15.5292	+0.6096	4.09
		12.2742	11.2925	10.4564	−0.8361	7.40
0.5	6	P=86.40				
		4.7591	4.1647	4.1119	−0.0528	1.27
	8	P=85.82				
		1.8199	1.5998	1.5618	−0.0380	2.38
		2.2123	1.8499	1.8986	+0.0487	2.63
		2.6863	2.2625	2.3054	+0.0429	1.90
		1.7125	1.5243	1.4697	−0.0546	3.58
		4.1197	3.2987	3.5355	+0.2368	7.18
		2.9636	2.4317	2.5434	+0.1117	4.59
		2.8894	2.5894	2.4797	−0.1097	4.24
		2.6127	2.2588	2.2422	−0.0166	0.73
		2.1855	1.9362	1.8756	−0.0606	3.13
		2.0249	1.6752	1.7378	+0.0626	3.74
		2.3550	2.1038	2.0211	−0.0827	3.93
		3.3408	2.6264	2.8671	+0.1907	7.26
		2.7290	2.3638	2.3420	−0.0218	0.92
		3.0331	2.5334	2.6030	+0.0696	2.75
		2.7566	2.2984	2.3657	+0.0673	2.93
		2.9904	2.6425	2.5664	−0.0761	2.88
		2.2819	2.1044	1.9583	−0.1461	6.94
		2.0092	1.7827	1.7243	−0.0584	3.28
		1.7119	1.5632	1.4692	−0.0940	6.01
		3.1062	2.6876	2.6657	−0.0219	0.81
		2.4548	1.9475	2.1067	+0.1592	8.17
		2.5978	2.1008	2.2294	+0.1286	6.12
		4.6707	3.6314	4.0084	+0.3770	10.38
		3.5601	2.8778	3.0553	+0.1775	6.17
		2.1655	1.8698	1.8584	−0.0114	0.61

掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角材積 誤差 (石)	柚角 材積 誤差率
0.5	8	3.3939	2.7557	2.9126	+0.1569	5.69
		4.0176	3.5460	3.4479	−0.0981	2.77
		3.6975	3.0853	3.1732	+0.0879	2.85
		3.5596	3.0591	3.0548	−0.0043	0.14
		4.6500	3.7171	3.9906	+0.2735	7.36
		3.9096	3.5011	3.3552	−0.1459	4.17
		6.8382	5.6193	5.8685	+0.2492	4.43
		3.9539	3.0748	3.3932	+0.3184	10.36
		2.3137	2.0223	1.9856	−0.0367	1.81
		3.1601	2.7299	2.7120	−0.0179	0.66
		5.8073	4.5795	4.9838	+0.4043	8.83
		3.5318	3.0363	3.0310	−0.0053	0.17
		3.3000	2.8710	2.8321	−0.0289	1.01
		2.3743	2.0139	2.0376	+0.0237	1.18
		3.4071	3.0094	2.9240	−0.0854	2.84
		2.2769	1.9659	1.9558	−0.0101	0.51
		4.0514	3.2597	3.4769	+0.2172	6.66
		2.0120	1.7497	1.7267	−0.0230	1.31
		2.6643	2.3686	2.2865	−0.0821	3.47
		1.9644	1.7248	1.6858	−0.0390	2.26
		5.5218	4.9576	4.7388	−0.2188	4.41
		4.0447	3.4312	3.4712	+0.0400	1.17
		3.0214	2.7658	2.5930	−0.1728	6.25
		2.8331	2.4701	2.4314	−0.0387	1.57
		3.3971	2.7869	2.9154	+0.1285	4.61
		3.2619	2.8298	2.7994	−0.0304	1.07
		2.3457	2.0767	2.0131	−0.0636	3.06
		3.1072	2.6944	2.6666	−0.0280	1.04
		2.6622	2.3312	2.2847	−0.0465	1.99
		1.5883	1.4229	1.3631	−0.0598	4.20
		2.5556	2.4058	2.1932	−0.2126	8.84
		5.8298	4.7908	5.0031	+0.2123	4.43
		5.5472	4.6262	4.7606	+0.1344	2.91
		4.4126	3.8870	3.7869	−0.1001	2.58
		3.8989	3.3611	3.3460	−0.0151	0.45
		5.2184	4.2620	4.4784	+0.2164	5.08
		4.0246	3.5272	3.4539	−0.0733	2.08
		2.8371	2.4733	2.4348	−0.0385	1.56
		7.2976	6.2557	6.2628	+0.0071	0.11
		3.7136	3.1359	3.1870	+0.0611	1.95
		2.2321	1.9461	1.9156	−0.0305	1.57

掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角材積 誤差 (石)	柚角 材積 誤差率
0.5	8	3.5536	2.9336	3.0497	+0.1161	3.96
		2.8274	2.4333	2.4265	−0.0068	0.28
		2.3470	2.1806	2.0142	−0.1664	7.63
		5.2755	4.6793	4.5274	−0.1519	3.25
	9	P=85.54				
		3.6293	3.1314	3.1045	−0.0269	0.86
		2.8996	2.4598	2.4803	+0.0205	0.83
		1.7121	1.4364	1.4645	+0.0281	1.96
		4.6440	3.8151	3.9725	+0.1574	4.13
		3.5711	3.1936	3.0547	−0.1389	4.35
		2.7957	2.3737	2.3914	+0.0177	0.75
	12	P=84.68				
		2.2861	1.8799	1.9359	+0.0560	2.98
		1.8904	1.7708	1.6008	−0.1700	9.60
		2.4338	2.1271	2.0609	−0.0662	3.11
		2.2166	1.9050	1.8770	−0.0280	1.47
		1.6289	1.3443	1.3794	+0.0351	2.61
		3.0476	2.6765	2.5807	−0.0958	3.58
		4.7583	4.2083	4.0293	−0.1290	3.07
		1.7989	1.5387	1.5243	−0.0154	1.00
		2.0843	1.7980	1.7650	−0.0330	1.84
		2.9408	2.6096	2.4903	−0.1193	4.57
		2.2244	1.8878	1.8836	−0.0042	0.22
		2.0226	1.7258	1.7127	−0.0131	0.76
		3.2313	2.6801	2.7363	+0.0562	2.10
		2.0625	1.7232	1.7465	+0.0233	1.35
		2.8700	2.4936	2.4303	−0.0633	2.54
		2.2967	1.9928	1.9448	−0.0480	2.41
		2.0033	1.6654	1.6964	+0.0310	1.86
		3.1985	2.7450	2.7085	−0.0365	1.33
		1.9605	1.7342	1.6771	−0.0571	3.29
		1.7414	1.5371	1.4746	−0.0625	4.07
		2.6545	2.0627	2.2478	+0.1851	8.97
		1.6361	1.4625	1.3854	−0.0771	5.27
		4.3516	3.6431	3.6849	+0.0418	1.15
		4.4084	3.6697	3.7330	+0.0633	1.72
		2.2824	1.9572	1.9327	−0.0245	1.25
		2.2302	1.8636	1.8885	+0.0249	1.34
		3.3628	2.8783	2.8476	−0.0307	1.07

樹數階	材長階 (尺)	丸太材積 (石)	實測 杣角材積 (石)	算出 杣角材積 (石)	杣角材積 誤差 (石)	杣角 材積 誤差率	樹數階	材長階 (尺)	丸太材積 (石)	實測 杣角材積 (石)	算出 杣角材積 (石)	杣角材積 誤差 (石)	杣角 材積 誤差率
0.5	14	P=84.10					0.5	14	7.7118	6.2351	6.4856	+0.2505	4.02
		5.1423	4.0827	4.3247	+0.2420	5.93			5.8046	4.9323	4.8817	−0.0506	1.03
		4.0041	3.3958	3.3674	−0.0284	0.84			4.2205	3.4686	3.5494	+0.0808	2.33
		3.5747	3.0680	3.0063	−0.0617	2.01			4.8902	3.9946	4.1127	+0.1181	2.96
		2.5455	2.0806	2.1408	+0.0602	2.89			7.0784	6.0357	5.9529	−0.0828	1.37
		4.3960	3.5851	3.6970	+0.1119	3.12			5.7103	5.0607	4.8024	−0.2583	5.10
		3.9189	3.1539	3.2958	+0.1419	4.50			5.9424	4.9125	4.9976	+0.0851	1.73
		4.5380	3.8032	3.8165	+0.0133	0.35			3.7320	3.0909	3.1386	+0.0477	1.54
		3.5479	3.0695	2.9838	−0.0857	2.79			4.5292	3.8537	3.8091	−0.0446	1.16
		5.5693	4.7345	4.6838	−0.0507	1.07			3.6834	3.0882	3.0977	+0.0095	0.31
		4.5010	3.7479	3.8358	+0.0879	2.35			4.5011	3.7401	3.7854	+0.0453	1.21
		3.2761	2.8479	2.7552	−0.0927	3.26			4.9201	3.9148	4.1378	+0.2230	6.70
		3.4829	2.9395	2.9291	−0.0104	0.35			3.6569	3.0994	3.0755	−0.0239	0.77
		2.7455	2.3342	2.3090	−0.0252	1.08			5.8192	5.0277	4.8939	−0.1338	2.66
		3.5151	2.9247	2.9562	+0.0315	1.08			4.6853	3.9050	3.9403	+0.0353	0.90
		2.7139	2.3093	2.2824	−0.0269	1.16			3.8896	3.2362	3.2712	+0.0350	1.08
		2.9318	2.4107	2.4656	+0.0549	2.28			5.2179	4.0456	4.3883	+0.3427	8.47
		4.1193	3.4356	3.4643	+0.0287	0.84			3.8800	3.2609	3.2631	+0.0022	0.07
		3.6520	2.8840	3.0713	+0.1873	6.49			3.8758	3.3834	3.2595	−0.1239	3.66
		3.0369	2.9307	3.0586	+0.1279	4.36			6.5111	5.1787	5.4758	+0.2971	5.74
		4.0126	3.8731	3.8792	+0.0061	0.16			4.7508	4.1363	3.9954	−0.1409	3.41
		8.1523	7.2606	6.8561	−0.4045	5.57			4.9805	4.3127	4.1886	−0.1241	2.88
		6.8393	5.7954	5.7519	−0.0435	0.75			3.2444	2.7806	2.7285	−0.0521	1.87
		4.9627	3.8779	4.1736	+0.2957	7.63			2.4869	2.1251	2.0915	−0.0336	1.58
		2.8430	2.3375	2.3910	+0.0535	2.29			3.8428	3.2620	3.2318	−0.0302	0.93
		3.9189	3.3815	3.2958	−0.0857	2.53			3.0423	2.5302	2.5586	+0.0284	1.12
		3.2193	2.7596	2.7074	−0.0522	1.89			3.3900	2.9089	2.8510	−0.0579	1.99
		4.7209	3.9927	3.9703	−0.0224	0.56			3.3919	2.9708	2.8526	−0.1182	3.98
		3.5887	3.0214	3.0181	−0.0033	0.11			5.7127	4.6639	4.8044	+0.1405	3.01
		9.5455	7.5397	8.0278	+0.4881	6.47			4.5295	4.0924	3.8093	−0.2831	6.92
		7.5038	6.8194	6.3107	−0.5087	7.46			3.7819	3.2667	3.1806	−0.0861	2.64
		6.3662	5.5880	5.3540	−0.2340	4.19			4.4097	3.7137	3.7086	−0.0051	0.14
		3.7359	3.1364	3.1419	+0.0055	0.18			2.7995	2.4503	2.3544	−0.0959	3.91
		2.4524	2.0542	2.0625	+0.0083	0.40			5.2700	4.4289	4.4321	+0.0032	0.07
		6.2550	5.0219	5.2605	+0.2386	4.75			4.1305	3.6204	3.4738	−0.1466	4.05
		5.1167	4 3302	4.3031	−0.0271	0.63			5.2661	4.1441	4.4288	+0.2847	6.87
		3.8034	3.2317	3.1987	−0.0330	1.02			3.8161	3.1559	3.2093	+0.0534	1.69
		6.2793	5.1887	5.2809	+0.0922	1.78			3.1507	2.7376	2.6497	−0.0879	3.21
		4.6781	3.9676	3.9343	−0.0333	0.84			2.9504	2.5557	2.4813	−0.0744	2.91
		4.0427	3.2197	3.3999	+0.1802	5.60			5.5275	4.6131	4.6486	+0.0355	0.77
		7.5396	6.6721	6.3408	−0.3313	4.97			4.7312	3.9739	3.9789	+0.0050	0.13

掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角材積 誤差 (石)	柚角材積 誤差率	掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角材積 誤差 (石)	柚角材積 誤差率
0.5	14	3.0910	2.5438	2.5995	+0.0557	2.19	0.5	14	6.9979	5.5797	5.8852	+0.3055	5.48
		4.5959	3.9522	3.8652	−0.0870	2.20			5.2948	4.6091	4.4529	−0.1562	3.39
		2.9877	2.4563	2.5127	+0.0564	2.30			4.6884	3.9938	3.9429	−0.0509	1.27
		4.0664	3.3737	3.4198	+0.0461	1.37			4.8220	4.2321	4.0553	−0.1768	4.18
		3.9241	3.1627	3.3002	+0.1375	4.35			4.1897	3.6584	3.5235	−0.1349	3.69
		4.9333	3.9059	4.1489	+0.2430	6.22			9.1019	7.5849	7.6547	+0.0698	0.92
		3.5998	3.1964	3.0274	−0.1690	5.29			7.3737	6.5368	6.2013	−0.3355	5.13
		6.6787	5.8273	5.6168	−0.2105	3.61			3.7195	3.2384	3.1281	−0.1103	3.41
		6.1811	5.2285	5.1983	−0.0302	0.58			3.1765	2.8169	2.6714	−0.1455	5.17
		5.8293	5.1027	4.9024	−0.2003	3.93			7.4890	6.2508	6.2982	+0.0474	0.76
		3.5141	3.0280	2.9554	−0.0726	2.40			5.7471	5.0261	4.8333	−0.1928	3.84
		6.8169	5.5331	5.7330	+0.1999	3.61			5.1651	4.5852	4.3438	−0.2414	5.26
		7.7856	6.6118	6.5477	−0.0641	0.97			10.9608	9.0655	9.2180	+0.1525	1.68
		3.9119	3.3067	3.2899	−0.0168	0.51			8.3533	7.1140	7.0251	−0.0889	1.25
		3.7865	2.9840	3.1844	+0.2004	6.72			6.2156	5.1117	5.2273	+0.1156	2.26
		5.3776	4.3203	4.5226	+0.2023	4.68			5.4954	4.4882	4.6216	+0.1334	2.97
		3.9205	3.4190	3.2971	−0.1219	3.57			3.6728	3.1767	3.1645	−0.0122	0.38
		3.0939	2.5820	2.6020	+0.0200	0.77			4.6262	3.9893	3.8906	−0.0987	2.47
		3.5388	2.7901	2.9761	+0.1860	6.67			3.8034	3.1791	3.1987	+0.0194	0.61
		2.3215	2.0690	1.9524	−0.1166	5.64			8.0198	6.7017	6.7447	+0.0430	0.64
		2.8188	2.4340	2.3706	−0.0634	2.60			6.7352	5.9451	5.6643	−0.2808	4.72
		6.0936	5.0071	5.1247	+0.1176	2.35			6.0929	5.1119	5.1241	+0.0122	0.24
		7.4426	6.4186	6.2592	−0.1594	2.48			4.3332	3.4223	3.6442	+0.2219	6.48
		9.3190	8.0266	7.8373	−0.1893	2.36			2.4585	1.9866	2.0676	+0.0810	4.08
		8.1536	7.0598	6.8572	−0.2026	2.87			8.5240	6.8137	7.1687	+0.3660	5.37
		4.9395	3.9159	4.1541	+0.2382	6.08			6.1218	5.2876	5.1484	−0.1392	2.63
		3.8719	3.4516	3.2563	−0.1953	5.66			4.0993	3.4850	3.4475	−0.0375	1.08
		4.4175	3.6891	3.7151	+0.0260	0.70			6.5939	5.2704	5.5455	+0.2751	5.22
		7.6907	6.4429	6.4679	+0.0250	0.39			5.9266	5.0971	4.9843	−0.1128	2.21
		6.1702	5.2210	5.1891	−0.0319	0.61			7.8419	6.0026	6.5950	+0.5924	9.87
		5.1507	4.5402	4.3317	−0.2085	4.59			4.8856	4.0399	4.1088	+0.0689	1.71
		7.1269	6.2448	5.9937	−0.2511	4.02			4.6834	3.7604	3.9387	+0.1783	4.74
		6.1193	5.4638	5.1463	−0.3175	5.81			3.6081	3.0418	3.0344	−0.0074	0.24
		5.3128	4.3820	4.4681	+0.0861	1.96			2.7687	2.2910	2.3285	+0.0375	1.64
		4.1574	3.5321	3.4964	−0.0357	1.01			4.1526	3.6603	3.4923	−0.1680	4.59
		3.4364	2.8791	2.8900	+0.0109	0.38			3.3028	2.8365	2.7777	−0.0588	2.07
		7.0599	5.7963	5.9374	+0.1411	2.43			5.8744	4.7641	4.9404	+0.1763	3.70
		8.0825	6.3623	6.7974	+0.4351	6.84			4.6074	3.9299	3.8748	−0.0551	1.40
		5.1175	4.2860	4.3038	+0.0178	0.42			3.8915	3.4157	3.2728	−0.1429	4.18
		5.1369	4.3152	4.3201	+0.0049	0.11			6.8701	5.8730	5.7778	−0.0952	1.62
		3.8739	3.1854	3.2579	+0.0725	2.28			5.1518	4.4709	4.3327	−0.1382	3.09

掛數階	材長階 (尺)	丸太材積 (石)	實測 抽角材積 (石)	算出 抽角材積 (石)	抽角材積 誤差 (石)	抽角材積 誤差率
0.5	14	7.1591	5.9543	6.0208	+0.0665	1.12
		5.8124	4.9669	4.8882	−0.0787	1.58
		5.3264	4.3304	4.4795	+0.1491	3.44
		3.8871	3.1546	3.2691	+0.1145	3.63
		2.7688	2.3369	2.3286	−0.0083	0.36
		5.8204	4.5272	4.8950	+0.3678	8.12
		6.2361	5.2618	5.2446	−0.0172	0.33
		4.1064	3.5548	3.4535	−0.1013	2.85
		5.3512	4.1896	4.5004	+0.3108	7.42
		3.9917	3.3669	3.3570	−0.0099	0.29
		5.1056	4.3631	4.2938	−0.0693	1.59
		4.5784	3.6809	3.8504	+0.1695	4.60
		3.1370	2.6757	2.6382	−0.0375	1.40
		7.2254	6.1640	6.0766	−0.0874	1.42
		8.2151	6.9230	6.9089	−0.0141	0.20
		7.2188	5.8058	6.0710	+0.2652	4.57
		5.3586	4.6445	4.5066	−0.1379	2.97
		4.6878	3.9031	3.9424	+0.0393	1.01
		8.0003	6.7328	6.7233	−0.0095	0.14
		6.5045	5.4189	5.4703	+0.0514	0.95
		3.3544	2.8052	2.8211	+0.0159	0.57
		5.9118	5.0743	4.9718	−0.1025	2.02
		4.5619	3.8785	3.8366	−0.0419	1.08
		3.7866	3.2226	3.1845	−0.0381	1.18
		3.0870	2.4996	2.5962	+0.0966	3.86
		4.6369	3.7358	3.8996	+0.1638	4.38
		3.9517	3.2315	3.3234	+0.0919	2.84
		4.3741	3.4995	3.6786	+0.1791	5.12
		4.1108	3.6334	3.4572	−0.1762	4.85
		2.8103	2.3920	2.3635	−0.0285	1.19
		2.4157	2.0881	2.0316	−0.0565	2.71
		3.5074	3.0103	2.9497	−0.0606	2.01
		7.7077	6.6686	6.4822	−0.1864	2.80
		6.2523	5.2307	5.2582	+0.0275	0.53
		2.9386	2.5518	2.4714	−0.0804	3.15
		7.6689	6.7070	6.4495	−0.2575	3.84
		3.7796	3.1977	3.1786	−0.0191	0.60
		3.1583	2.5722	2.6561	+0.0839	3.26
		4.2006	3.3337	3.5327	+0.1990	5.97
		3.0002	2.4743	2.5232	+0.0489	1.98
		4.2727	3.5698	3.5933	+0.0235	0.66

掛數階	材長階 (尺)	丸太材積 (石)	實測 抽角材積 (石)	算出 抽角材積 (石)	抽角材積 誤差 (石)	抽角材積 誤差率
0.5	14	5.6197	4.6492	4.7262	+0.0770	1.66
		6.3014	5.0086	5.2995	+0.2909	5.81
		4.4851	3.6892	3.7720	+0.0828	2.24
		4.0400	3.4229	3.3976	−0.0253	0.73
		3.5286	3.0023	2.9676	−0.0347	1.16
		8.0778	6.4389	6.7934	+0.3545	5.51
		5.9933	5.5270	5.0404	−0.4866	8.80
		9.1565	8.3081	7.7006	−0.6075	7.31
		4.9846	4.1268	4.1920	+0.0652	1.58
		4.9889	3.8024	4.1957	+0.3933	10.34
		3.5368	2.9747	2.9744	−0.0003	0.01
		2.7962	2.2894	2.3516	+0.0622	2.72
		4.4917	3.4924	3.7775	+0.2851	8.16
		3.3131	2.8065	2.7863	−0.0202	0.72
		2.4886	2.0798	2.0929	+0.0131	0.63
		3.2315	2.7632	2.7177	−0.0455	1.65
		5.9451	5.0734	4.9998	−0.0736	1.45
		4.2584	3.7361	3.5813	−0.1548	4.14
		3.3991	2.9880	2.8586	−0.1294	4.33
		3.7725	3.0363	3.1727	+0.1364	4.49
		2.7831	2.3288	2.3406	+0.0118	0.51
		5.0544	4.1008	4.2508	+0.1500	3.66
		4.6726	3.8302	3.9297	+0.0995	2.60
		3.5296	2.9788	2.9684	−0.0104	0.35
		5.1466	4.0633	4.3283	+0.2650	6.52
		3.5001	2.9203	2.9436	+0.0233	0.80
		4.7862	3.8961	4.0244	+0.1283	3.29
		3.5541	3.0227	2.9890	−0.0337	1.11
		2.7495	2.2700	2.3123	+0.0423	1.86
		4.1773	3.4595	3.5131	+0.0536	1.55
		5.4922	4.2296	4.6189	+0.3893	9.20
		2.8872	2.4821	2.4281	−0.0540	2.18
		6.4286	5.4507	5.4065	−0.0442	0.81
		6.8969	5.9548	5.8003	−0.1545	2.59
		6.1740	5.2857	5.1923	−0.0934	1.77
		4.9117	4.1233	4.1307	+0.0074	0.18
		3.9519	3.3886	3.3235	−0.0651	1.92
	15	P=83.82				
		2.2821	1.9212	1.9129	−0.0083	0.43
		2.2873	1.8882	1.9172	+0.0290	1.54

掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角材積 誤差 (石)	柚角材積 誤差率
0.5	15	1.9102	1.5568	1.6011	+0.0443	2.85
		2.4825	2.0212	2.0808	+0.0596	2.95
		3.8919	3.3611	3.2622	−0.0989	2.94
		3.5197	3.1026	2.9502	−0.1524	4.91
		5.3168	4.5695	4.4565	−0.1130	2.47
		5.5569	4.6092	4.6578	+0.0486	1.05
		4.4358	3.5962	3.7181	+0.1219	3.39
	19	P=82.69				
		3.7626	2.8904	3.1105	+0.2201	7.61
		5.7248	4.8949	4.7327	−0.1622	3.31
		4.6345	3.7281	3.8313	+0.1032	2.77
		4.2405	3.5650	3.5056	−0.0594	1.67
		4.2132	3.7137	3.4831	−0.3306	8.90
		4.3279	3.7120	3.5779	−0.1358	3.66
		5.0729	4.2997	4.1938	−0.1059	2.46
		4.1879	3.2565	3.4621	+0.2056	6.31
		3.9311	3.1670	3.2498	+0.0828	2.61
		3.6307	3.0915	3.0015	−0.0900	2.91
		3.7704	3.0509	3.1170	+0.0661	2.17
		4.4448	3.7610	3.6745	−0.0865	2.30
		4.6696	3.6535	3.8604	+0.2069	5.66
		10.2038	8.2561	8.4355	+0.1794	2.17
		7.7724	6.6219	6.4254	−0.1965	2.97
		7.0748	5.9390	5.8487	−0.0903	1.52
		8.9168	7.4670	7.3715	−0.0955	1.28
		5.9281	4.6655	4.9008	+0.2353	5.04
		6.9461	5.2675	5.7423	+0.4748	9.01
		4.8218	4.0363	3.9862	−0.0501	1.24
		5.2642	4.2261	4.5319	+0.1258	2.98
		4.8143	3.9711	3.9800	+0.0089	0.22
		7.1670	5.7782	5.9250	+0.1468	2.54
		7.0280	5.7395	5.8100	+0.0705	1.23
		6.4091	5.5476	5.2984	−0.2492	4.49
		5.2232	4.1934	4.3180	+0.1246	2.97
		3.6005	2.9436	2.9765	+0.0329	1.12
		5.1175	4.2099	4.2306	+0.0207	0.49
		3.8693	3.2940	3.1988	−0.0952	2.89

掛數階	材長階 (尺)	丸太材積 (石)	實測 柚角材積 (石)	算出 柚角材積 (石)	柚角材積 誤差 (石)	柚角材積 誤差率
0.5	19	5.3301	4.2657	4.4064	+0.1407	3.30
0.6	8	P=82.75				
		2.4789	2.1207	2.0513	−0.0694	3.27
		2.3795	1.9199	1.9690	+0.0491	2.56
		3.0029	2.4554	2.4849	+0.0295	1.20
		1.4806	1.2376	1.2252	−0.0124	1.00
	9	P=82.46				
		2.1692	1.8319	1.7887	−0.0432	2.36
		1.4861	1.1870	1.2254	+0.0384	3.24
	12	P=81.60				
		1.7071	1.3638	1.3930	+0.0292	2.14
	14	P=81.03				
		3.1691	2.5155	2.5679	+0.0524	2.08
		5.5990	4.5233	4.5369	+0.0136	0.30
		5.3635	4.5540	4.3460	−0.2080	4.57
		3.5772	2.9071	2.8986	−0.0085	0.29
		3.0156	2.4495	2.4435	−0.0060	0.24
		3.3298	2.7427	2.6981	−0.0446	1.63
		5.0596	4.3628	4.0998	−0.2630	6.03
		2.8191	2.2203	2.2843	+0.0640	2.88
		6.0169	5.2802	4.8755	+0.4047	7.66
		4.2148	3.6164	3.4153	−0.2011	5.56
		3.3233	2.7633	2.6929	−0.0704	2.55
		5.1824	4.2585	4.1993	−0.0592	1.39
		3.9420	3.1845	3.1942	+0.0097	0.30
		3.4124	2.8541	2.7651	−0.0890	3.12
		2.8623	2.2564	2.3193	+0.0629	2.79
		4.5635	3.6962	3.6978	+0.0016	0.43
		8.1488	6.7747	6.6030	−0.1717	2.53
	19	P=79.60				
		3.9969	3.1985	3.1815	−0.0170	0.53
		3.9073	3.1787	3.1102	−0.0685	2.16
		5.3650	4.3612	4.2705	−0.0907	2.08

今此結果ヲ細檢スルニ實測回數五七〇回中杣角材積誤差ハ最大額(0.8361)ト最小額(0.0002)トノ間ヲ占メ誤差ノ總額ハ 61.6924 ヲ計上シ且正負ノ配分及個數並正負兩値ノ各和等ノ關係ハ敢テ不良ナラズ又杣角材積誤差率ニ就キテ觀察スルニ假ニ其ノ誤差率 5% ヲ以テ批判ノ標準トスレバ其以上即 5% 及其以上ノモノト其以下即 4.99—0.00% ノ間ニ位スルモノトノ二種ニ分ツトキハ五七〇回中 5% 以下ニ屬スルモノ四七四回即實測回數ノ約 83% ヲ占メ 5—11% ノ範圍ヲ上下スルモノ九六回即約 17% ヲ領スル關係ナリ

吾人ノ杣角求積法ニ於ケル誤差關係ハ大要前段ノ如シ然ラバ之ヲ從來慣用ノ方法ニ比シテ其優劣ハ如何之ヲ評定スルコト又緊要トス而シテ從來慣用ノ方法ニモ多種アルベシト雖吾人ハ玆ニ本道ニ於テ最普通ニ行ハルヽ角材求積法即掛數ノ如何ヲ顧ズ只末口角徑(現實ノモノヨリ二分ヲ控除シ寸位以下切捨テノコト)ノ自乘ニ材長(延寸三寸ヲ引キ尺位以下切捨テノコト)ヲ乘ジテ求ムルモノ及其稍精密ト稱セラルヽ方法即末口角徑ノ自乘ヨリ四隅ノ弧部ヲ均同ノ三角形ト看做シテ引キ去リ之ニ材長ヲ乘ジテ求ムルモノヽ二種ヲ採擇シ夫々同一ノ材料ニ對シテ適用シタル結果ニ就キ誤差關係ヲ見ルニ

前法ノ杣角材積誤差ハ最大額(1.0798)ト最小額(0.0003)トノ間ヲ上下シ誤差ノ總額ハ 143.4712 ヲ計上ス而シテ正負ノ配分及個數ノ如キハ極メテ不良ナル關係ニ在リ一七回ノ正値ヲ除ク外ハ悉ク負値ニシテ大多數過小ノ結果ヲ與フル所ナリ又杣角材積誤差率ニ於テモ其 5% 以下ノモノ一八八回即總回數ノ約 33% ヲ占メ 5—23.7% ニ屬スルモノ三八二回即約 67% ニ相當スル割合ナリ

又後法ノ杣角材積誤差ハ最大額(1.6337)ト最小額(0.0385)トノ間ヲ徘徊シ誤差ノ總額ハ 160.1828 ヲ計上シ正負ノ配分及個數ノ如キハ前法ヨリ一層不良ニシテ全部負値ナリ從ヒテ常ニ過小ノ結果ヲ與ヘ多數ノ角材ヲ求積スルモ其間誤差ヲ相殺スルノ機會全クナシトス又杣角材積誤差率ニ於テモ其 5% 以下ノモノ僅ニ八四回即總回數ノ約 15% ニ過ギズ之ニ反シ

5—18.01%ノ間ヲ上下スルモノ頗多ク總計四八六回ニ上リ即約總回數ノ85%ノ多キヲ占ムル所ナリ

尙此等誤差關係ノ詳細ハ左表ニ就キテ看ルベシ　但簡單ノ爲吾人ノ求積法=I;稍精密ト稱セラルヽ法=II;普通慣用法=III;ト命ゼリ

以上ノ所述ニヨリ短評ヲ下セバ吾人ノ求積法ハ最精確ニシテ他ノ二法ハ到底同格ニ論ズベキ價値ナシトス

掛數階	材長階 (尺)	本數	誤差ノ正負 (+) I	(+) II	(+) III	(−) I	(−) II	(−) III	枕角材積誤差率 5%以下 I	5%以下 II	5%以下 III	5%以上 I	5%以上 II	5%以上 III	10%以上 I	10%以上 II	10%以上 III
0.3	9	2	0	0	0	2	2	2	2	0	0	0	2	2	0	2	2
	12	3	1	0	1	2	3	2	3	0	1	0	3	2	0	3	1
	14	1	0	0	0	1	1	1	1	0	1	0	1	0	0	1	0
	15	1	0	0	0	1	1	1	1	0	1	0	1	0	0	1	0
	19	1	1	0	0	0	1	1	1	0	0	0	1	1	0	1	0
0.4	6	1	0	0	0	1	1	1	1	0	1	0	1	0	0	0	0
	8	16	6	0	0	10	16	16	12	0	3	4	16	13	0	4	6
	9	14	3	0	0	11	14	14	13	0	3	1	14	11	0	2	7
	12	16	5	0	0	11	16	16	14	0	2	2	16	14	0	11	10
	14	87	42	0	7	45	87	80	73	12	40	14	75	47	1	33	20
	15	4	2	0	0	2	4	4	4	0	0	0	4	4	0	2	3
	19	13	6	0	1	7	13	12	9	0	5	4	13	8	0	9	3
0.5	6	1	0	0	0	1	1	1	1	1	0	0	0	1	0	0	1
	8	70	28	0	1	42	70	69	53	21	18	17	49	52	2	2	21
	9	6	4	0	0	2	6	6	6	2	3	0	4	3	0	1	2
	12	27	9	0	1	18	27	26	24	3	5	3	24	22	0	4	13
	14	241	118	0	4	123	241	237	199	25	91	42	216	150	1	23	54
	15	9	5	0	0	4	7	9	9	1	1	0	8	8	0	2	6
	19	30	17	0	2	13	30	28	24	0	10	6	30	20	0	8	8
0.6	8	4	2	0	0	2	4	4	4	3	0	0	1	4	0	0	3
	9	2	1	0	0	1	2	2	2	2	0	0	0	2	0	0	1
	12	1	1	0	0	0	1	1	1	0	0	0	1	1	0	0	1
	14	17	6	0	0	11	17	17	14	11	3	3	6	14	0	1	6
	19	3	0	0	0	3	3	3	3	3	0	0	0	3	0	0	0
計		570	257	0	17	313	570	553	474	84	188	96	486	382	4	110	168