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Illyrian Personal Anthroponyms

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Abstract

This article follows a previous publication dedicated to Venetic personal anthroponyms. In the present article, we investigate Illyrian personal anthroponyms from the Corpus Inscriptionum Latinarum, a continuously updated Latin inscription catalogue covering the Roman Empire period and its provinces. The Illyrian anthroponyms appear deeply latinised and graecised and the meaning of their roots was identified by comparing each one of them with corresponding lexemes in the present surviving Slavic languages. The result is that the Illyrian personal anthroponyms having Slavic roots is 45.93%, which permits to estimate that during the Roman Empire period, i.e. about five cen., roughly 46% of the Illyrian population had Slavic ascendancies. This highlights that Slavs were already present in areas incorporated by the Roman Empire well before the VII cen. A.D. the date, according to the generally accepted theory, of the Slav late arrival in Europe. The logical consequence is that this theory is wrong and should be rejected.

Keywords

Illyrians, Anthroponyms, Veneti, Slavs, Late Arrival, Roman Empire, C.I.L., Linguistics

1. Introduction

A great number of publications deal with the origins, the languages and the territories of the ancient Illyrians (I.). Because they did not left written documents, the conclusions of both classical and contemporary scholars concerning I. matters are normally divergent (Wilkes, 1992). In essence, it is possible to say that the entity constituted by the ancient I. is rather uncertain. The approach to acquire information about the I. through I. anthroponyms was object of some publications. One of them (Krahe, 1929) listed I. anthroponyms systematically according to their appearance in the Corpus Inscriptionum Latinarum (C.I.L.)

without providing their etymology. Purpose of this article is to deepen the knowledge about the I. by considering the etymology of the I. personal anthroponyms. This article follows a similar one dedicated to the etymology of Venetic (V.) personal anthroponyms (Stein & Tomezzoli, 2020) and *inter alia* provides a reply to the question set out in a recent publication (Pigozzo, 2020): "the I. belonged to the paleo Slavic family and, consequently, were they related to the ancient V.?"

2. Illyrian Personal Anthroponyms

The above mentioned publication (Krahe, 1929), on pages 1-131, lists I. personal anthroponyms. We considered them one by one and only those having Slavic roots were retained in alphabetic order in **Table 1**.

Each record in **Table 1** comprises: Re, the progressive record number, I. Anth, the I. anthroponyms sharing the same Slavic root, R. Mean, the root meaning, Sl. Lexem., the corresponding lexemes in present surviving Slavic languages from which the root meaning was inferred, C.I.L., the corresponding C.I.L. entry if available, p, the page in said publication where each I. anthroponym resides and V.T1.n, the I. anthroponyms correspondence, if any, with V. anthroponyms in **Table 1** in the corresponding publication (Stein & Tomezzoli, 2020). **Table 1** should be read bearing in mind the conventions of **Table 2**.

Table 1. Illyrian anthroponym list.

Re.	I. Anth.	R. Mean.	Sl. Lexem.	C.I.L.	Page	V.T1.n

A

1 †Adgeleius: hell - Bos. had, Blg. ад, Cro. had, O.Ch.Sl. адъ, Rus. ад, Ser. хад, Ukr. ад; C.I.L. III, 4844, p 3; V.T1.1.

2 †Ambisavus: granary - Bel. амбар, Bos. ambar, Cro. ambar, Rus. амбар, Ser. амбар, Ukr. амбар; C.I.L. III 13406, p 4.

3 †Atrans: quick - Bos. hitar, Cro. hitar, Lit. atrs, O.Blg. ѩдръ, Rus. хитрый, Ser. хитар, Slo. hitro; C.I.L. III, 5117, p 12; V.T1.3.

4 †At(t)o, Attu: shout to dogs - Bel. ату, Rus. ату, Ukr. ату; C.I.L. III 6010, 26, p 12; p 12.

5 *Avidiaccus, Avittius, *Avitus: reality - Bos. java, Cro. java, Rus. явь, Ser. јава; C.I.L. IX, 346, p 13; C.I.L. IX 423, p 13; C.I.L. III, 3853, p 14; V.T1.5.

B

6 *Baezocrusu, *Baezus: without - Bel. без, Bos. bez, Blg. без, Blg.dial. бизая, Cro. bez, Cze. bez, Lit. be, Mac. без, Pol. bez, Rus. без, Ser. без, Slo. brez, Slv. bez, Ukr. без; C.I.L. III, 14321^{1}, p 14; C.I.L. III, 1270, p 14; V.T1.6.

7 *Bateia, *Βάτεια, Bato, Batoniana, Batonius, *Battarios, Batun: dad - Bel. баця, Rus. батя, Ukr. батя; C.I.L. III, 5031, p 16; p 16; C.I.L. III, 12779, p 17; C.I.L. III 14633, p. 20; p 20; p 20; C.I.L. III 9845, p 20; V.T1.7.

8 *Bedarus: trouble - Bel. бяда, Bul. беда, Lit. bėda, Pol. bieda, Rus. беда, Ukr. біда; C.I.L. III 917, p 20.

9 †Bellus, *Bilisa: white - Bel. бел, Bos. bela, Blg. бял, Cro. bijela, Cze. bílý, Lit. balta, Mac. бело, O.Ch.Sl. бѣлъ, Pol. biały, Rus. белый, Ser. бео, Slo. bela, Slv. biely, Ukr. білі; p 20; C.I.L. III 6010, p 21; V.T1.8.

Continued

10 *Beres, †Bersasius: birch - Bel. бяроза, Bos. breza, Bul. бреза, Cro. breze, Cze. bříza, Lit. beržas, Mac. бреза, O.Ch.Sl. брѣза, Pol. brzoza, Rus. берёза, Ser. бреза, Slo. breza, Slv. breza, Ukr. береза; C.I.L. III 8734, p 20; C.I.L. V 3516, p 21; V.T1.9.

11 *Bisena, *Bisius, Βιζατιος, Bizo: spring - Bel. вясна, Lit. versmė, O.Ch.Sl. весна, Rus. весна, Ukr. весна; C.I.L. V 1363, p 22; C.I.L. III 1266, p 22; p 22; C.I.L. III 2782, p 22; V.T1.10.

12 Blazziza: whim - Bel. блажь, Rus. блажь, Ukr. блажь; C.I.L. III 8292, p 23.

13 *Boicus, *Boius: fighter - Bel. баец, Bos. borac, Blg. боец, Cro. borac, Cze. bojovník, Mac. борец, O.Ch.Sl воинъ, Pol. bojowiec, Rus. боец, Ser. војник, Slo. borec, Slv. vojak, Ukr. боєць; C.I.L. V 433, p 23; C.I.L. V 579, p 23; V.T1.11.

14 Boria: pine - Bos. bor, Bul. бор, Cro. bor, Cze. borovice, Mac. бор, O.Ch. Sl. боль, Rus. бор, Ser. бор, Slo. bor, Slv. borovica; C.I.L. V 7, p 24.

15 Breucus, Bricena, *Bricussa: shore - Bel. бераг, Blg. бряг, Cze. břeh, Mac. брегот, O.Ch.Sl. брѣгъ, Pol. brzeg, Rus. берег, Slv. breh, Ukr. берег; C.I.L. VIII 21041, p 24; C.I.L. III 917, p 24; p 24; V.T1.13.

16 *Brisia, *Brizidia, *Brizinus: go away! - Bel. брысь, Rus. брысь, Ukr. брись; C.I.L. V 4912, p 25; C.I.L. III 8302, p 25; C.I.L. IX 6192, p 25.

17 Bui(i)o: rowdy – Bel. буян, O.Ch.Sl. буий, Rus. буян; C.I.L. III 3790 p 25; V.T1.16.

18 *Burnia, Burnio: storm – Blg. буря, Cze. bouřka, Mac. бура, O.Ch.Sl. вѣтръ, Pol. burza, Rus. буря, Slv. búrka, Ukr. буря; C.I.L. X 7144, p 26; C.I.L. VIII 21041, p 26; V.T1.17.

19 Busa, Busia, Busidius, Busio, Buzetius, Buzos: alcoolic drink - Bel. буза, Rus. буза, Ukr. буза; p 26; C.I.L. IX 689, p 26; C.I.L. IX 335, p 26; C.I.L. III 10362, p 26; C.I.L. III 9929a, p 27; p 27.

C

20 Calas, †Calsasia: mud - Bos. kal, Blg. кал, Cro. kal, Mac. кал, Ser. кал, Slo. kal, Ukr. кал; p 27; C.I.L. V 2414, p 27; V.T1.18.

21 Cammica, *Cammius, †Coemoius, †Coimo, *Cummia: stone - Bel. камень, Bos. kamena, Blg. камък, Cro. kamen, Cze. kámen, Lit. akmuo, Mac. камен, O.Ch.Sl. камы, Pol. kamień, Rus. камень, Ser. камен, Slo. kamen, Slv. kameň, Ukr. камінь; C.I.L. V 2327, p 27; C.I.L. V 961, p 27; C.I.L. III 3792, p 31; C.I.L. III 10854, p 31; C.I.L. III 4496, p 33; V.T1.19.

22 †Candalio: shackles - Bel. кайданы, Pol. kajdany, Rus. кандалы, Ukr. кайдани; C.I.L. III 9813a, p 27.

23 *Carpia, *Carp(i)us: carp - Bel. карп, Bos. karaš, Cro. karaš, Cze. kapr, Lit. karpis, Mac. крап, Pol. karp, Rus. карп, Ser. караш, Slo. krap, Slv. kapor, Ukr. короп; C.I.L. III 9839, p 28; C.I.L. III C VIII, p 28.

24 *Catandio, *Cato, †Cattu, [Caturus]: hut - Bel. хата, Cze. chata, Pol. chata, Rus. хата, Slv. chata, Ukr. хата; C.I.L. III 2425, p 29; C.I.L. III 4392, p 29; C.I.L. III 5042, p 29; C.I.L. III 2779, p 29.

25 Ciasicianus, Ciassicus: hour - Bel. час, Bul. час, Mac. час, O.Ch.Sl. часъ, Rus. час; C.I.L. III 2757, p 30; C.I.L. III 9810, p 30.

26 *Clevas, Clevatus: barn - Bel. хлеў, Rus. хлев, Ukr. хлів; p 31; p 31.

27 *Cornuinus: root - Bel. корань, Bos. korijen, Blg. корен, Cro. korijen, Cze. kořen, Mac. корен, O.Ch.Sl. корєнь, Pol. korzeń, Rus. корень, Ser. корен, Slo. koren, Slv. korUkr. корінь; C.I.L. V 417, p 32; V.T1.20.

28 *Corragos: mountain - Bel. гара, Cze. hora, Lit. krūva, O.Ch.Sl. гора, Pol. góra, Rus. гора, Slo. gora, Slv. hora, Ukr. гора; p 32.

29 Crapus: dot - Bel. крап, Pol. kropka, Rus. крап, Ukr. крап; C.I.L. III 2979, p 32.

30 Cynna, †Cynnis: rank - Bel. чын, Bos. čin, Cro. čin, O.Ch.Sl. чинъ, Rus. чин, Ser. чин, Slo. čin, Ukr. чин; p 33; p 33.

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D

31 Dardana, *Dardas, *Darmo: gift - Bel. дар, Cro. dar, Cze. dar, Pol. dar, Rus. дар, Ser., Slo. darilo, Slv. darček, Ukr. дар; p 34; p 34; C.I.L. III 2779, p 34.

32 Dasant-, Dasantilla, Dases, Dasianius, Dasiatius, Dasimianus, Dasimius, Dasumius, Dasimos, Dasmenus, Dasmus, Das(s)ianus, Das(s)ius, Dastidius, Dasto, Dasumius, Dasummius, Daszos: to give - Bel. даваць, Bos. dati, Blg. дадеш, Cro. dati, Cze. dát, Lit. duoti, Mac. дава, O.Ch.Sl. дати, Pol. dawać, Rus. даст, Ser. дати, Slo. dajati, Slv. dať, Ukr. Давати; C.I.L. III 14316[5], p 34; C.I.L. III 14774, p 35; C.I.L. III, 4276, p 35; C.I.L. VI 16774, p 35; C.I.L. X 8059$_{140}$, p 35; C.I.L. IX 338, p 35; C.I.L. IX 373, p 35; C.I.L. IX 373, p 35; p 36; C.I.L. III D LXI, p 36; C.I.L. IX 390, p 36; C.I.L. III 3540, p 37; C.I.L. III 1938, p 37; C.I.L. IX 2115, p 38; C.I.L. III 8551, p 38; p 38; p 38; p 38; V. T1.26.

33 Daziscus: to oppress - Bos. tlačiti, Cro. tlačiti, Rus. давить, Ser. тлачити, Slo. tlačiti, Ukr. давити; p 40; V.T1.25.

34 Daza, Dazas, Dazanus; Dazen, Dazeta, Dazier, Dazima, Dazimos, Dazios, Dazipos, Daziscus Dazomenus, Dazos, Dazun-, Dazupos, Dazymos, *Dizo: the tenth - Bel. дзясяты, Bos. deseti, Blg. десетата, Cro. deseti, Cze. дахум, Lit. dešimtas, Mac. десеттиот, O.Ch.Sl. десѧтъ, Pol. dziesiąty, Rus. десятый, Ser. десети, Slo. deseto, Slv. desiaty, Ukr. десятий; C.I.L. III 13861, p 39; C.I.L. VIII 9377, p 39; C.I.L. III 3349, p 39; p 39; p 39; C.I.L. III, 8350, p 39; p 39; p 39; p 40; p 40; p 40; C.I.L. III 9024, p 40; p 40; p 40; p 41; p 41; C.I.L. V 893, p 44; V.T1.29.

35 *Denio, Dennata: day - Bel. дзень, Bos. dan, Bul. ден, Cro. dan, Cze. den, Lit. diena, Mac. ден, O.Ch.Sl. дьнь, Rus. день, Ser. дан, Slo. dan, Slv. deň, Ukr. день; C.I.L. III 2847, p 41; C.I.L. III 13278, p 41.

36 †Deuso, †Deusus: (1) robust - Bel. дужы, Rus. дюжий, Ukr. дужий; C.I.L. III 10883, p 42; C.I.L. III 5303, p 42; V.T1.28.

: (2) soul - Bel. душа, Bos. duša, Blg. душа, Cro. duša, Cze. duše, Lit. dvasia, Mac. душа, O.Ch.Sl. доуша, Pol. dusza, Rus. душа, Ser. душа, Slo. duša, Slv. duše, Ukr. душа; C.I.L. III 10883, p 42; C.I.L. III 5303, p 42; V.T1.28.

37 *Dida, *Dita: child - Bel. дзіця, Bos. dijete, Bul. дете, Cro. dijete, Cze. dítě, Lit. duktė, Mac. дете, O.Ch.Sl. дѣть, Pol. dziecko, Rus. дитя, Ser. дете, Slv. dieťa, Ukr. дитя; C.I.L. V 1958, p 42; p 43.

38 Diteius, Ditica, Ditio, Dito, Ditueius, Ditus: children - Bel. дзеці, Bos. deca, Bul. деца, Cro. djeca, Cze. děti, Mac. деца, O.Ch.Sl. дѣти, Pol. деца, Rus. дети, Ser. деца, Slv. deti, Ukr. діти; C.I.L. III 9032, p 43; C.I.L. V 461, p 43; C.I.L. V 1830, p 43; C.I.L. III 1927, p 44; C.I.L. III 10040, p 44; C.I.L. III D VI, p 44.

39 *Domator Dommus, Dumma: home/house - Bel. дом, Bos. dom, Bul. дом, Cro. dom, Cze. dům, Mac. дом, O.Ch.Sl. домъ, Pol. dom, Rus. дом, Ser. дом, Slv. dom, Ukr. дім; C.I.L.V 449, p 44; C.I.L. V 443, p 44; C.I.L. III 2858, p 45.

40 †Drus(s)ius, Drus(s)ia: friends - Bel. друзья, Lit. draugai, Rus. друзья, Ukr. друзі; C.I.L. IX 505, p 44; C.I.L. IX 505, p 44.

41 †Ducetios: spirit - Bel. дух, Bos. duh, Bul. дух, Cro. duh, Cze. duch, Lit. dvasia, Mac. дух, O.Ch.Sl. доухъ, Pol. duch, Rus. дух, Ser. дух, Slo. duha, Slv. duch, Ukr. дух; p 45.

E

42 Egirus: urchin - Bos. jež, Lit. ežys, Rus. ёж, Ser. јеж, Slo. jež, Slv. ježko, Ukr. їжак; C.I.L. V 727, p 45.

43 Elonia, †Flonia: fir - Bel. елка, Bos. jelka, Bul. ела, Cro. jela, Cze. jedle, Lit. eglė, Mac. ела, Pol. jodła, Rus. ель, Ser. јела, Slo. jelka, Slv. jedľa; p 46; C.I.L. V 2253, p 51.

44 Ettritus: nucleus - Bel. ядро, Bos. jezgra, Blg. ядро, Cro. jezgra, Cze. jádro, Mac. јадро, Pol. jądro, Rus. ядро, Ser. језгро, Slo. jedro, Slv. jadro, Ukr. ядро; p 49; V.T1.31.

45 Etuta: this - Bel. гэта, Cze. tento, O.Ch.Sl. тъ, Pol. to, Rus. этот, Slo. to, Slv. toto; p 49.

46 [Extionia]: to go - Bel. ехаць, Lit. eiti, O.Ch.Sl. ехати, Rus. ехать, Ukr. їхати; C.I.L. V 456, p 50.

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	F
47	Fasaca, Fasena: face - Bel. фас, Rus. фас, Ukr. фас; C.I.L. V 410, p 50; C.I.L. III 12285, p 50.
48	Fata, Fato: veil - Bel. фата, Rus. фата, Ukr. фата; C.I.L. III 3134, p 50; C.I.L. III 12014_{34}, p 50.
	G
49	*Gillos: lived - Bel. жылі, Bul. живял, Cro. živjeli, Cze. žil, Pol. żył, Rus. жил, Slv. žíl; p 54.
50	*Glavus: head - Bel. галава, Bos. glava, Bul. глава, Cro. glava, Cze. hlava, Lit. galva, Mac. главата, O.Ch.Sl. глава, Pol. głowa, Rus. голова, Ser. глава, Slo. glavo, Slv. hlava, Ukr. голова; p 55.
51	Grabon, Grabos, Grabovius: hornbeam - Bel. граб, Bos. graba, Bul. габър, Cro. grab, O.Ch.Sl. грабъ, Pol. grab, Rus. граб, Ser. граба, Slo. gaber, Slv. hrab, Ukr. граб; p 55; p 55; p 55.
52	†Graecidius: buckwheat - Bel. грэчка, Lit. grikiai, Pol. gryka, Rus. греча, Ukr. гречка; C.I.L. IX 338, p 55.
53	Gresa: dream - Bel. грёза, O.Ch.Sl. грѣза Rus. грёза, Ukr. греза; C.I.L. III 14538, p 55.
	H
54	*Hanicus: to hunt – Bos. goniti, Blg. гоня, Cro. goniti, Cze. hon, Lit. guiti, O.Ch.Sl. гонити, Pol. uganiać, Rus. гнать, Ser. гонити, Slv. hon, Ukr. гнати; C.I.L. III 4367; p 56; V.T1.32.
55	Hoplon: stronghold - Bel. аплот, Rus. оплот, Ukr. оплот; p 56.
56	Hostila, Hostil(i)us, Hostius, Hostus: to remain/to stay - Bos. ostati, Blg. остават, Cro. ostati, Cze. zůstat, Mac. остане, O.Ch.S. стати, Rus. остаться, Ser. остати, Slo. ostati, Slv. ostať; C.I.L. III, 10746, p 56; C.I.L. V 4965, p 56; C.I.L. III 10726, p 56; C.I.L. V 431, p 56; V.T1.36.
	I
57	†Itto, Ittu, †Iturius, Jettus: to go - Bel. ісці, Bos. ići, Blg. отида, Cro. ići, Cze. jít, Lit. eiti, Mac. Да оди, O.Ch.Sl. ити, Pol. iść, Rus. идти, Ser. иде, Slo. iti, Slv. ísť, Ukr. йти; p 58; C.I.L. III, 4784, p 58; C.I.L. V 2036, p 59; C.I.L. III, 2768, p 58; V.T1. 39.
	J
58	†Jadia: poison - Bel. яд, Cze. jed, Pol. jad, Rus. ядъ, Slv. jed, Ukr. яд'; C.I.L. III 2563, p 56.
59	*Jaemiota, †Jamusioi: hole - Bel. яма, Bos. jama, Bul. яма, Cro. jama, Cze. jáma, Mac. јама, O.Ch.Sl. ꙗма, Rus. яма, Ser. јама, Slo. jama, Slv. jama, Ukr. яма; C.I.L. III 6389, p 57; C.I.L. V 2780, p 57.
60	Jasus: clear - Bel. ясна, Bos. jasno, Bul. ясно, Cro. jasno, Cze. jasný, Mac. јасно, Pol. jasny, Rus. ясный, Ser. јасан, Slo. jasen, Slv. jasný, Ukr. ясний; C.I.L. III D LX, p 57.
61	Javia: reality - Bel. ява, Rus. явь, Ukr. ява; p 57.
62	Jutossica: stern - Rus. ют; C.I.L. 10174, p 59.
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63	*Laeca: hunting dog - Bel. лайка, Rus. лайка, Ukr. лайка; C.I.L. V 1980, p 60.
64	*Lannus: deer - Bel. алені, Bos. jelen, Blg. елен, Cro. jelen, Cze. jelen, Lit. elnias, Mac. елен, Pol. jeleń, Rus. олень, Ser. јелен, Slo. jelen, Slv. jeleň, Ukr. олень; CIL. V, 1. no. 3655, p 62; V.T1.43.
65	*Lava, Lavincia, Lavius, Lavo, Laevicus, Laevonicus: lion - Bel. леў, Bos. lav, Blg. лъв, Cro. lav, Cze. lev, Lit. liūtas, Mac. лав, Pol. lew, Rus. лев, Ser. лав, Slo. lev, Slv. lev, Ukr. лев; C.I.L. XI 1626, p 64; C.I.L. III, 2773, p 64; C.I.L. III 1269, p 64; C.I.L. III 9846, p 64; C.I.L. V 449, p 60; C.I.L. XIV 263, p 61; V.T1.42.
66	Laid(i)us: boat - Bel. ладдзя, Bul. лодка, Cze. loď, O.Ch.Sl. ладии, Pol. łódka, Rus. ладья; C.I.L. III D VI, p 61.

Continued

67 *Lasagos, *Lasaiu, Lasimos, Lasinius, Laso, Lassonia: hole - Bel. лаз, Cze. laz, Pol. łaz, Rus. лаз, Ser. лаз, Slo. laz, Ukr. лаз; p 62; C.I.L. III 3817, p 63; p 63; C.I.L. 8856, p 63; C.I.L. III 3824, p 63; C.I.L. 10723, p 63.

68 [Lascontia]: weasel - Bel. ласкі, Bos. lasica, Cro. lasica, Cze. lasička, O.Ch.Sl. ласица, Pol. łasica, Rus. ласка, Ser. ласица, Slo. lasica, Slv. lasička, Ukr. ласка; C.I.L. III 3855, p 63.

69 Ledia, Ledietis, Ledrus: ice - Bel. лёд, Bos. led, Blg. лед, Cro. led, Cze. led, Lit. ledas, Mac. лед, Pol. lód, Rus. лёд, Ser. лед, Slo. led, Slv. ľad, Ukr. лід; C.I.L. III. 4743, p 64; C.I.L. III 2778, p 64; C.I.L. III 9819, p 64; V.T1.44.

70 Levo, *Levonicus: lion - Bel. леў, Bos. lav, Blg. лъв, Cro. lav, Cze. lev, Lit. liūtas, Mac. лав, Pol. lew, Rus. лев, Ser. лав, Slo. lev, Slv. lev, Ukr. лев; C.I.L. V 61, p 66; C.I.L. XIV 1228, p 66; V.T1.42.

71 *Licaea, *Licaius, *Licaus, *Licca, *Liccaeus, Liccaius, *Licca(v)us, Licco, †Licovius, Licovia: (1) front - Bel. лік, Bos. lice, Bul. лице, Cro. lice, Mac. лице, O.Ch.Sl. лицє, Rus. лик, Ser. лице, Ukr. лик; C.I.L. V 8409, p 66; C.I.L. III 3224, p 66; p 66; p 67; C.I.L. III D C, p 66; C.I.L. V 1001, p 66; C.I.L. III 15101, p 67; C.I.L. III 3224, p 67; C.I.L. VIII 21041, p 67; C.I.L. III 5265, p 67; C.I.L. V 1958, p 67; V.T1.45.

: (2) personal - Bos. lični, Blg. личен, Cro. lični, Mac. лично, Rus. личный, Ser. лични; C.I.L. V 8409, p 66; C.I.L. III 3224, p 66; p 66; p 67; C.I.L. III D C, p 66; C.I.L. V 1001, p 66; C.I.L. III 15101, p 67; C.I.L. III 3224, p 67; C.I.L. VIII 21041, p 67; C.I.L. III 5265, p 67; C.I.L. V 1958, p 67; V.T1.45.

72 Lomoliavus: scrap - Bel. лом, Bul. лом Pol. złom, Rus. лом, Ser. лом, Slo. lòm, Ukr. лом; C.I.L. V 450, p 68.

73 Lonus: breast - Bel. ўлонне, Bul. лоно, Pol. łono, Rus. лоно, Ukr. лоно; C.I.L. III. C XX, p 68.

74 [Lubana], [Lubia], [Lubiamus]: (1) love - Bel. люб, Bos. ljubavi, Bul. любов, Cro. ljubav, Mac. убов, O.Ch.Sl. люб, Rus. люб, Ser. љубав, Slo. ljubezen, Ukr. люб; C.I.L. V 4637, p 69; C.I.L. V 5033, p 69; C.I.L. V 4992, p 69.

: (2) forehead - Bel. лоб, Rus. лоб, Ukr. лоб; C.I.L. V 4637, p 69; C.I.L. V 5033, p 69; C.I.L. V 4992, p 69.

75 Lunnicus: moon - Bel. луна, Bul. луна, O.Ch.Sl. лоуна, Rus. луна, Slo. luna, Ukr. луна; C.I.L. III, 6412, p 69.

76 Lykkeios: (1) bow - Bel. лук, Bos. luk, Blg. лък, Cro. luk, Lit. lankas, Mac. лак, Pol. łuk, Rus. лук, Ser. лук, Slo. lok, Slv. lúk, Ukr. лук; p 69; V.T1.46.

: (2) onion - Bel. лук, Bos. luk, Bul. лук, Cro. luk, O.Ch.Sl. ʌnjən, Rus. лук, Ser. лук; p 69, V.T1.46.

M

77 *Malabanus, Malennius, *Mollicius, *Mollo, *Mollonia: small - Bel. маленькі, Bos mali, Blg. малък, Cro. mali, Cze. malý, Mac. мал, O.Ch.Sl. малъ, Pol. mały, Rus. малый, Ser. мали, Slo. majhen, Slv. malý, Ukr. малий; C.I.L. V 150, p 71; p 71; C.I.L. V 587, p 76; C.I.L. V 1305, p 77; C.I.L. V 2974 p 77; C.I.L. V 3500, p77; V.T1.47.

78 Mandeta: vagina - Rus. манда, Ukr. манда; C.I.L. III 14617[4], p 71.

79 *Medaurus, Medella: (1) honey - Bel. мёд, Bos. med, Bul. мед, Cro. med, Cze. med, Lit. medus, Mac. мед, O.Ch.Sl. медъ, Pol. miód, Rus. мед, Ser. мед, Slo. med, Slv. med, Ukr. мед; C.I.L. VIII 2581, p 72; C.I.L. IX 390, p 72.

: (2) copper - Bel. медзь, Bul. мед, Cze. měď, Pol. miedź, Rus. медь, Slv. meď, Ukr. мідь; C.I.L. VIII 2581, p 72; C.I.L. IX 390, p 72.

80 Melesocus, †Mellito: chalk - Bel. мел, O.Ch.Sl. мѣлъкъ, Pol. miałki, Rus. мел, Ukr. мел; C.I.L. V 8127, p 73; C.I.L. III 2999; p 73.

81 *Metellus: blizzard - Bel. мяцеліца, Rus. метель, Ukr. заметіль; C.I.L. V 443, p 75.

Continued

82 Milizza: dear - Bul. мил, Cze. milý, Lit. mielas, Mac. мил, Rus. милый, Slv. milý, Ukr. милий; C.I.L. III 8294, p 75.

83 Moicus, Moienus, Moilicus, Moiota: my - Bel. мой, Bos. moj, Bul. мой, Cro. moj, Cze. můj, Mac. мојата, O.Ch.Sl. мои, Pol. mój, Rus. мой, Ser. мој, Slo. moj, Slv. môj, Ukr. мій; C.I.L. III 2558, p 76; C.I.L. III 3647, p 76; C.I.L. V 587, p 76; C.I.L. III 3785, p 77.

84 Morcos: sea - Bel. мора, Bos. more, Blg. море, Cro. more, Cze. moře, Mac. море, Pol. morze, Rus. море, Ser. море, Slo. morje, Slv. more, Ukr. море; p 77; VT1.50.

85 [Mottu]: prodigal - Bel. мот, Bos. mot, Bul. мот, Cro. mot, Cze. mot, Lit. mot, Mac. мот, Pol. mot, Rus. мот, Ser. мот, Slo. mot, Slv. mot, Ukr. мот; C.I.L. III 5624, p 78.

86 †Mucatus: (1) flour - Bel. мука, Cze. mouka, O.Ch.Sl. мѫка, Pol. mąka, Rus. мука, Ser. мука, Slo. moka, Slv. múka, Ukr. мука; p 78.

: (2) throe - Bul. мъки, Rus. мука, Slv. muky, p 78.

87 †Mutronius: dreary - Mac. тмурна, Rus. муторный; C.I.L. IX 342, p 78.

88 Mutteia: dregs - Bel. муць, Pol. męty, Rus. муть, Ukr. муть; C.I.L. V 2909, p 78.

89 †Mytil(i)us: to wash - Bel. мыць, Cze. mytí, Mac. мие, O.Ch.Sl. мыти, Pol. umyć, Rus. мыть, Slv. umytie, Ukr. мити; p 78.

N

90 †Nammavos: to us - Bel. нам, Bos. nama, Cro. nama, Cze. nám, Rus. нам, Ser. нама, Slo. nam, Slv. nám, Ukr. нам; C.I.L. III 5901, p 79.

91 *Naro: people - Bel. народ, Bul. народ, Cro. narod, O.Ch.Sl. народъ, Pol. naród, Rus. народ, Ukr. народ; p 79.

92 *Nebres: careless - Bul. небрежен, Rus. небрежный; C.I.L. V 8133, p 79.

93 *Nebus: sky - Bel. неба, Bos. nebo, Bul. небе, Cro. nebo, Cze. nebe, Mac. небо, O.Ch.Sl. небо, Pol. niebo, Rus. небо, Ser. небо, Slo. nebo, Slv. neba, Ukr. небо; C.I.L. III D LXXXIX, p 79.

94 Nevica, Nevilla, †Nevius, Nevola: new - Bel. новы, Bos. novo, Bul. нов, Cro. novi, Cze. nový, Lit. nauja, Mac. ново, O.Ch.Sl. новъ, Pol. nowy, Rus. новый, Ser. нови, Slo. novo, Slv. nový, Ukr. новий; C.I.L. V 453, p 79; C.I.L. III 3090, p 79; C.I.L. V 7641, p 79; C.I.L. V 498, p 80.

O

95 Oeplus, Oplica, Oplus, Oplusa, Op(p)alo: stronghold - Bel. аплот, Rus. оплот, Ukr. оплот; C.I.L. III 2891, p 80; C.I.L. III 3149, p 81; C.I.L. III, 3322, p 81; C.I.L. III, 3322, p 81; C.I.L. III 3866, p 82.

96 *Olcias: alder - Bos. jelša, Bul. елша, Cze. olše, Lit. alksnis, Pol. olcha, Rus. ольха, Ser. јелша, Slo. jelša, Slv. jelša, Ukr. ольха; p 80.

97 [Ophelestes]: itinerant trader - Bel. офеня, Rus. офеня, Ukr. офеня; p 81.

98 Opia, Opiavus: experience - Bel. вопыт, Bul. опит, Rus. опыт; C.I.L. III 3144, p 81; C.I.L. III 10121, p 81; V.T1.56.

99 Oplica, Oplus, Oplusa, Op(p)alo: disgrace - Bel. апала, Rus. опала, Ukr.опала; C.I.L. III 3149, p 81; C.I.L. III 3322, p 81, C.I.L. III 3322, p 81, C.I.L. III 3866, p 82.

100 *Osthilos, Ostiala, Ostila, Ostilius, Ostus: to remain/to stay - Bos. ostati, Blg. остават, Cro. ostati, Cze. zůstat, Mac. остане, Rus. остаться, Ser. остати, Slo. ostati, Slv. Ostať; p 83; C.I.L. V 2906, p 83; C.I.L. III 3853, p 83; C.I.L. V 2251, p 83; C.I.L. III 3806, p 83; V.T1.57.

101 Ovia, †Ovincius, †Ovinconius: sheep - Bel. авечка, Bos. ovce, Blg. овца, Cro. ovca, Cze. ovce, Lit. avys, Mac. овца, Pol. owca, Rus. овца, Ser. овца, Slo. ovca, Slv. ovca, Ukr. овець; C.I.L. V 449, p 83; C.I.L. III 5139, p 83; C.I.L. VI 2613, p 83; V.T1.58.

Continued

P

102 *Pacuvius: bye - Bel. пока, Rus. пока, Ukr. поки; p 83.

103 *Paeticus: the fifth - Bel. пяты, Bos. peti, Blg. петият, Cro. peti, Cze. pátý, Mac. петтиот, Pol. piąty, Rus. пятый, Ser. пети, Slo. peti, Slv. piaty, Ukr. п'ятий; C.I.L. V, 2035, p 83; V.T1.59.

104 Pai(i)o, Paius: (1) share – Bul. пай, Lit. pajus, Rus. пай, Ukr. пай; C.I.L. III 9839, p 84; C.I.L. V 1956, p 84.

: (2) obedient - Bel. пай, Rus. пай, Ukr. пай; C.I.L. III 9839, p 84; C.I.L. V 1956, p 84.

105 *Palaus, *Palavellius: burnt - Rus. пал; C.I.L. XIV 1445, p 84; C.I.L. V 2392, p 84.

106 Panent-, Panentius, Panet- †Pantauchos, Pantia, Panto: antlers - Bel. панты, Rus. панты, Ukr. панти; C.I.L. III 2426, p 84; C.I.L. XI 93, p 84; p 85; p 85; C.I.L. III 9253, p 85; C.I.L. III 2786, p 85.

107 *Paravellius, *Paris: vapour - Bel. пара, Bos. para, Bul. пара, Cro. para, Cze. pára, Mac. пареа, O.Ch.Sl. паръ, Pol. para, Rus. пар, Ser. пара, Slo. pare, Slv. para, Ukr. пара; C.I.L. VI 2405, p 86; p 86.

108 Patalicus, Patalius, Patalus: marmalade - Rus. пат, Ukr. пат; C.I.L. V 452, p 86; C.I.L. III 13295, p 86; C.I.L. III 11661, p 87.

109 *Phalacriōn, Phalacros, †Phalinos, [Phalios]: halyard - Bel. фал, Bul. фал, Pol. fał, Rus. фал, Ukr фал; p 88; p 88; p 89; p 89.

110 Platino, Plator, Platorius, Platura, Platurius, Platus, Platyr: pay - Bel. плата, Bos. plata, Bul. плащане, Cro. plata, Cze. plat, Mac. плата, Pol. zapłata, Rus. плата, Ser. плата, Slo. plača, Slv. výplata, Ukr. плата; C.I.L. III 2788, p 92; C.I.L. III 7821, p 92; C.I.L. III 2148, p 94; C.I.L. VI 24672, p 94; p 94; p 94; p 94.

111 Plaetor, Plaetorianus, Plaetorius, Pletor, Pletorius, Pletoronius: whip - Lit. plakti, Rus. плеть, Ukr. пліть; C.I.L. III 3149, p 91; p 91; C.I.L. III 2728, p 91; C.I.L. III 3804, p 95; C.I.L. VI 2544, p 95; C.I.L. V 455, p 95.

112 Plesont-: stretch of river - Bel. плёс, Rus. плёс, Ukr. плесо; C.I.L. III 3042, p 94.

113 †Potisus: sweat - Bel. пот, Bul. пот, Cze. pot, Mac. пот, O.Ch.Sl. потъ, Pol. pot, Rus. пот, Slo. pot, Slv. pot, Ukr. піт; C.I.L. III 2985, p 96.

114 Pravaus: right - Bel. правы, Bos. u pravu, Bul. правилно, Cro. pravo, Cze. pravá, Mac. право, O.Ch.Sl. правъ, Pol. prawo, Rus. правый, Ser. право, Slo. prav, Slv. správny, Ukr. правий; p 96.

115 Pyllos: saw - Bel. піла, Bos. pila, Cro. pila, Cze. pilka, Mac. пила, Pol. Piła, Rus. пила, Slv. Pílka, Ukr. пила; p 97.

Q

R

116 *Raecius, *Raecus, Recus: language - Bul. реч, Cze. řeč, O.Ch.Sl. рѣчь, Rus. речь, Slv. reč; C.I.L. III, 3116, p 97; C.I.L. III 5789, p 97; C.I.L. III 9958, p 97.

117 †Ritius: to dig - Bel. рыць, Pol. ryć, Rus. рыть, Ukr. рити; C.I.L. V 1894, p 98.

S

118 Sallas, †Salynthios: salt - Bel. соль Bos. sol, Bul. сол, Cro. sol, Cze. sůl, Mac. сол, O.Ch.Sl. соль, Pol. sól, Rus. соль, Ser. со, Slo. sol, Slv. soľ, Ukr. сіль; p 99; p 99; V.T1.71.

119 †Samanna, †Samiarus: alone - Bos. sam, Blg. сам, Cro. sam, Cze. sám, Mac. сам, Pol. sam, Rus. сам, Ser. сам, Slo. sam, Slv. sám, Ukr. сам; C.I.L. III 2610, p 100; C.I.L. V, 1046, p 100; V.T1.66.

120 *Sanic(i)us: dignity - Bul. сан, Rus. сан, Ukr. сан; C.I.L. V 2433, p 100.

Continued

121 †Sattava: hundred - Bel. сто, Bos. stotinu, Blg. сто, Cro. сто, O.ChSl. съто, Pol. sto, Rus. сто, Ser. сто, Slo. sto, Slv. sto, Ukr. сто; C.I.L. V 3605, p 100; V.T1.67.

122 Sceno, Scenobarbus Scenobarvus, Scenua, Scenus: hay - Bel. сена, Bos. sijeno, Bul. сено, Cro. sijeno, Cze. seno, Lit. šienas, Mac. сено, O.Ch.Sl. сѣно, Pol. sienny, Rus. сено, Ser. сено, Slo. seno, Slv. seno, Ukr. сіно; C.I.L. V 186, p 101; C.I.L. III 1265, p 101; C.I.L. III 1265, p 101; C.I.L. XI 214, p 101; C.I.L. III 7372, p 101.

123 Scerdilaedus, Scerdis: heart - Bel. сэрца, Bos. srce, Bul. сърце, Cro. srce, Cze. srdce, Lit. širdis, Mac. срце, O.Ch.Sl. срьдьцє, Pol. serce, Rus. сердце, Ser. срце, Slo. srce, Slv. srdce, Ukr. серце; p 101; p 102.

124 *Scilus: awl - Bel. шыла, Bos. šilo, Bul. шило, Cro. šilo, Cze. šídlo, Mac. шило, O.Ch.Sl. шило, Pol. szydło, Rus. шило, Ser. шило, Slo. šilo, Slv. šidlo, Ukr. шило; C.I.L. III 4377, p 102.

125 *Scirtios, *Scirtia, *Scirtos: breadth - Bul. широта, Cro. široka, Rus. широта, Ukr. широта; p 102; C.I.L. X 8264, p 102; p 102 .

126 *Scordeia, *Scordias: soon - Bos. uskoro, Bul. скоро, Cro. uskoro, Mac. наскоро, Rus. скоро, Ser. ускоро, Slv. čoskoro, Ukr. скоро; p 103; p 103.

127 Sei(i)o: this - O.Ch.Sl. сь, Rus. сей, Ukr. сей; C.I.L. III 2756, p 103.

128 Selio: village - Bel. сяло, Bos. selo, Bul. село, Cro. selo, Mac. село, Rus. село, Ser. село, Ukr. село; C.I.L. III 8604, p 103.

129 †Seminiacca: seven - Bel. сем, Rus. семь, Ukr. сім; C.I.L. IX 3486, p 103.

130 Sera, Serus: sulfur - Bel. сера, Bul. сяра, Cze. síra, Lit. sieros, Pol. siarka, Rus. сера, Slv. síra, Ukr. сірка; C.I.L. III 2787, p 103; p 103.

131 Sestus, Sexticus, Sexto, Sextus: sixth - Bel. шосты, Bos. šesto, Bul. шести, Cro. šesti, Cze. šestý, Lit. šeštas, Mac. шесто, O.Ch.Sl. шєстъ, Pol. szósty, Rus. шестой, Ser. шесто, Slo. šesti, Slv. šiesty, Ukr. шостий; C.I.L. III 9876, p 103; C.I.L. V 456, p 104; C.I.L. III 10079, p 104; C.I.L. III 2790, p 104.

132 †Sibalis: rapid - Bel. шыбко, Rus. шибкий, Ukr. шыбко; p 104.

133 †Silo: force - Bel. сіла, Bos. silu, Blg. сила, Cro. sila, Cze. síla, Mac. сила, Pol. siła, Rus. сила, Ser. сила, Slo. silo, Slv. sila, Ukr. сила; C.I.L. III 5165, p 104; V.T1.70.

134 *Sinus: son - Bel. сын, Bos. sin, Bul. син, Cro. sin, Cze. syn, Lit. sūnus, Mac. син, O.Ch.Sl. сынъ, Pol. syn, Rus. сын, Ser. син, Slo. sin, Slv. syn, Ukr. син; C.I.L. III 2778, p 105.

135 *Sipa, Sipo, †Sippas: thorn - Bel. шып, Bul. шип, Rus. шип, Ukr. шип; C.I.L. III 12014_{529}, p 105; C.I.L. V 2327, p 105; p 105.

136 Sirras: cheese - Bel. сыр, Bos. sir, Bul. сирене, Cro. sir, Cze. sýr, Lit. sūris, Mac. сирење, O.Ch.Sl. сыръ, Pol. ser, Rus. сыр, Ser. сир, Slo. sir, Slv. syr, Ukr. сир; p 105.

137 Slator: gold - Bel. золата, Bos. zlato, Bul. злато, Cro. zlato, Cze. zlato, Mac. злато, O.Ch.Sl. злато, Pol. złoto, Rus. злато, Ser. злато, Slo. zlato, Slv. zlato, Ukr. золото; C.I.L. III 9810, p 105.

138 *Sola, †Solia: salt - Bel. соль, Bos. sol, Bul. сол, Cro. sol, Cze. Sůl, Mac. сол, O.Ch.Sl. соль, Pol. sól, Rus. соль, Ser. со, Slo. sol, Slv. soľ, Ukr. сіль; C.I.L. III 787, p 106; C.I.L. III 5487, p 106; V.T1.71.

139 †Sōnylos: dream - Bos. san, Bul. сън, Cro. san, Cze. sen, Mac. сон, O.Ch.Sl. сънъ, Pol. sen, Rus. сон, Ser. сан, Slo. sanje, Slv. sen, Ukr. сон; p 106.

140 *Stataria, Staticus, Statinius: become - Bel. стаць, Cze. stát se, O.Ch.Sl. стати, Pol. stają się, Rus. стать, Slv. stať sa, Ukr. стати; C.I.L. III 8323, p 106; C.I.L. III 2795, p 106; C.I.L. III 2790, p 106.

141 Stul-, *Stulio: chair - Bos. stolica, Bul. стол, Cro. stolica, Cze. stolice, Mac. стол, Rus. стул, Ser. столица, Slo. stol, Slv. stolica, Ukr. стілець; C.I.L. III 13205, p 106; C.I.L. V 2856, p 106.

142 †Surco, *Suricus: marmot - Bel. сурок, Rus. сурок; p 107; C.I.L. III 4197, p 107.

Continued

143 *Surilla, *Surinus, *Surio, *Surus: severe - Bel. суровы, Blg. суров, Pol. surowy, Rus. суровый, Slv. surový, Ukr. суворий; C.I.L. III 4834, p 107; C.I.L. V 483, p 107; C.I.L. VI 3184, p 107; C.I.L. III 1189, p 108; V.T1.73.

144 Sutta, Suttihus, Suttis, Sutt(i)us: essence - Bos. suština, Cro. suština, Rus. суть, Ser. суштина, Ukr. суть; C.I.L. III 8021, p 109; C.I.L. III 4831, p 109; C.I.L. III 14316[7], p 107; p 107.

T

145 *Talasios, *Talasus, †Tals(i)us: (1) hostage - Cro. talac, Rus. таль, Ser. талау, Slo. talca, Ukr. таль; p 110; C.I.L. V 2323, p 110; C.I.L. III 3811, p 110.

: (2) thawed - Bel. талы, Rus. талый, Ukr. талий; p 110; C.I.L. V 2323, p 110; C.I.L. III 3811, p 110.

146 †Tata, Tato, Tatta, Tattaia, Tattaris, *Tattu, Tattuia, *Tattus, †Tatusius: thief - Bel. тать, O.Ch.Sl. татъ, Rus. тать, Slo. tat, Ukr. тать; C.I.L. III 5504, p 111; C.I.L. 8095, p 111; C.I.L. III 12775, p 111; C.I.L. III 8342, p 111; C.I.L. III 12800, p 111; C.I.L. III 11600, p 111; p 111; C.I.L. III 4948, p 111; C.I.L. III 3191, p 111.

147 Telavia: body - Bel. цела, Bos. tijelo, Bul. тяло, Cro. tijelo, Cze. tělo, Mac. тело, O.Ch.Sl. тѣло, Rus. тело, Ser. тело, Slo. telo, Slv. telo, Ukr. тіло; p 112.

148 Temans, Temeia, Temus: darkness - Bos. tama, Bul. тъмнина, Cro. tama, Cze. tma, Lit. tamsa, Mac. темнина, O.Ch.Sl. тьма, Rus. темь, Ser. тама, Slo. temo, Slv. tma, Ukr. темь; C.I.L. X 3666, p 112; p 112; C.I.L. III 8489, p 112.

149 Tergitio: (1) market - Bos. tržište, Bul. тържище, Cro. tržnica, Cze. tržiště, Lit. turgaviet, Pol. targ, Ser. тржиште, Slo. trg, Slv. trh; C.I.L. III 4251, p 112; V.T1.77.

: (2) bargain - Bel. торг, Cze. targ, Pol. targ, Rus. торг; C.I.L. III, 4251, p 112; V.T1.77.

150 *Terna, *Ternila: blackthorn - Bel. цёрн, Bos. trn, Bul. трън, Cro. trn, Cze. trnka, Mac. трн, Pol. tarnina, Rus. тёрн, Ser. трњина, Slo. trn, Slv. trnka, Ukr. терен; C.I.L. V 4716, p 112; C.I.L. V 449, p 112.

151 †Tertaus, Tritanerus, Tritano, Tritanus, Triteuta, Tritos: third - Bel. трэці, Bos. treće, Bul. трето, Cro. treći, Cze třetí, Mac. Трети, O.Ch.Sl. трєти, Pol. trzeci, Rus. третий, Ser. трећи, Slo. tretji, Slv. tretí, Ukr. третій; C.I.L. XI 4092, p 112; C.I.L. III 2796, p 117; C.I.L. III 2792, p 117; p 117; p 117; C.I.L. III 6411, p 118; V.T1.76.

152 Testimos, Testo: father in law - Bel. цесць, Bos. tast, Cro. tast, Mac. test, Pol. test, Rus. тесть, Ser. тест, Slo. test, Slv. test, Ukr. тест; p 113; C.I.L. III 8326, p 113.

153 Trosantios, Trosius: rope - Bel. трос, Rus. трос, Ukr. трос; p 118; C.I.L. III 633 II 8, p 119.

154 Truppicus: corpse - Bel. труп, Bul. труп, Mac. труп, Pol. trup, Rus. труп, Slo. truplo, Ukr. труп; C.I.L. V 2435, p 119.

155 Tudania, Tudicius: there - Bel. туды, Rus. туда, Ukr. туди; C.I.L. III 2797, p 119; C.I.L. V 2515, p 119.

156 *Turelius, Turia, Turica, Turo, Turoius, Turus: aurochs - Lit. tauras, O.Ch.Sl. туръ, Pol. tur, Rus. тур; C.I.L. III 4150, p 120; C.I.L. III 2700, p 120; C.I.L. V 477, p 120; C.I.L. III 2794, p 120; C.I.L. III 10724, p 120; C.I.L. III 13295, p 120.

157 Tutia, *Tutor, *Tutorina, *Tutorius: mulberry - Bos. dud, Cro. dud, Rus. тута, Ser. дуд, Ukr. тута; C.I.L. III. 10949, p121; C.I.L. IX 1920, p 121; C.I.L. IX 351, p 121; C.I.L. IX 24, p 121.

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V

158 †Val(l)ius: wave - Bel. хваля, Bos. val, Bul. вълна, Cro. val, Cze. vlna, Rus. вал, Slo. val, Slv. vlna, Ukr. вал; C.I.L. III 6423, p 122.

159 †Vanamiu: bath - Bel. банята, Blg. баня, Lit. vonia, Mac. бања, Rus. баня, Ukr. баня; C.I.L. III 4244, p 122; V.T1.79.

Continued

160 Varieus, Varro: cook - Bel. вары, Cze. vařit, Lit. virėjas, Rus. вари, Slv. uvariť, Ukr. вари, p 123; C.I.L. III 8551, p 123.

161 †Veianius, †Veiedius, †Veienus, †Veionius, †Veius: blowing - Bel. веючы, Rus. вея, Ukr. вея; C.I.L. III 2600, p 123; C.I.L. V 1442, p 123; C.I.L. V 2724, p 123; C.I.L. V 3058, p 124; C.I.L. V 1356, p 124.

162 Venda, Vendes, Vendo: to lead - Bos. voditi, Blg. води, Cro. voditi, Cze. vedení, Lit. vadovauti, Mac. да води, Rus. водити, Ser. водити, Slo. voditi, Slv. vodiť, Ukr. водити; C.I.L. V3425, p 124; C.I.L. III 13278, p 124; C.I.L. III 2796, p125; V.T1.82.

163 †Venesavos: crown - O.Ch.Sl. вѣньць, Pol. wieniec, Rus. венец, Ukr. вінець; p 125.

164 Verzo, *Verzobius, Verzovia: top - Bel. верх, Bos. vrh, Bul. връх, Cro. vrh, Lit. viršuje, Pol. wierzch, Rus. верх, Ser. врх, Slo. vrh, Ukr. верх; C.I.L. III 9056, p 126; C.I.L. IX 2123, p 126; C.I.L. III 1217, p 126.

165 Vescleves: authoritative - Bel. важкі, Pol. ważki, Rus. веский; C.I.L. III 3038, p 126; V.T1.83.

166 †Veseca, *Veselia, *Vesidia, *Vesius: whole - Bel. весь, Lit. visas, Rus. весь, Ukr. весь; C.I.L. III 5922, p 127; C.I.L. III 3093, p 127; C.I.L. III 2525, p 127; C.I.L. III 1797, p 127.

167 Viniocus: wine - Bel. віно, Bos. vino, Blg. вино, Cro. vino, Cze. víno, Lit. vyno, Mac. вино, Pol. wino, Rus. вино, Ser. вино, Slo. vino, Slv. víno, Ukr. вино; C.I.L. III 3154, p 127; V.T1.84.

168 Virno, Virraus: vortex - Bel. вір, Bul. вихър, Cro. vir, Cze. vír, Lit. verpetas, O.Ch.Sl. верхъ, Pol. wir, Rus. вихрь, Ser. вир, Slv. vír, Ukr. вир; C.I.L. III 2897, p 127; C.I.L. V 3842a, p 127.

169 Volsetis, Volsimus, Volsius, Volso, Volsouna, Volsun-, Volsus: hair - Bel. валасоў, Cze. vlasy, O.Ch.Sl. власъ, Pol. włosy, Rus. волос, Slv. vlasy, Ukr. волось; C.I.L. III 3055, p 128; p 128; C.I.L. III 2617, p 128; C.I.L. III 2968a, p 128; C.I.L. III 3149, p 128; C.I.L. III 3151, p 128; C.I.L. III 2985, p 128.

170 Voltisa: power - Bos. vlast, Blg. власт, Cro. vlast, Pol. władza, Rus. власть, Ser. власт, Ukr. влада; C.I.L. III 2900, p 130; V.T1.85.

171 *Voranicca: crow - Bel. ворон, Bos. vrana, Bul. врана, Cro. vrana, Cze. vrána, Lit. varna, Mac. врана, O.Ch.Sl. врана, Pol. wrona, Rus. ворон, Ser. врана, Slo. vrana, Slv. vrana, Ukr. ворон; C.I.L. V 467, p 131.

172 Votticius, Votticia: behold - Rus. вот; C.I.L. V 1829, p 131; C.I.L. III 4735, p 131.

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173 Zaca: sunset - Bel. закат, Rus. закат, Ukr. закат; C.I.L. III 12718, p 131.

174 Zaiio: rabbit - Bos. zec, Blg. заек, Cro. zec, Lit. zuikis, Mac. зајак, Pol., Rus. заяц, Ser. зец, Slo. zajec, Slv. zajac, Ukr заєць; C.I.L. III 2756, p. 131; V.T1.86.

175 Zanatis: to take - Bel. заняць, Rus. занять, Ukr. зайняти; C.I.L. III 14620, p 131.

176 Zorada: sunrise - Bel. зоръ, Bos. zora, Cro. zora, Lit. aušra, Mac. зора, Pol. zorza, Rus. зоръ, Ser. зора, Slo. zora, Ukr. зор'; C.I.L. III 14620, p 131.

Table 2. Language conventions.

sure I. anthr.	* very prob. I. anthr.	† doubt. I. anthr.	[ ] to be seen as I. ant.
Bel. Belarusian	Bos. Bosnian	Blg. Bulgarian	Cro. Croatian
Cze. Czechosl.	Lit. Lithuanian	Mac. Macedonian	O.Ch.Sl. Old Church Slavonic
O.Blg. Old Bulg.	Pol. Polish	Rus. Russian	Ser. Serbian
Slo. Slovenian	Slv. Slovakian	Ukr. Ukrainian	

3. Discussion

The C.I.L. is a continuously updated Latin inscription catalogue covering the Roman Empire period and its provinces, therefore, it is not surprising that Table 1 I. anthroponyms are deeply latinised and graecized. The Slavic root for each I. anthroponym was identified by comparing it with corresponding lexemes in the present surviving Slavic languages (Table 2), this because ancient Slavic documents are rare (Ambrozic & Tomezzoli, 2003) (Ambrozic, 2005) (Ambrozic et al. 2006) (Šavli et al., 1996) (Serafimov, 2006) (Serafimov, 2007a) (Serafimov, 2007b) (Serafimov & Tomezzoli, 2009) (Serafimov & Tomezzoli, 2012) (Tomažič & Tomezzoli, 2003) (Tomezzoli, 2001) (Tomezzoli & Čudinov, 2002) (Tomezzoli, Serafimov & Vodopivec V, 2009) (Tomezzoli & Serafimov 2013) (Vodopivec, 2008) (Vodopivec, 2009a) (Vodopivec, 2009b) and normally contain few lexemes, insufficient for meaningful comparisons with I. anthroponyms.

3.1. Initial Considerations

Similarly to what already observed in considering the V. anthroponyms (Stein & Tomezzoli, 2020), the following is observed.

The concept of nature is present in: T1.1 hell T1.5 reality, T1.9 white, T1.10 birch, T1.11 spring, T1.14 pine, T1.15 shore, T1.20 mud, T1.21 stone, T1.23 carp, T1.25 hour, T1.27 root, T1.28 mountain, T1.35 day, T1.42 urchin, T1.43 fir, T1.44 nucleus, T1.51 hornbeam, T1.52 buckwheat, T1.59 hole, T1.60 clear, T1.61 reality, T1.64 deer, T1.65 lion, T1.67 hole, T1.68 weasel, T1.69 ice, T1.70 lion, T1.75 moon, T1.76(2) onion, T1.79(2) copper, T1.80 chalk, T1.81 blizzard, T1.84 sea, T1.93 sky, T1.101 sheep, T1.105 burnt, T1.107 vapour, T1.112 stretch of river, T1.118 salt, T1.122 hay, T1.130 sulfur, T1.135 thorn, T1.137 gold, T1.138 salt, T1.142 marmot, T1.148 darkness, T1.150 blackthorn, T1.156 aurochs, T1.157 mulberry, 158 wave, T1.164 top, T1.166 whole, T1.171 crow, T1.173 sunset, T1.174 rabbit, T1.176 sunrise.

The concept of person is present in: T1.3 quick, T1.6 without, T1.16 go away, T1.33 to oppress, T1.36(1) robust, T1.36(2) soul, T1.40 friends, T1.41 spirit, T1.46 to go, T1.47 face, T1.49 lived, T1.50 head, T1.53 dream, T1.56 to remain/to stay, T1.57 to go, T1.71(1) front, T1.71(2) personal, T1.73 breast, T1.74(1) love, T1.74(2) forehead, T1.77 small, T1.78 vagina, T1.83 my, T1.86(2) throe, T1.91 people, T1.99 disgrace, T1.100 to remain/to stay, T1.102 bye, T1.113 sweat, T1.116 language, T1.119 alone, T1.120 dignity, T1.123 heart, T1.128 village, T1.133 force, T1.139 dream, T1.140 become, T1.145(1) hostage, T1.146 thief, T1.147 body, T1.154 corpse, T1.159 bath, T1.169 hair, T1.170 power.

The concept of personality is present in: T1.12 whim, T1.17 rowdy, T1.82 dear, T1.87 dreary, T1.92 careless, T1.98 experience, T1.104(2) obedient, T1.114 right, T1.143 severe, T1.165 authoritative.

The concept of family is present in: T1.7 dad, T1.34 the tenth, T1.37 child, T1.38 children, T1.39 home/house, T1.90 to us, T1.103 the fifth, T1.131 sixth, T1.151 third, T1.152 father in law.

The concept of profession is present in: T1.2 granary, T1.4 shout to dogs, T1.8

trouble, T1. 13 fighter, T1.19 alcoolic drink, T1.22 shackles, T1.24 hut, T1.26 barn, T1.29 dot, T1.30 rank, T1.31 gift, T1.32 to give, T1.45 this, T1.48 veil, T1.54 to hunt, T1.55 stronghold, T1.58 poison, T1.62 stern, T1.63 hunting dog, T1.66 boat, T1.72 scrap, T1.76(1) bow, T1.79(1) honey, T1.86(1) flour, T1.88 dregs, T1.89 to wash, T1.94 new, T1.95 stronghold, T1.97 itinerant trader, T1.104(1) share, T1.108 marmalade, T1.109 halyard, T1.110 pay, T1.111 whip; T1.115 saw, T1.117 to dig, T1.121 hundred, T1.124 awl, T1.125 breadth, T1.126 soon, T1.127 this, T1.129 seven, T1.132 rapid, T1.136 cheese, T1.141 chair, T1.145(2) thawed, T1.149(1) market, T1.149(2) bargain, T1.153 rope, T1.155 there, T1.160 cook, T1.161 blowing, T1.162 to lead, T1.163 crown, T1.167 wine, T1.168 vortex, T1.172 behold, T1.175 to take.

3.2. Intermediate Considerations

Similarly to what already observed in considering the V. anthroponyms (Stein & Tomezzoli, 2020), the following is observed.

T1.1 hell is linked to the ancient Gr. Ἄιδης and indicates the underworld, a concept passed lately to the Christian tradition as hell.

T1.3 quick is linked to the hydronyms Adriatic: the sea facing the ancient I. territories, to Adrias/Atrianus: a no longer existing, ancient channel of the today Po river delta, mentioned by Hecateus, Theopompus and Ptolemy (Wikipedia, 2018) and to Jantra a today's Blg. river, tributary of Danube, which was named Athrys by the ancient Thracians.

T1.71(1)/(2) front/personal, T1.84 sea, T1.142 marmot preserve the suffix -co present in today's Slavic personal anthroponyms like, for example: Vinko, Stanko and Slavko.

T1.7 dad, T1.11 spring, T1.15 shore, T1.30 rank, T1.31 gift, T1.47 face, T1.74(1)/(2) love/forehead, T1.119 alone, T1.150 blackthorn, T1.157 mulberry, T1.169 hair preserve the suffix-na present in today's Slavic personal anthroponyms like, for exsmple: Dragana, Stana and Svetlana.

3.3. Final Considerations

In said publication (Krahe, 1929), the I. anthroponyms total is 899 which represents a good sample for a statistical consideration. The I. anthroponyms in **Table 1** having Slavic roots are 413 which represent 45.93% of the I. anthroponyms in said publication. The V. anthroponyms in **Table 1** of the previous publication (Stein & Tomezzoli, 2020), having Slavic roots is roughly 24% of the V. anthroponyms in the corresponding publication (Pauli, 1891). This permits to estimate that during the Roman Empire period, i.e. about five cen., roughly 46% of the I. population and 24% of the V. population had Slavic ascendancies. This permits therefore to reply to the above question (Pigozzo, 2020) that ancient I. and V. were related through their Slavic ascendancies.

4. Conclusion

Said 46% of I. population and said 24% of V. population having Slavic ascendancies, during the Roman Empire period, highlight that Slavs were already present in areas incorporated by the Roman Empire well before the VII cen. A.D., the date, according to the generally accepted theory, of the Slav late arrival in Europe. The logical consequence is that this theory is wrong and should be rejected.

Conflicts of Interest

The authors declare no conflict of interests regarding the publication of this paper.

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How Obelisks Were Constructed, Moved, Shaped, and Erected in the Ancient Egypt

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Abstract

An entirely new feasible theory is presented about how they constructed, moved, shaped, and erected obelisks in ancient Egypt around 1500 BC. In particular, we propose two simple ways to erect obelisks, inspired by the historical fact that all of obelisks were originally erected "in pairs," except the single "Lateran" obelisk. Our aim is to "excavate" ancient Egyptian methods to raise heavy high obelisks, using only the most primitive means including forerunners of pulley, but excluding further mechanical devices, like capstan or winch, which were employed in most cases of re-erection and re-location of obelisk outside of Egypt.

Keywords

Obelisk, Pulley, Moment

1. Introduction

We present a new theory of how obelisks were constructed, moved, shaped, and erected in ancient Egypt. This theory is entirely new, never appeared before in literatures, and aims at "excavating" the architectural techniques in ancient Egypt buried in the passage of time. Due to the religious or aesthetic reason obelisks were originally erected "in pairs" at the entrance of ancient Egyptian temple, except the single "Lateran" obelisk commissioned by Tuthmosis III (1504-1450 BC). Though "erection of two obelisks" usually implies the doubling of efforts to erect each one, we propose in this article how to turn this disadvantage into an advantage. In other words, we assume that the ancient Egyptians found a new architectural reason that high obelisks were easier to be raised "in pairs" than to be raised separately. The prototype of our way of erection can be seen in **Figure 35** where one obelisk, acting as an anchor, helps another to be raised. The ropes and the carrier with rotatable poles are our principal means, and our method of erection of a pair of obelisks, described in Section 5 or Section 6, is quite effective and much simpler than the methods appeared hitherto in literatures (Engelbach, 1923; Isler, 1976; Habachi, 1985). We never used any "modern" mechanical devices like capstan or winch, which were employed in most cases of re-erection and re-location of obelisk outside of Egypt. Even using such mechanical devices, re-erection and re-location was quite hard as described in many literatures (King, 1880; Gorringe, 1885; Siwicki, 2020; Brier, 2021). What we include in "ancient" mechanical devices is "forerunners of pulley" so that we assume throughout this article that:

Forerunners of simple or movable pulley were used with ropes in moving and raising stones.

This assumption we already adopted in (Kato, 2020) as a reasonable one to explain the construction of the Great Pyramid and so, we may even be able to adopt more than this, since the time of high obelisk we concern in this article is about 1500BC, a millennium after the Pyramid Age. A bit precisely, we might say that the history of the truely high obelisks started when Sesostris I (1971-1928 BC, the Middle Kingdom) erected obelisks, one of which is 20.7 meters high (weighs about 121 tons) and is still standing in its original position at Heliopolis; see the chronological list of obelisks in (Jansson, 2019). About "pulley" Arnold (Arnold, 2003: p. 195) notes that "stone grooves and pulleys, around which ropes would have passed, are preserved from the 4th Dynasty, and wooden wheels for simple rope pulleys existed from the Middle Kingdom onwards." As for rope, its good examples can be seen in the Great Boat of Khufu museum; Soros (Soros, 2018) praises the outstanding ability of ancient Egyptians in making rope, and noted that "pieces of ancient rope with a diameter of twelve or thirteen centimetres are found, capable of a strain of several tons." See also (Arnold, 1991: Fig. 6.25).

General Caution about Figures: Most of our figures are not in scale since obelisks are too long, and are simplified to illustrate "mechanism" rather than the actual way in which many strong ropes as well as thick poles or posts would be necessary.

This article is organized according to the timeline from the extraction to the erection of obelisk. First, we explain in Section 2 how an obelisk was cut and extracted from the bedrock. Next, in Section 3 how it was moved, and in Section 4 how it was shaped. Erection of a pair of obelisks is explained in Section 5 and Section 6 showing its force diagram to estimate moments. Section 7 proposes how to erect a single obelisk, and Section 8 explains how to set an obelisk on its pedestal. The only topic we did not concern in this article is about how the obelisk on the barge was transported down the Nile to its destination, about which see (Engelbach, 1923; Hoogeveen, 2018; Jansson, 2019). We have utilized the fine report (Negus, 2015) about the Unfinished Obelisk in Aswan, and could uncover almost all of myths questioned there.

2. How to Cut and Extract an Obelisk from the Bedrock

We begin to explain how an obelisk was cut and extracted from the bedrock. A good resource to learn the way can be found in the Unfinished Obelisk in Aswan, about which (Negus, 2015) reports that:

"It was cut from the granite bedrock with the great uniformity in their cuts and shape. These cuts are quite consistent in their verticality and width in such a way that the cut lines are vertical to the horizon not to the obelisk (the obelisk itself lies on the slope of 10 degrees to the horizontal), and the sides of the cuts, each approximately 20 to 25 cm wide, show vertical ridge lines at a regular spacing, the face between these ridge lines in nearly flat and the ridges themselves are minimal in height. At the bottom of the cut there is a radius."

Taking account of these observations and as well the excavated examples of axe head and rammer (Arnold, 1991: Fig. 6.12, Fig. 6.17), we propose a thick blade for cutting an obelisk as illustrated in **Figure 1** where the size of PQ is about a foot or 30 centimeters. Such a blade should be made of stone, a bit harder than the red granite of the bedrock. But the red granite itself is quite hard, so we believe such a blade was easy to be blunt and consumed a lot. To cut an obelisk, such a blade, set in proper position, should be hit by a strong force, and the best way to generate such a strong power would be to drop a heavy stone in the way of **Figure 4** and **Figure 5**. (Such simple mechanism can be seen nowadays in the so-called "pile driver" or "post pounder.") So, some device to raise and drop a heavy stone would be needed, and we propose a wooden lift with horizontal rotatable poles as in **Figure 2**, which was already proposed in (Kato, 2020) for the construction of the Great Pyramid. **Figure 2** is somewhat simplified to show rather its mechanism (as remarked at the end of Section 1), and note that the vertical thick posts in this figure can be replaced by any wooden towers as in **Figure 3**, where two such towers support a rotatable pole. One man's pulling down force would be about 70 kg or 80 kg utilizing his weight. A cubic stone of side length half a meter weighs about 300 kg so that it can be raised only by four men. But, a bit unexpectedly, a cubic stone of side length 0.7 meters, weighing about 850 kg, needs twelve (850/75 = 11.33···) many men to be raised. Therefore, in **Figure 2** the dimensions of the stone would be appropriate if the maximum of its side lengths is half a meter, assuming that four men pull down the ropes. Observe that the horizontal rotatable poles in **Figure 2** can act as simple pulleys (see Section 9).

To cut vertically into the bedrock, we can use the simple method of **Figure 4**, while, to cut slantwise we need some additional control over the direction of the blade like **Figure 5**. It would not be easy to carve the lower side flat, so we better carve it convexly like **Figure 6** employing the method of **Figure 5** still utilizing the gravity, and the final whole entity extracted from the bedrock should be like **Figure 7** with the convex lower side, either (1) or (2), resembling some cargo ship. Such a convex shape reinforces the whole structure. For instance, as pointed out in (Negus, 2015), suppose on the contrary that the lower side were

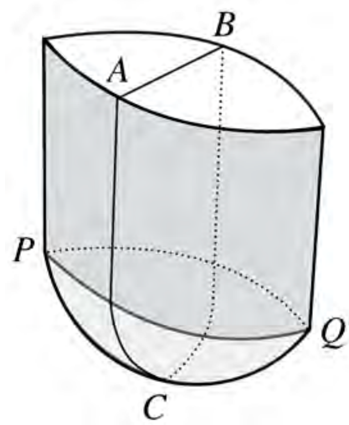


Figure 1. Blade for cutting obelisk.

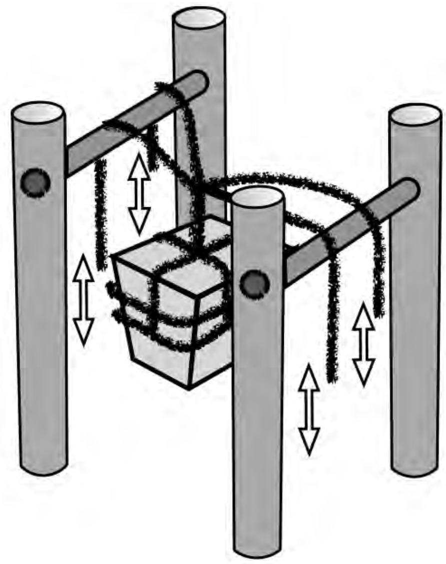


Figure 2. Wooden lift to raise and drop a stone.

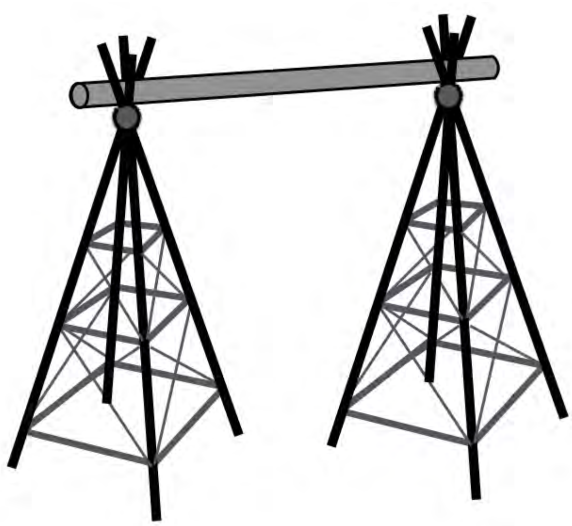


Figure 3. Two towers supporting a rotatable pole.

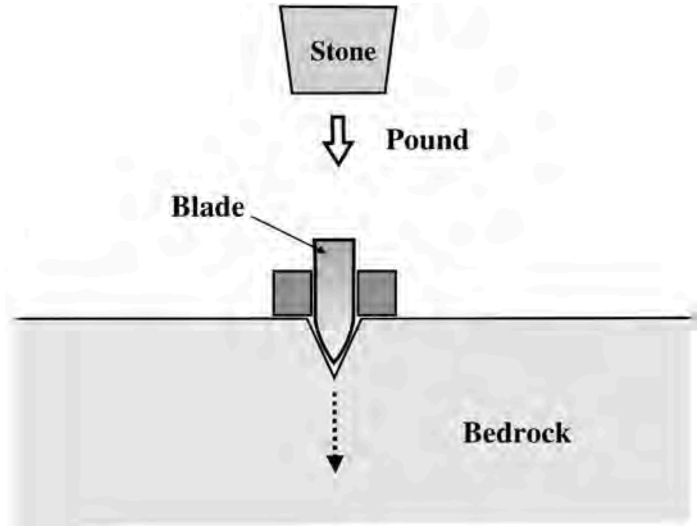


Figure 4. How to use the blade to cut vertically into the bedrock. The blade in this illustration is the cross sectin *ABC* of **Figure 1**, and is kept vertical by the two stones (colored dark grey).

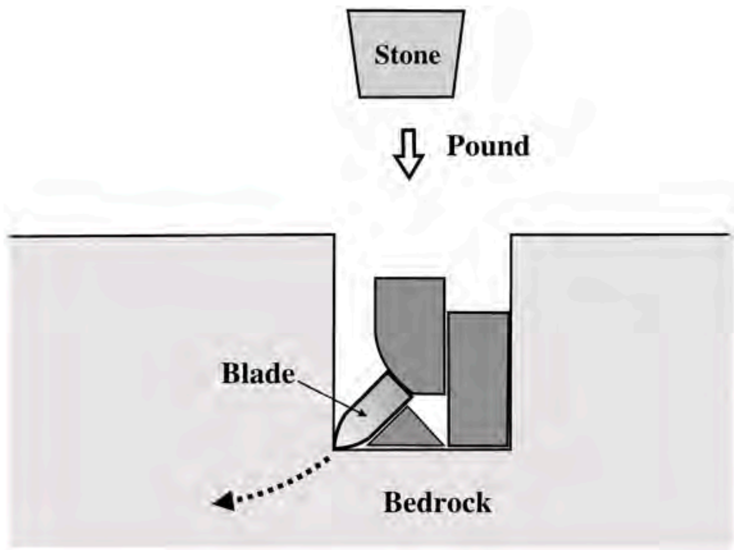


Figure 5. How to control the blade using stones (colored dark grey).

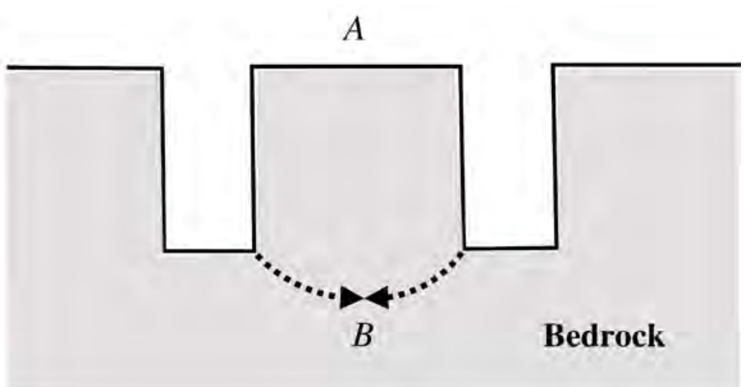


Figure 6. How to carve the lower side.

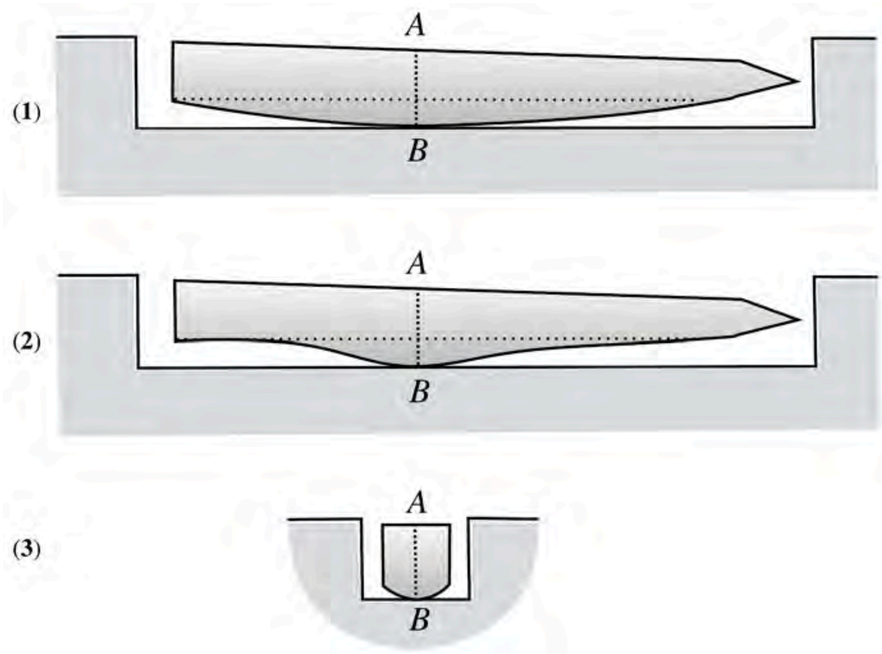


Figure 7. Vertical cross sections of the pre-obelisk to be extracted from the bedrock; (1) or (2) is along the central axis of the obelisk, and (3) is along the plane passing *AB*, parallel to the bottom face of the obelisk.

carved flat, then the long heavy obelisk would be snapped in two once the middle of the flat side were placed with a jerk on some stone. The convex shape also makes easy to maneuver the obelisk, as will be explained in the next section. Let us temporarily call such convex obelisk *pre-obelisk*, short for "predecessor of obelisk," and its convex lower part *belly*.

Now, suppose we have succeeded in detaching the belly from the bedrock so that the pre-obelisk lies in the "dock" of bedrock as illustrated in **Figure 7**. Then how should we raise this pre-obelisk up to the ground level? Our solution is "rolling," i.e., an oscillation around the long axis, one of the technical terms used for ship as in **Figure 8**. First, pass many ropes around the pre-obelisk, each one as in (1) of **Figure 9**. Note that we can pass ropes under the belly since the belly touches the bottom of the dock only on its small central part, thanks to the convexity, as can be seen in **Figure 7**. Next, pour some sand into the trenches, and "roll" the pre-obelisk by pulling each side of rope alternately as in (2). This simple rolling works due to the convexity of the belly, and would not need so big power since it is rather an oscillation, not a lift. Then, the sand will "flow" downwards to raise the pre-obelisk a bit as in (3) of **Figure 10**, looking like "the ship of obelisk floats on sand." The point is that "rolling" stirs sand, and moving sand behaves like water, hence it would be better to keep the sand stirring with oar-like sticks, while rolling. Repeating this process many times, each time pouring small amount of sand and rolling, we will finally be able to raise the pre-obelisk up to the ground level as in (4) of **Figure 10**.

Two shapes of the pre-obelisk were proposed in **Figure 7**: The shape (1) would

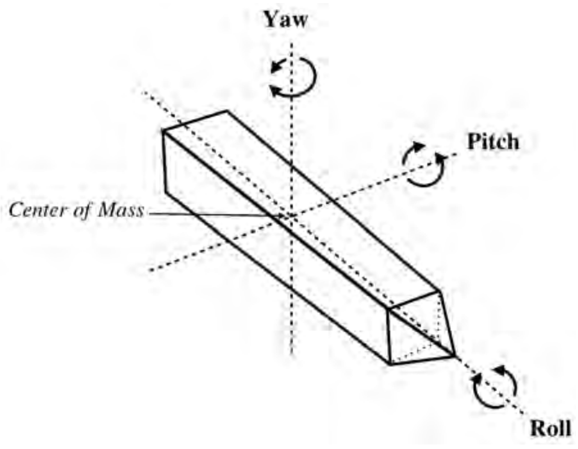


Figure 8. Terms used for ship.

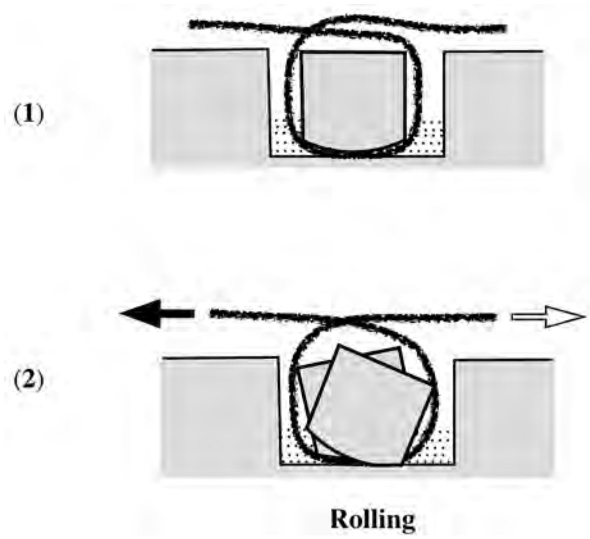


Figure 9. Rolling to raise the pre-obelisk.

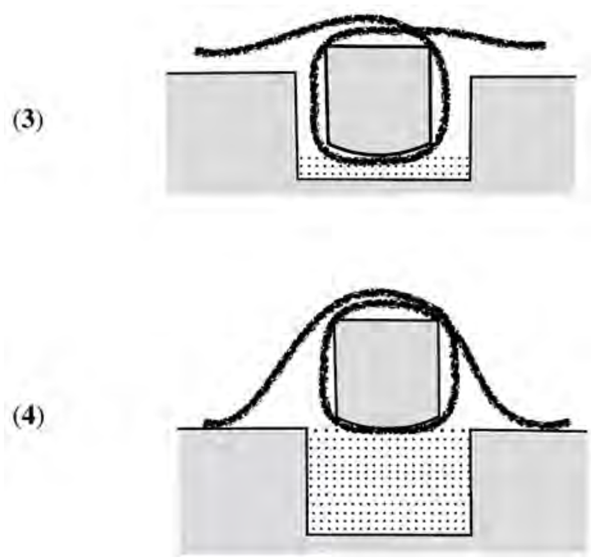


Figure 10. Raising up to the ground level.

be easier to be carved and easier to be rolled than (2), while the shape (2) would be lighter and hence easier to be moved than (1). Thereore, the best choice is that: First carve the pre-obelisk in the shape (1) and raise it to the ground level by rolling, then shape it into the slim form (2) for moving.

Summary of Section 2:

Using a simple lift **Figure 2** with a heavy stone to pound a big blade **Figure 1** into the bedrock, we can cut and extract from the bedrock a "pre-obelisk," a predecessor of obelisk with a convex belly like a ship. After detaching the belly from the bedrock, we can apply "rolling," an oscillation around the long axis, to raise the pre-obelisk up to the ground level.

3. How to Move an Obelisk Overland

Now we need to move the extracted pre-obelisk overland. The geological details around the Unfinished Obelisk was described in (Negus, 2015) that:

"The obelisk lies on the slope of 10 degrees to the horizontal, and it would be in the order of 6 meters above the adjacent level surface and would have had to have been moved approximately 65 meters to that area (i.e., the riverside where the obelisk was to be loaded on to some barge). The course leading down to the river need not be straight."

Taking care of these observations, we now show how to move the pre-obelisk. Assume that the pre-obelisk is now on the ground level as in (4) of **Figure 10**. Then, first we enclose it with a wooden framework as in **Figure 11** and **Figure 12**. Notice that the central part of the belly of the pre-obelisk remains touched upon the ground, in other words, the pre-obelisk is not "on" the framework. This framework, looking like a skeleton of a barge, is composed of round poles and would not be so difficult to be built just by inserting (relatively) short poles into the holes of thicker poles. These inserted poles may or may not be rotatable, but note that these properties can be convertible when used with ropes: Rotatable pole can be fixed whenever neccesary by inserting wedge between it and the hole, while any fixed pole can be converted into an essentially rotatable one by wearing a bronze tube on the contact surface of the pole with a rope as in **Figure 13**, or by lubricating the contact surface. Such a care would be preferable, if possible, also for rotatable poles in order to protect both poles and ropes from wearing out. Thus we can assume that all round poles are essentially rotatable.

Now fasten the pre-obelisk well with the framework using ropes as in **Figure 12**. Then we pass ropes around poles of this framework as in **Figure 14** and pull the free ends of ropes to move the pre-obelisk rightwards. Each rope on the right side of **Figure 14** passes around one or two round poles which act as "movable pulleys" together with some fixed post. See Remark 3.1 for this mechanism. Though **Figure 14** illustrates only a few ropes and poles, practically many many ropes, poles and posts would be necessary to move the heavy pre-obelisk. Indeed, the main reason we introduced the wooden framework is to provide many essentially rotatable poles, and the framework can be extended whenever more

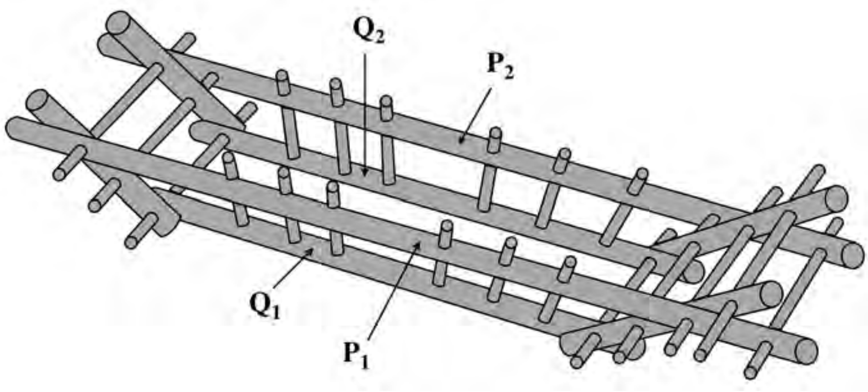


Figure 11. Wooden Framework, looking like a skeleton of a barge, for Moving the Pre-obelisk, with upper long poles P_1, P_2 and lower long poles Q_1, Q_2. (Not in scale: Actually, P_1, P_2, Q_1, Q_2 should be very long, more than 20 meters.)

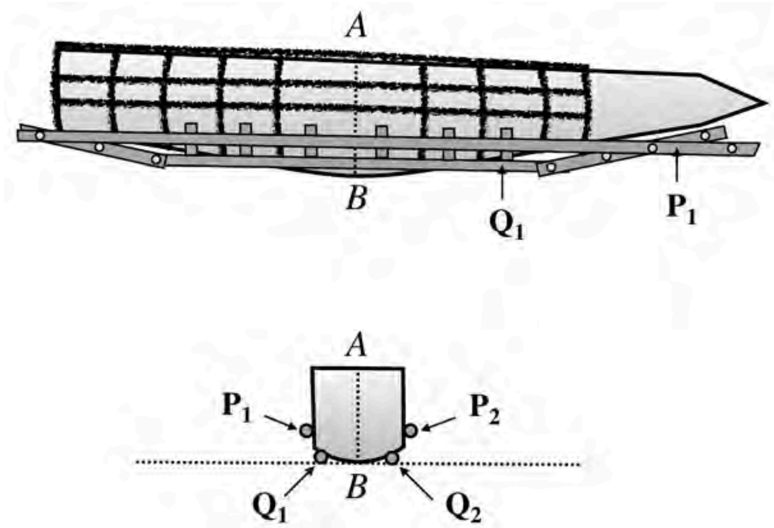


Figure 12. Pre-obelisk equipped with the framework of Figure 11. Above: side-view, below: cross-section along *AB*.

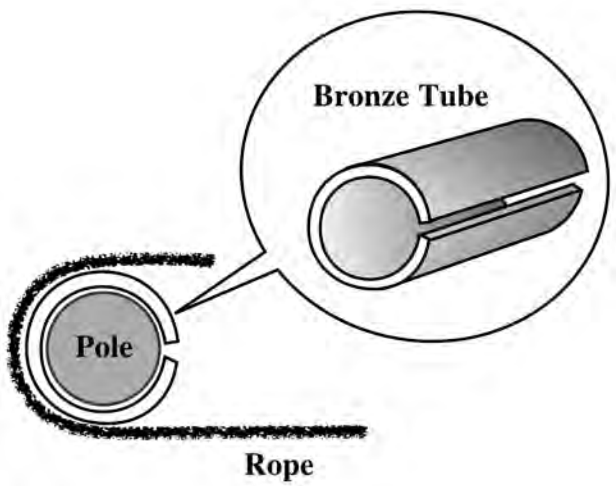


Figure 13. Wearing a Bronze tube on a pole to reduce the friction with a rope (Side view).

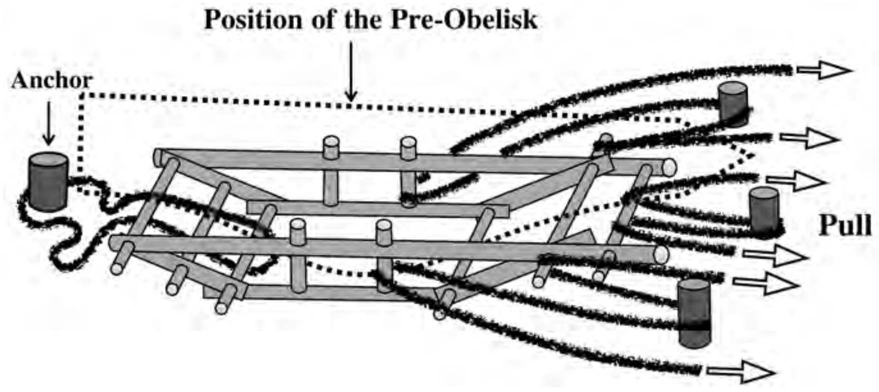


Figure 14. How to move the pre-obelisk using ropes.

poles are needed. The big post on the left side of Figure 14 is an "anchor" for the ship of pre-obelisk, and many of such anchor would be needed in the might-be-dangerous move on a downhill. The fact that the convex belly touches the ground only on its small central part has various advantages in moving the pre-obelisk. For example, it will be not so difficult to turn the pre-obelisk around the center of the convex belley, like "yaw" (see Figure 8), since the pre-obelisk is long enough for a force couple to be applied efficiently. By the same reason "pitching" the pre-obelisk would be also possible and helpful in moving over some bumps. Surely some abrasion would occur to the belly, but this causes no problem since the convex belly would be removed to be leveled at the destination of obelisk. It would be also possible to place wooden rollers just before the central part of the belly, and the length of these rollers should be a bit shorter than the distance of the two long poles Q_1 and Q_2 (see Figure 12), so they need not be long.

As is well known, long thick woods were scarce in ancient Egypt (Jansson, 2019), but they were quite needed as the case of the wooden framework of Figure 11. So, we believe the ancient Egyptians would have some ideas to get around such difficulties, perhaps like Figure 15 or Figure 16. Long poles like P_1, P_2, Q_1, Q_2 in Figure 11 can be obtained by connecting short ones as in Figure 15 using ropes (or the bronze tube of Figure 13 instead of ropes). Thick pole with holes big enough to accept strong rotatable poles are also needed, and such one could be obtained by combining two poles as in Figure 16; we can see such an example in Figure 17.

The report (State, 2007) revealed that "The unfinished Obelisk Quarry in Aswan, Egypt, has a canal that may have connected to the Nile and allowed the large stone monuments to float to their permanent locations." So, the pre-obelisk might be moved by such a canal, not overland, from the quarry to the Nile. Note that even in canal we can still apply our moving method of Figure 14, fixing the posts on the banks of the canal. The ship-like shape of the pre-obelisk in Figure 7 as well as the barge-like wooden framework of Figure 11, getting some buoyancy, would be quite appropriate also in canal. Imagine the pre-obelisk of Figure 12 in the canal, which would surely look like a cargo ship!

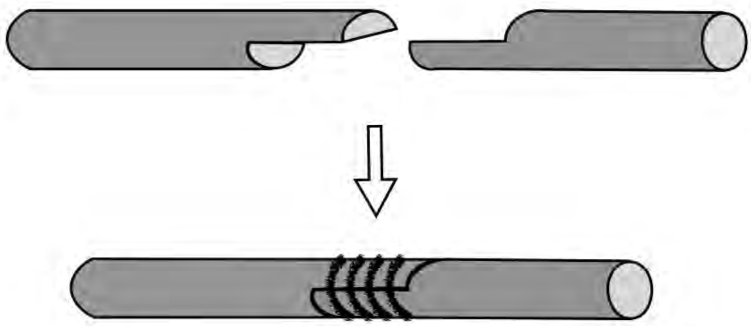


Figure 15. Connecting short poles to get a long pole.

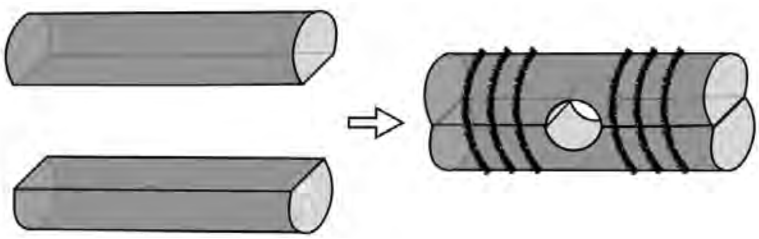


Figure 16. Combining two poles to get a pole thick enough to have a big hole.

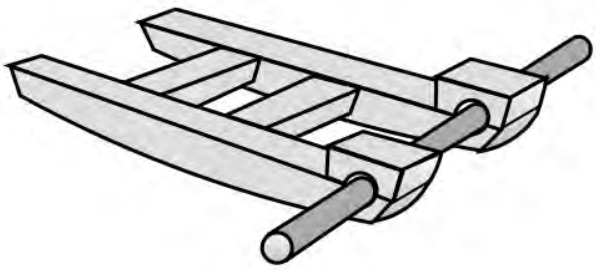


Figure 17. Sledge with a rotatable round pole at its front.

Summary of Section 3:

The "ship" of pre-obelisk can be moved overland by enclosing it with a wooden framework like a skeleton of "barge." We can pass many ropes around the poles of the framework, and pull them to move the pre-obelisk utilizing essentially the mechanism of "movable pulley" as described in the next Remark 3.1. Note that the belly of the pre-obelisk remains touched upon the ground.

Remark 3.1. Let us explain the mechanism of Figure 14. Consider a sledge of Figure 17 with a round pole at its front, and let us regard this sledge as a simplified version of the framework of Figure 11. Suppose we want to move a stone using this sledge, and pass ropes around the front pole as in Figure 18 where only two ropes are shown for simplicity. Assume the both ends of each rope are pulled by the forces F_1, F_1' and F_2, F_2' such that $F_1 = F_1' = F_2 = F_2'$ approximately. Then the stone will move if the sum of these forces $F_1 + F_1' + F_2 + F_2'$ overcomes the friction force between the sledge and the ground. But this simple way would need many men to pull ropes, and with use, we believe, they soon found its improved version Figure 19 to reduce the number of needed men,

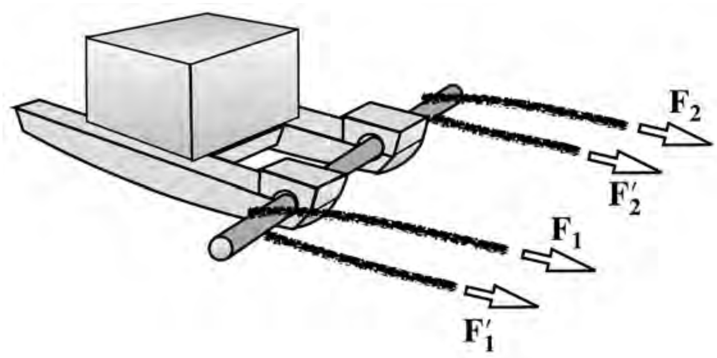


Figure 18. Use of a sledge and ropes to move a stone.

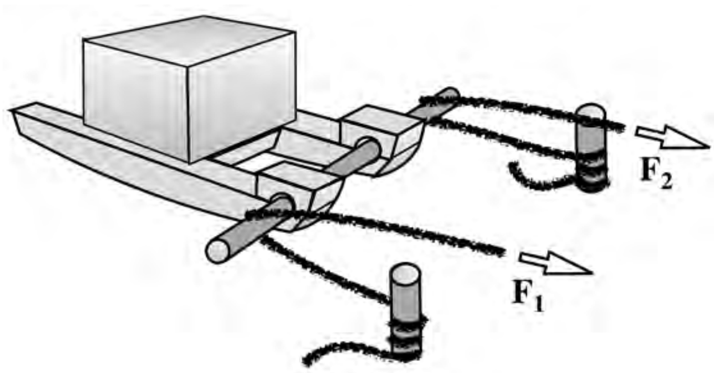


Figure 19. Use of anchoring posts to reduce the pulling power by half compared with **Figure 18**.

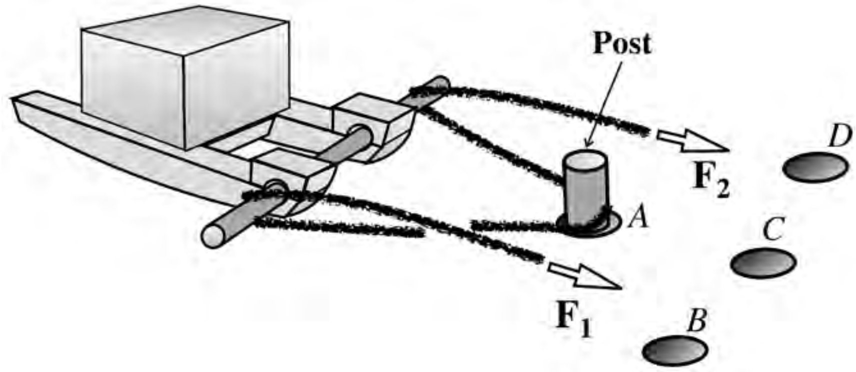


Figure 20. Effective use of post improving the case of **Figure 19**. *A*, *B*, *C*, *D* are holes for posts.

perhaps through the following experience. For example, suppose the men applying the forces F_1', F_2' were lazy in pulling, and the ropes were pulled mainly only by the men applying the forces F_1, F_2. Then, the ropes sliding around the round pole would have still moved the stone, though a bit slowly. Consequently they would have learned that the stone can be moved even if one end of each rope is anchored to something fixed like **Figure 19**, and that the front pole is better to be rotatable. Such a front pole acts as a "movable pulley" and reduces almost by half the effort needed to move the stone, while increasing twice the distance to pull (see Section 9). We can further improve **Figure 19** into **Figure 20** which decreases the number of fixed posts just by hanging a rope on a fixed post as was the case of **Figure 14**. In order to use such a post effectively we better prepare many deep holes like A, B, C, D. Then, for example, when we want to move the stone in the direction $\overrightarrow{AC}$, we can first move the post from the hole A into the hole C, and then pull the rope. We believe that this kind of simple sledge like **Figure 17** was already utilized in the construction of the Great Pyramid around 2500 BC, a millennium earlier than the age of high obelisk.

4. What to Do before Erection of Obelisk

As mentioned in Section 1, we do not argue about how the obelisk on the barge was transported down the Nile to its destination. So, now assume that the pre-obelisk arrived at the site of its erection. Then, first we need to level the belly, then a precision shaping and the inscriptions, about which we explain in detail in this section. For such purposes we need to rotate the heavy obelisk around its axis. But how should we do it? Our solution is already given essentially in (Kato, 2020), which we are going to explain. First, we prepare prisms of stone as in **Figure 21**, either of which can be obtained by chamfering a stone of cuboid or triangular prism, and with use any prism on the left side will soon be worn into the shape on the right side. Let us call such a stone of prism *rocker*. The use of such "rocker" was already introduced in (Kato, 2020: Remark 4.2) where we described it as "trapezoidal prism." (So, "rocker" in this article always means such a device made of "stone," not a wooden one as excavated.) Such rockers of suitable size would make easy to rotate the (pre-)obelisk if they were properly placed as in **Figure 22**. How to rotate the pre-obelisk to remove its belly, and how to rotate the obelisk for inscriptions are shown in **Figure 23** and **Figure 24**, respectively. Though in these figures big rockers are drawn for the simplicity of illustration, they can be always replaced by a multiple of smaller rockers.

"How the precision shaping of the obelisk was done" was questioned in (Negus, 2015). We present here our answer. A simple useful device to check the flatness of a surface is a plumb, a plumb-line with a plumb-bob, which can examine if the surface is vertical or not. So, we can use it as in **Figure 25** to examine the flatness of the bottom or side faces of the obelisk. Further, a pendant-like plumb or a long string of stone beads can be used for checking the vertical flatness of a two-dimensional surface, together with a straight rod, as illustrated in **Figure 25**. Note also that a plumb can be used to measure the height so that it is possible to draw a horizontal line on every side face of the obelisk if we use just one plumb keeping its plumb-bob barely touched to a horizontal platform set beforehand, like the line ℓ in **Figure 25**. Of course, we can draw a vertical line on every side face of the obelisk along a plumb-line. Hence we can draw both horizontal lines and vertical lines anywhere on all side faces of the obelisk in **Figure 25**. (We showed in (Kato, 2020) how a plumb was effectively used in the precision shaping of the Great Pyramid.)

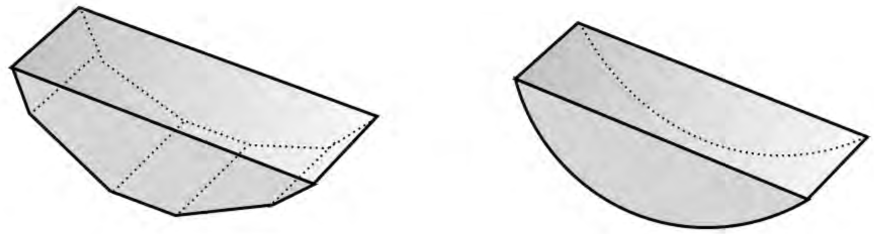


Figure 21. Rockers made from stones of cuboid by chamfer.

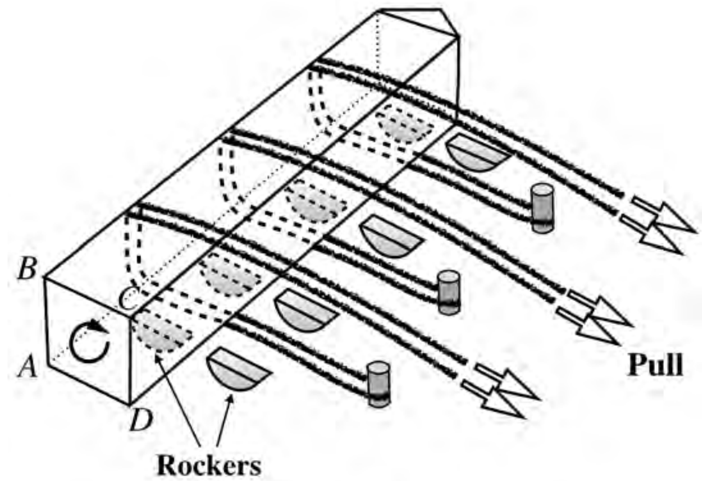


Figure 22. Bird's-eye view of rotation of obelisk.

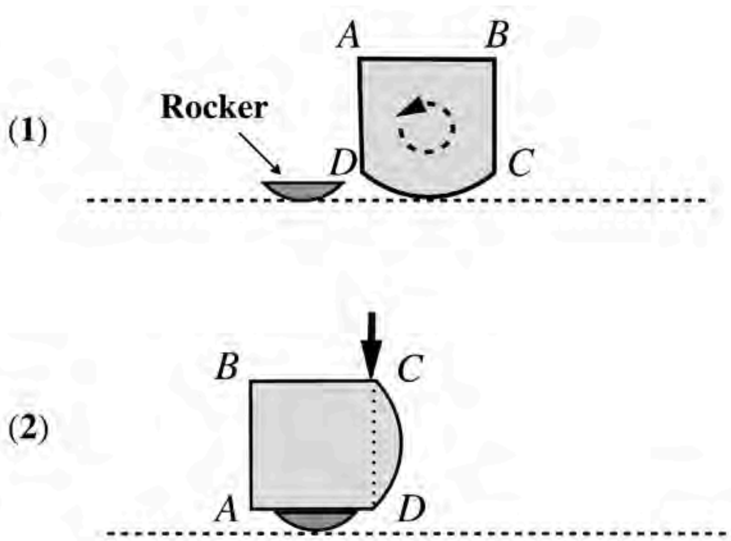
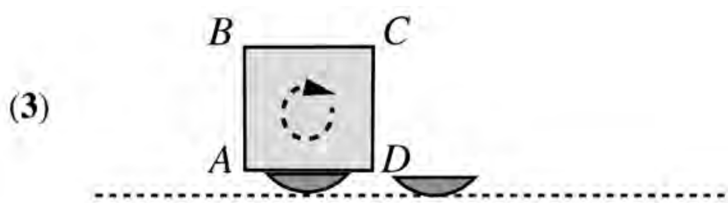


Figure 23. Rotation to remove the belly *CD*.



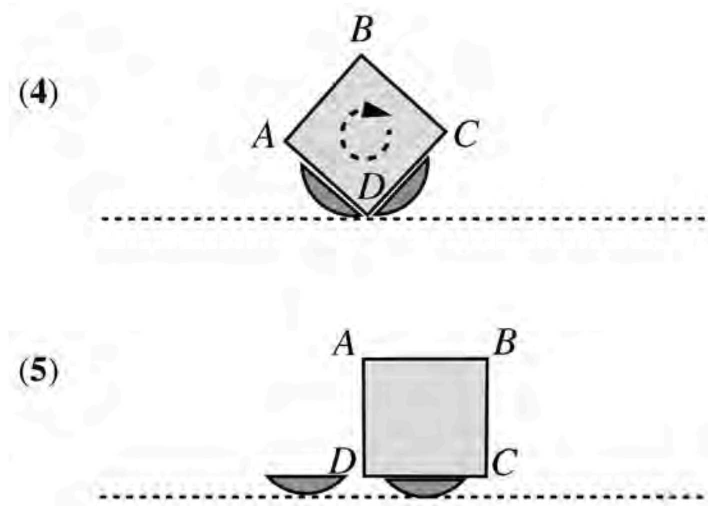


Figure 24. Rotation needed for inscriptions.

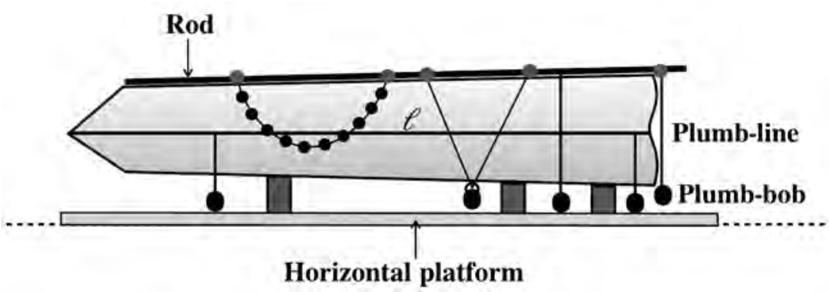


Figure 25. How to examine the flatness of the bottom or side faces of the obelisk, and how to draw a horizontal line.

In order to flatten the faces of the obelisk we propose a blade as in Figure 26 a bit different from the blade of Figure 1. This blade has a feature that the faces $ABCD$ and $EFGH$ are parallel and both of them are dead flat. We can use this blade as in Figure 27 letting its face $ABCD$ contact with a dead flat vertical side of some heavy stone on the right side.

The whole process of the precision shaping of the obelisk would be like as follows. See Figure 28. Let us denote the unshaped obelisk as $TABCD$ where $ABCD$ is its bottom and T is chosen to be a point which becomes the top point of (the pyramidion of) the shaped obelisk. Next, choose a point O of the bottom face $ABCD$ as a candidate of the center of the bottom square of the shaped obelisk. (Note that the quadrangle $ABCD$ is not yet a square.) We identify the line TO as the central axis of the shaped obelisk. Set a horizontal platform under the obelisk and adjust the line TO to be horizontal measuring the same height of T and O from the platform using a plumb. Then, again using a plumb, draw on the side faces of the obelisk the horizontal lines connecting T and O which surround the obelisk (denoted ℓ in Figure 28), and the vertical line passing O (the line MON in Figure 28). Further draw a line connecting T and M on the upper surface, denoted m in Figure 28. Observe then that the central axis TO is the intersection of the horizontal plane determined by ℓ and the vertical plane determined

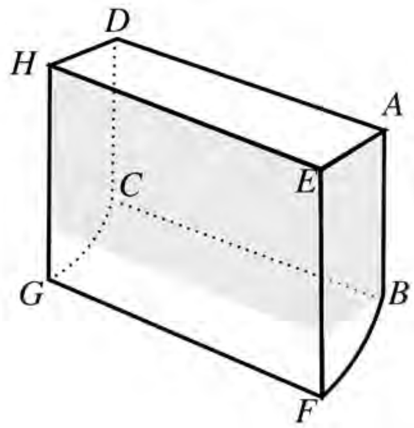


Figure 26. Blade to flatten a surface vertically.

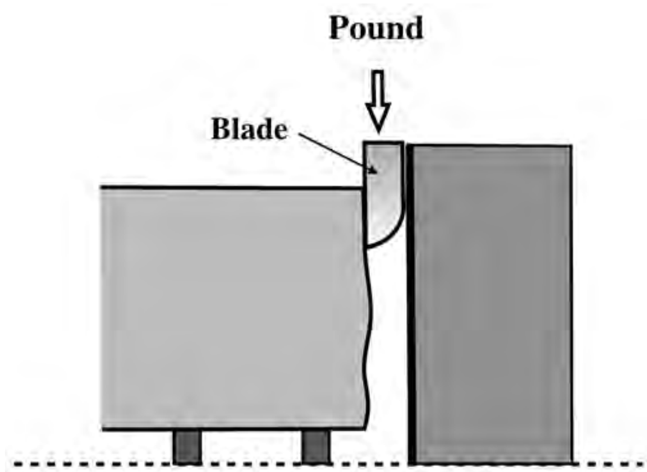


Figure 27. How to level a surface vertically.

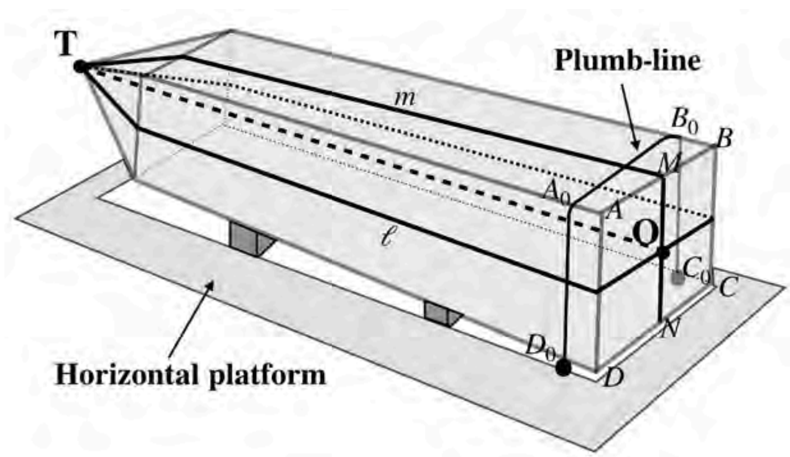


Figure 28. How to draw lines necessary for the precision shaping.

by m. Since the upper surface of the Unfinished Obelisk in Aswan looks almost flat, we may assume that the upper plane that m is on in Figure 28 is flat, but note that this upper plane is not horizontal since the obelisk is tapered; what we can assume is that the edge AB is horizontal. The bottom face $ABCD$ of the unshaped obelisk need not be perpendicular to the axis TO, so we have to correct it. For this purpose we have a very simple useful way, that is, near the bottom hang a plumb $D_0A_0B_0C_0$ with plumb-bobs at D_0 and C_0 in such a way that the line A_0B_0 is perpendicular to the line m, like in **Figure 28**. Then, this plumb-line determines the correct bottom face perpendicular to the axis TO. (Of course, this plumb-line should be hung the closest possible to the bottom face $ABCD$; for example, in the case of **Figure 28** we may hang it like $A_0D_0 = AD$.) Now suppose we have succeeded in cutting the new vertical bottom face $A_0B_0C_0D_0$ using the method of **Figure 27** to get a reshaped obelisk $TA_0B_0C_0D_0$ with the central axis TO^*. Then, moving a plumb like $D_0A_0B_0C_0$ along the line m, we mark the obelisk with lots of lines vertical to the central axis (or either to the line ℓ or m) as in **Figure 29** (such marked lines would be quite helpful also in inscriptions); in particular, A_1B_1 and A_1D_1 are the marked lines perpendicular to m and ℓ, respectively. Now the final step for the precision shaping. Adjust the positions of A_0, B_0, A_1, B_1 so that A_0, B_0 are equidistant from m, and A_1, B_1 are also equidistant from m. Along the adjusted lines A_0A_1 and B_0B_1 cut down vertically to level the side faces $A_0A_1D_1D_0$ and $B_0B_1C_1C_0$. Next, rotate the obelisk 90 degrees around the axis (like **Figure 22**), and do a similar thing to level the side faces $A_0A_1B_1B_0$ and $D_0D_1C_1C_0$, taking care so that $\overline{A_0D_0} = \overline{A_0B_0}$ and $\overline{A_1D_1} = \overline{A_1B_1}$. This finishes the precision shaping of the obelisk, and after this precision shaping the obelisk would be beautifully decorated with the inscriptions and colors.

Summary of Section 4:

For shaping and decoration we need to rotate an obelisk around its long axis, and such rotation can be done using "rocker," a semi-circular prism made by stone. Use of a plumb with a horizontal platform would accomplish the precision shaping of the obelisk.

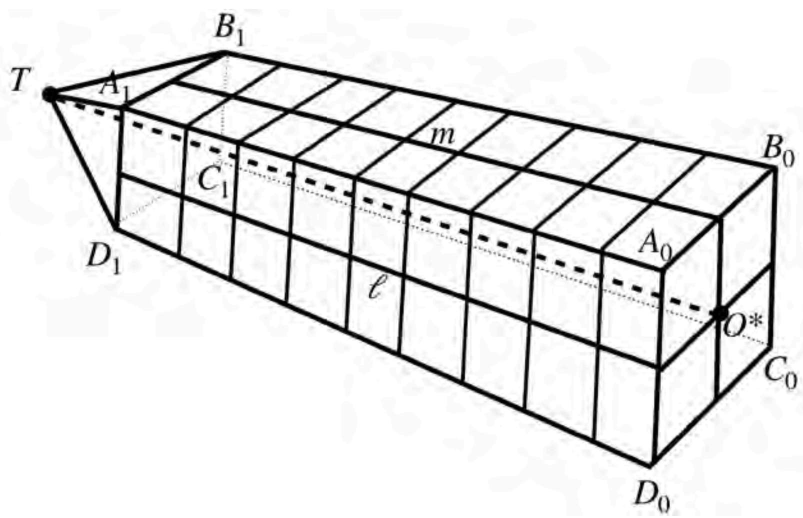


Figure 29. Obelisk whose bottom face was reshaped to be perpendicular to the central axis.

5. How to Erect a Pair of Obelisks

Now we are going to raise the inscribed and colored artefacts carefully. But, the problem is they are quite heavy, and here in this section we present a new idea how to reduce the efforts to raise them. As mentioned in the Introduction, obelisks were originally erected in pairs at the entrance of ancient Egyptian temple, except the single "Lateran" obelisk commissioned by Tuthmosis III, about which we will mention later in Section 7. Though the historical reason to be erected "in pairs" would be religious or aesthetic, we add here an architectural reason in particular to high obelisks:

High obelisks were easier to be erected "in pairs" than to be erected separately, because one obelisk somewhat inclined can serve as a high anchoring post to raise another, as illustrated typically in **Figure 35** and **Figure 42** which we will explain later.

First of all, to raise a pair of obelisks, we equip each obelisk with a carrier, a "back support" for obelisk, as in **Figure 30**, and the carrier should be composed of round poles like **Figure 31**. Recall that we can assume all round poles in the carrier are essentially rotatable, as noted in Section 3. We raise this carrier rather than the obelisk itself. Generally speaking, it would be not so easy to erect an obelisk from a horizontal position, so we believe the ancient Egyptians first tried to incline it a bit using a slope, a traditional idea since the Pyramid Age. In this section we adopt such an idea: Incline each obelisk separately about 30 degrees using a mound of sand or gravel. An alternative way of erection from a horizontal position is proposed in the next section, using a wooden framework instead of a mound of sand. Note that any slope of a mound of sand up to 30 degrees is stable because "the angle of repose" for sand ranges from 30 degrees to 35 degrees (Al-Hashemi & Al-Amoudi, 2018). We do the inclination by first raising each obelisk up onto a mound of sand, and for this purpose we attach to each obelisk

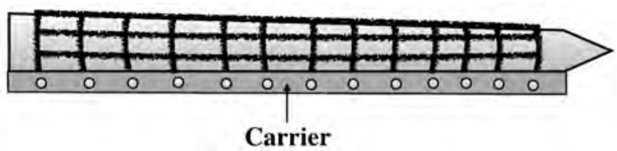


Figure 30. Obelisk with the carrier.

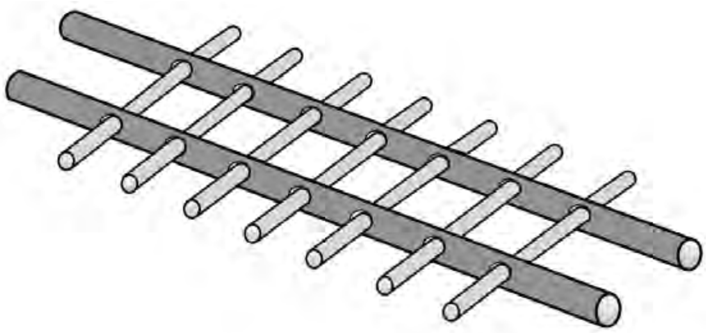


Figure 31. Carrier composed of round poles.

four rockers, the front ones R_1, R_1' and the rear ones R_2, R_2', as in **Figure 32**. (We can get the space for rockers just by removing a few poles from the carrier **Figure 31**.) These rockers do the same role as the convex belly of the pre-obelisk; compare **Figure 32** with (2) of **Figure 7**. The front rockers R_1, R_1' should be placed under the center of mass of the obelisk, which is just where the center of the belly of the pre-obelisk was and is slightly below the mid point of the obelisk.

Then, the rockers can induce the "pitching" movement to raise an obelisk: See **Figure 33**. First, insert sand (or gravel) under the obelisk until the four rockers "dip" in sand, and "pitch" the obelisk as in (2). This pitching should be about the rockers R_1, R_1', i.e., about the center of mass of the obelisk. Then sand will flow under the rockers to lift the obelisk a bit. Next, add sand under the obelisk again until the rockers "dip" in sand, and "pitch" the obelisk as in (4). Repeat this process many times until the mound of sand makes its slope of the angle of repose $\alpha \geq 30^\circ$ as in (5) of **Figure 34**. (Each time we can lift the obelisk only at most the height of the rocker, so we have to repeat the process many times.) Then, pivot the obelisk around the rockers R_2, R_2' controlling the pressing-down forces onto the top side A and the bottom side B carefully, and finally we would be able to set the obelisk as in (6) on the slope of the angle about 30˚ so that its bottom edge touches properly onto the pedestal (see Section 8), using the carrier as a guide to the pedestal. This process from (5) to (6) would need a great care, should be slow and gentle, and this is why we chose the angle of the slope to be that of repose: The obelisk would not easily slip down on the slope with the angle of repose, and moreover, the rockers as well as the carrier would also work to prevent a sudden slip. Note also that the carrier protects the face of the artefact. The mound of sand would form a cone whose base is a circle with a diameter slightly less than the length of the obelisk, so it might occupy somewhat wide space, but since what we apply is "pitching," it need not be so wide and long as the large sloping embankment described in (Engelbach, 1923: Fig. 27) which is for pulling up an obelisk.

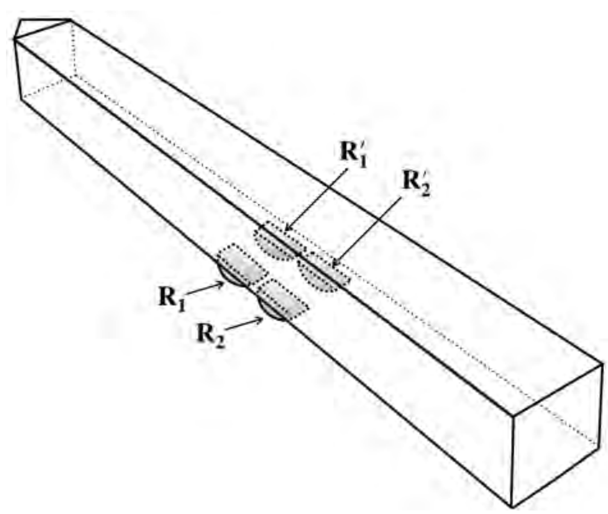


Figure 32. Obelisk with rockers.

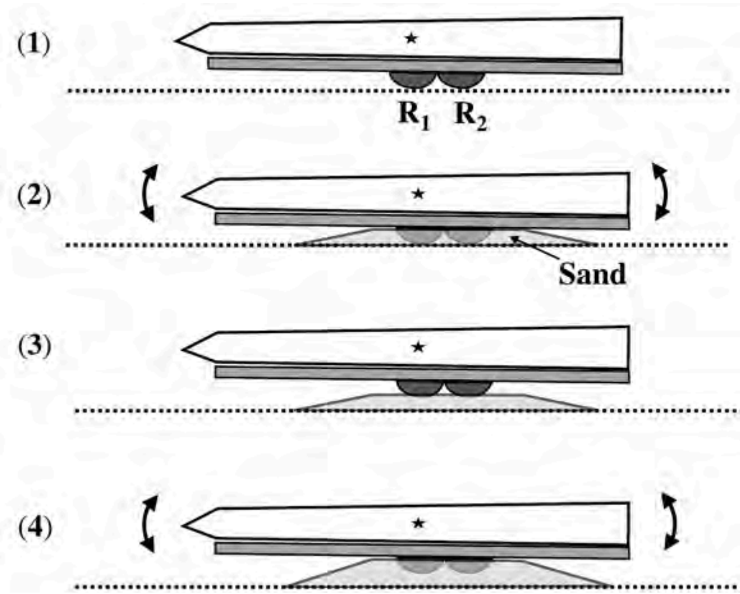


Figure 33. Lifting the obelisk on the mound of sand by pitching, adding sand for the steps from (1) to (2) and from (3) to (4).

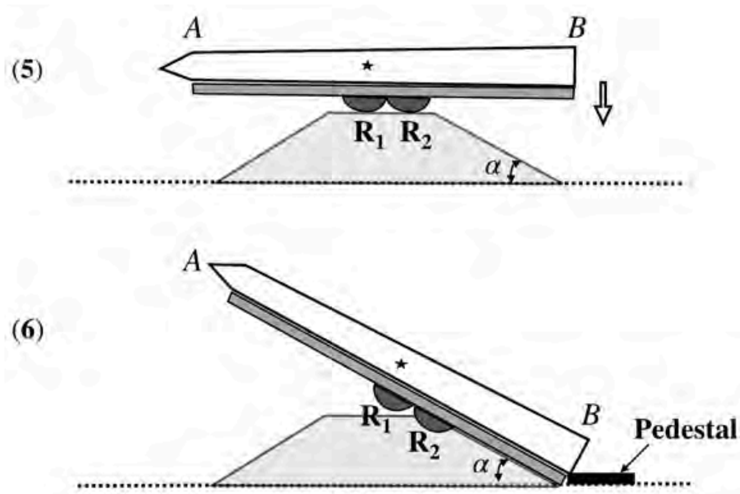


Figure 34. Incline the obelisk up to the angle of repose $\alpha \geq 30^\circ$.

Now let O_1 and O_2 be two obelisks of the same weight and the same length, and suppose we have succeeded in inclining them about 30 degrees. Then, we erect such a pair of obelisks setting rope as in **Figure 35**, which emphasizes the carriers and illustrates the use of just one or two ropes though actually we need many many ropes. Essential point is "one obelisk O_1 can help to erect another O_2," as we explain next. Let P_1 and P_2 denote the highest horizontal round poles in the carriers of O_1 and O_2, respectively. The rope starts from one end A, passes around the pole P_2, then wraps the obelisk O_1 (just above the pole P_1) and passes again around the pole P_2, and finally returns to the other end B, placed near A; let us denote this rope setting simply as

$$A \to P_2 \to O_1 \to P_2 \to B.$$

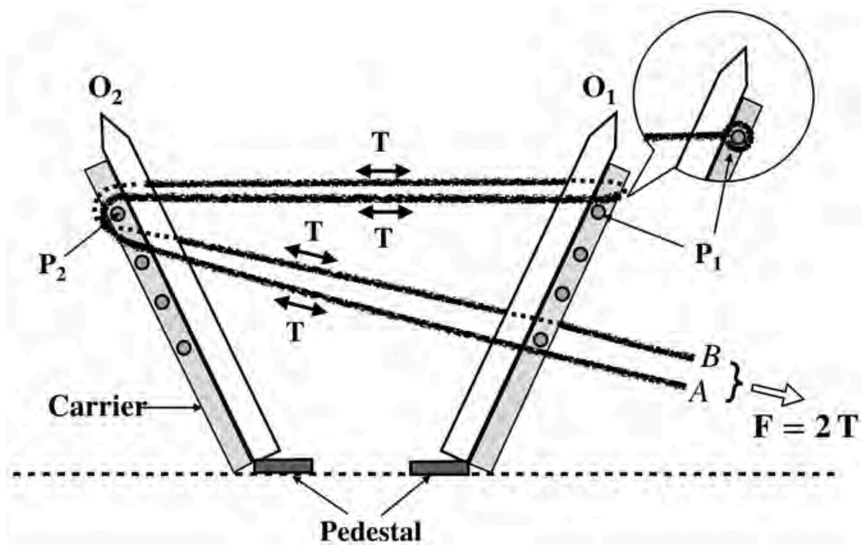


Figure 35. Use of a "Pair" of obelisks: raise one of them, O_2, keeping a twin O_1 fixed, utilizing the highest poles P_1, P_2. The rope can be fixed at P_1 instead of wrapping O_1 as shown in the quote bubble.

Each free end A, B of the rope should be pulled by the equal power, and then the rope will slide around the rotatable pole P_2, though will not slide around the obelisk O_1. So, instead of "wrapping O_1" we can fix the rope to the obelisk O_1 or to the pole P_1 (as shown in the quote bubble; then we may use two ropes, $A \to P_2 \to P_1$ and $P_1 \to P_2 \to B$).

Let us denote the tension in the rope by T. Then, roughly speaking, if the free ends of the rope are pulled by the total force $F = 2T$, the obelisk O_2 is pulled almost by $2F$, while O_1 is pulled only by F. So, even when O_2 starts moving, O_1 stays fixed. This means that O_1 acts as an anchoring post, and the pole P_2 essentially works as a movable pulley reducing almost by half the effort to raise the obelisk O_2. (Observe that the rope setting in Figure 35 is essentially the same as Figure 20 if we regard O_1 and O_2 as the anchoring post and the stone with the sledge in Figure 20, respectively.) Note that ropes connecting two obelisks are high, and this is the advantage of raising "in pairs." To avoid a bit cumbersome description like Figure 35 let us simplify it into Figure 36, which shows only this side and should be paired with the same setting of rope also on the other side (we also eliminate the illustration of the pedestals). The practical version of Figure 36 would be like Figure 37, where the rope just passes around P_1 and is fixed to the lower (non-rotatable) pole P_3. Note that to fix the rope to the pole P_3 we only need to wind the rope several times around the pole, no need to form the rope into a knot; see for example Figure 19. Mechanically, Figure 37 is the same as Figure 36 since the tension of the rope P_1P_3, directing to or away from the pivot point of O_1, gives no moment to O_1. Let us explain the force diagram Figure 38 for Figure 36. Let W be the weight of obelisks O_1, O_2. For $i = 1, 2$ let B_i denote the pivot point on the bottom of O_i, and we use the same letter P_i to denote the position of the pole P_i. (As for the precise position of the pivot

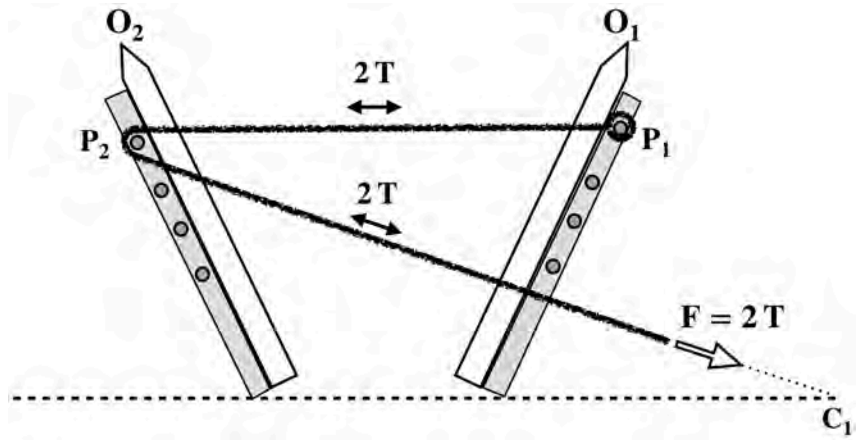


Figure 36. Simplified illustration of **Figure 35**, where $2T$ indicates the sum of the tensions of ropes on this side and the other side.

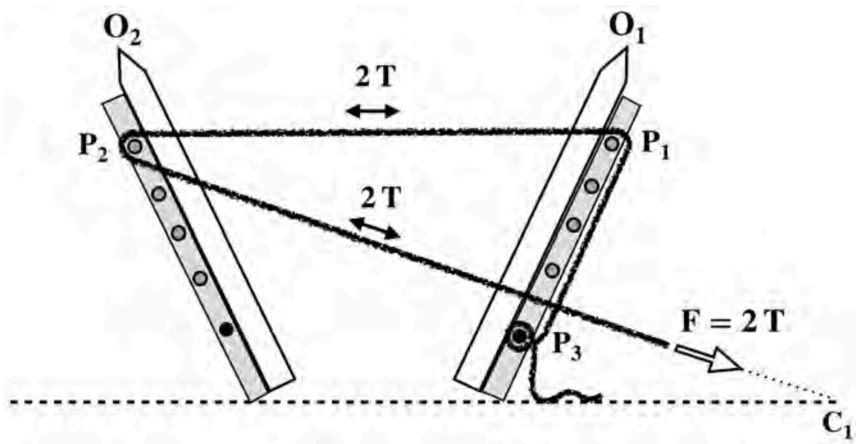


Figure 37. Practical version of **Figure 36**.

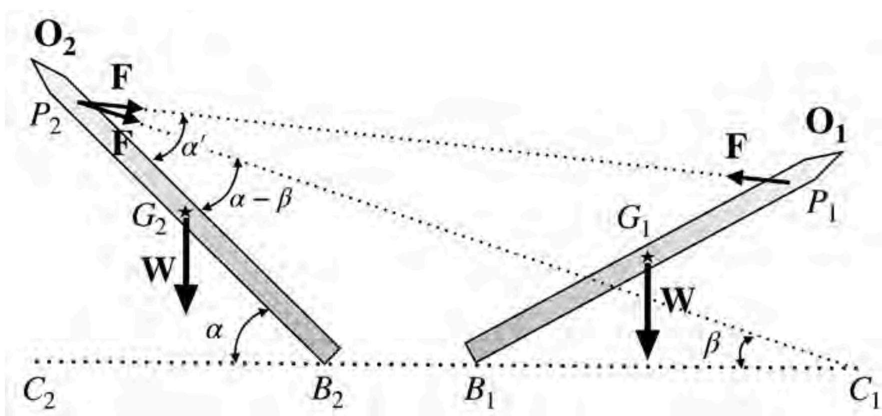


Figure 38. Force diagram of **Figure 36**.

point B_i see Section 8.) It would be natural to assume that the center of mass of O_i, denoted G_i, is at the mid point of B_iP_i so that $\overline{B_iG_i} = \overline{G_iP_i} = l/2$ where $\overline{B_iP_i} = l$. Suppose that the total pulling force $F = 2T$ was applied at the free ends of the ropes in the direction of $\overrightarrow{P_2C_1}$. Put

$$\angle P_2B_2C_2 = \alpha, \quad \angle P_1P_2B_2 = \alpha', \quad \angle P_2C_1C_2 = \beta.$$

Let $M(B_2;O_2)$ be the moment of *clockwise* turn of O_2 about B_2. Then we get

$$(*) \quad M(B_2;O_2) = Fl(\sin\alpha' + \sin(\alpha-\beta)) - W(l/2)\cos\alpha.$$

Let us consider the particular case that the two obelisks were inclined at the same angle α. Then we have $\alpha' = \alpha$, and the condition $M(B_2;O_2) > 0$ to raise O_2 is equivalent to

$$\frac{F}{W} > \frac{1}{2}\cdot\frac{\cos\alpha}{\sin\alpha + \sin(\alpha-\beta)}.$$

In case $\alpha = 30^\circ > \beta = 15^\circ$ this condition becomes

$$\frac{F}{W} > \frac{1}{2}\cdot\frac{\cos(30^\circ)}{\sin(30^\circ)+\sin(15^\circ)} = 0.570\cdots,$$

concluding that we need the power about 0.6 W to raise O_2. In case $\alpha = 45^\circ > \beta = 20^\circ$ we need much less power, only about a third of the weight:

$$\frac{F}{W} > \frac{1}{2}\cdot\frac{\cos(45^\circ)}{\sin(45^\circ)+\sin(25^\circ)} = 0.312\cdots.$$

(In case $\alpha = 60^\circ > \beta = 30^\circ$ we get $F/W > 0.183\cdots$.) These evaluations tell us that to incline an obelisk up to 45 degrees is the hardest part of its erection, where we should employ any techniques available to reduce the burden of erection. As one of such techniques we next present an effective method to improve the above way. That is **Figure 39** such that $P_1 \to P_2 \to P_1' \to C_1$ where P_1' is a pole just below P_1, and its force diagram is illustrated in **Figure 40**. The rope $P_2 \to P_1'$ in **Figure 39** is higher than the rope $P_2 \to C_1$ in **Figure 36**, which is why **Figure 39** improves **Figure 36**. Here we have assumed that the obelisks O_1 and O_2 were inclined at the same angle $\alpha \geq 30^\circ$, and assume for simplicity that the position of P_1' is the same as P_1. Let the direction $\overrightarrow{P_1C_1}$ of the pulling force F be at the angle $\angle P_1C_1B_1 = \gamma$ where $0 < \gamma < \pi - \alpha$. Then the moment $M(B_2;O_2)$ of clockwise turn of O_2 about B_2 is

$$M(B_2;O_2) = 2Fl\sin\alpha - W(l/2)\cos\alpha,$$

which corresponds to the particular case $\alpha = \alpha', \beta = 0$ of the above formula (*) for **Figure 40**. So, the condition $M(B_2;O_2) > 0$ to raise O_2 is

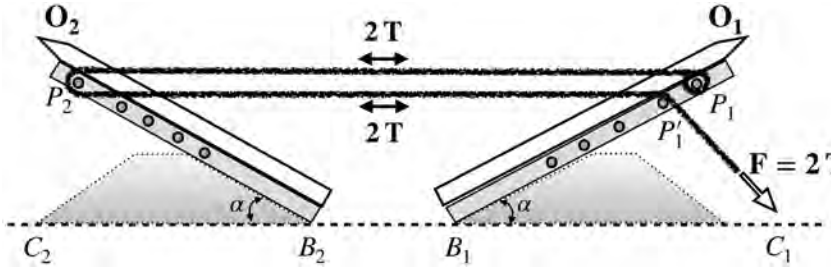


Figure 39. An improved method to Raise O_2 stabilizing O_1, where the pulling force F directs to C_1 on the right side of B_1.

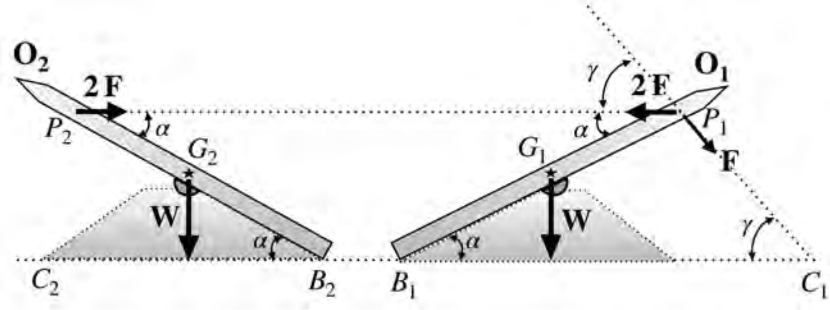


Figure 40. Force diagram of Figure 39 where $0 < \gamma < \pi - \alpha$, i.e., C_1 is on the right side of B_1.

$$\frac{F}{W} > \frac{\cot\alpha}{4}.$$

In case $\alpha = 30^\circ$ this condition becomes

$$\frac{F}{W} > \frac{\sqrt{3}}{4} = 0.4330\cdots$$

telling that we need the power about $0.45W$ to raise O_2. In case $\alpha = 45^\circ$ we need much less power, only a quarter of the weight:

$$\frac{F}{W} > \frac{1}{4}.$$

One may wonder about Figure 40 if the pulling force F towards C_1 might cause some clockwise turn of the obelisk O_1 about its center G_1 of mass. Let us show this is not the case. Indeed, let $M(G_1;O_1)$ denote the moment of *counterclockwise* turn of O_1 about G_1. Then we have

$$\begin{aligned} M(G_1;O_1) &= 2F(l/2)\sin\alpha - F(l/2)\sin(\alpha+\gamma) \\ &= Fl\cdot\left(\sin\alpha - \frac{1}{2}\sin(\alpha+\gamma)\right) \ge Fl\cdot\left(\sin\alpha - \frac{1}{2}\right). \end{aligned}$$

Hence our assumption $\alpha \ge 30^\circ$ implies $M(G_1;O_1) \ge 0$, concluding that the pulling force F towards C_1 does not cause any clockwise turn of the obelisk O_1 about G_1. It would be worth noting that we can use counterweight in Figure 39 which is just the case $\gamma = 90^\circ$ of Figure 40.

Further improvements are possible as shown in Figure 41 with the rope setting $P_1 \to P_2 \to P_1' \to C_2$, which illustrates the way of raising rather O_1, not O_2, fixing O_2. Note that Figure 41 is almost the same as Figure 39 except the direction of the pulling force F so that Figure 40 can be a force diagram also for Figure 41 if we replace C_1 by C_2 assuming $\pi - \alpha < \gamma < \pi$, i.e., $0 < \beta = \pi - \gamma < \alpha$. The moment $M(B_1;O_1)$ of counterclockwise turn of O_1 in Figure 41 can be evaluated in a similar way to the case of $M(B_2;O_2)$ in Figure 36. In particular, the condition $M(B_1;O_1) > 0$ to raise O_1 in case $\alpha = 30^\circ > \beta = 15^\circ$ is

$$\frac{F}{W} > \frac{1}{2}\cdot\frac{\cos(30^\circ)}{2\sin(30^\circ)+\sin(15^\circ)} = 0.3439\cdots,$$

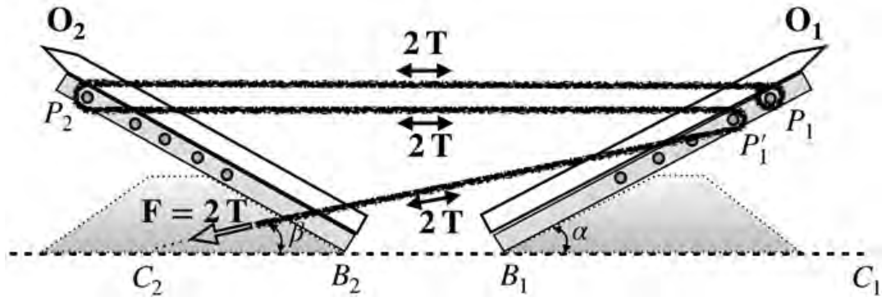


Figure 41. Another effective method (similar to **Figure 36**), to Raise O_1 stabilizing O_2, where the pulling force F directs to C_2 on the Left side of B_1.

telling that we need the power about $W/3$ to raise O_2. We note that all of the above estimations are just theoretical, and actually we would encounter various reduction of power, including slack in long rope and the energy-consuming friction between rope and pole.

We have shown how to raise one obelisk keeping another fixed. But, note that one obelisk already raised very high compared with another can not serve as an anchoring post; this fact can be convinced if we consider the extreme case of one obelisk stood upright. Therefore, in order to raise both obelisks up to the vertical position effectively we need to employ an alternate raising, one after the other little by little. For example, first, stabilizing O_1 raise O_2 a bit higher than O_1 in the way of (1) of **Figure 42**, next, stabilizing O_2 raise O_1 a bit higher than O_2 in the way of (2) of **Figure 42**, etc., which would look like an "almost simultaneous" erection of the pair of obelisks. If both obelisks were inclined sufficiently high, about more than 60 degrees, we would not need so much power to raise them further so that we may employ a simpler method as (3) of **Figure 43**, where, as long as the difference between the angles α_1, α_2 of obelisks is small, we can choose which to raise, either O_2 or O_1 just by decreasing the pulling angle β_1 or β_2, respectively. A simple way to hold both obelisks is shown in (4) of **Figure 43**. We believe the advantage of raising obelisks "in pairs" is well embodied in **Figure 42** and **Figure 43**. Note that the rope illustrated in (1), (2), (3) and (4) of **Figure 42** and **Figure 43** can be the same one, that is, these four rope settings are convertible each other. Another "almost simultaneous" erection would be possible by applying the methods of **Figure 39** and **Figure 41** alternately, just by changing the direction of the pulling force. We also want to remark that we can dispense with extremely long ropes as can be the case of the rope in **Figure 44** with the big connecting knots $K_i\left(i=1,2,3\right)$. Note for example that the knot K_1 about the mid point between two obelisks does not interfere raising obelisks since it does not move so much from side to side in the above almost simultaneous raising.

Summary of Section 5:

A pair of obelisks can be raised effectively letting one obelisk act as an anchor in helping another to be raised. First equip each obelisk with a carrier, and then incline them about 30 degrees using a mound of sand since it is quite difficult to

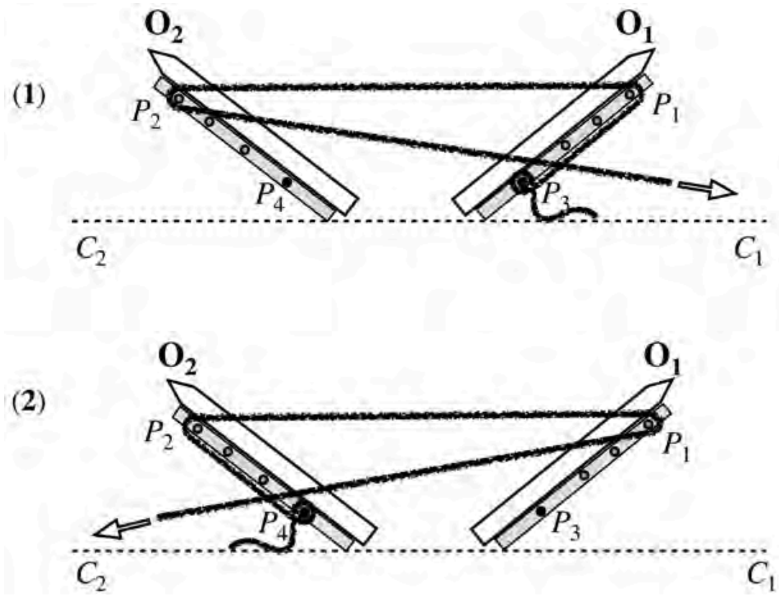


Figure 42. Actual method of raising of a pair of obelisks.

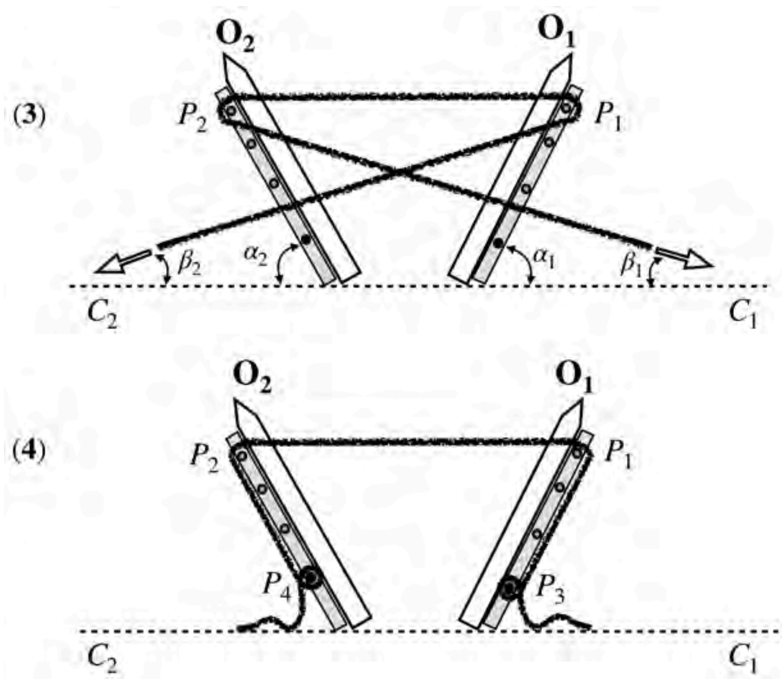


Figure 43. Simple way to raise a Pair of Obelisks (3), and to Hold them (4).

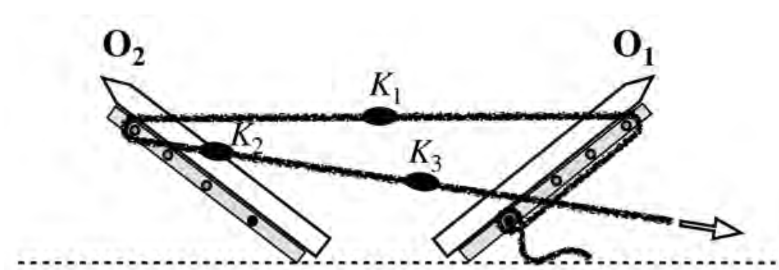


Figure 44. Rope with the connecting knots K_1, K_2, K_3.

raise an obelisk directly from its horizontal position. Passing many ropes high around the two carriers and pulling them, we can raise the pair "almost simultaneously." This way essentially utilizes the mechanism of "movable pulley," and its advantage of raising efforts is about

1) 0.6 W by applying the method of **Figure 42**, or

2) $W/3$ by applying the methods of **Figure 39** and **Figure 41** alternately,

where W is the weight of each obelisk. Counterweights are also available.

Remark 5.1. As noted before, most of our figures illustrate "mechanism" rather than "actual details." For instance, just one pole like P_1 or P_2 in the above figures would be vulnerable to sustain any strong force to raise a heavy obelisk. Therefore, we need to use many poles as well as a stronger carrier. For this purpose we propose the following three adjustments for "actual applications of ropes, poles and carrier."

1) Enclose an obelisk with a framework as in **Figure 45**, which surely provides many rotatable poles, and affix (non-rotatable) new round poles under the carrier to reinforce it. Note that the carrier or framework can be easily turned into a ladder or scaffold, just by inserting wedges between rotatable poles and holes, which would be quite necessary in setting ropes around poles.

2) Let a rope pass around a multiple of poles like **Figure 46**, where a rope passes around three poles P_1, P_1' and R; the pole R is a newly added one in the above (1) and is not rotatable, so it should be well greased or preferably, some bronze tube should be inserted between the rope and the pole R, as in **Figure 13**.

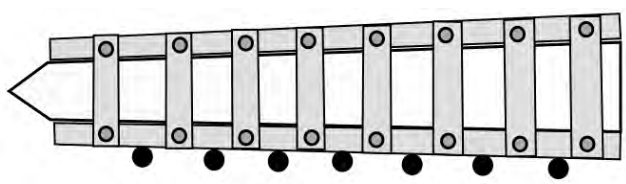


Figure 45. Enclosure with framework and reinforcement of the carrier by affixing poles, colored black. (Side view)

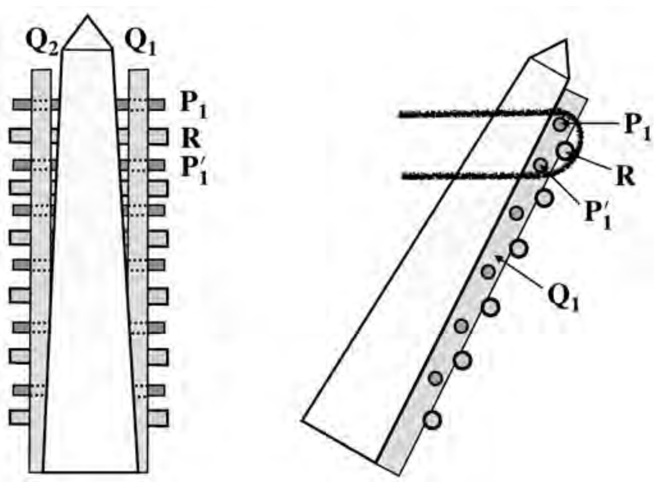


Figure 46. Passing a rope around a multiple of poles. (Left: Front view, Right: Side view)

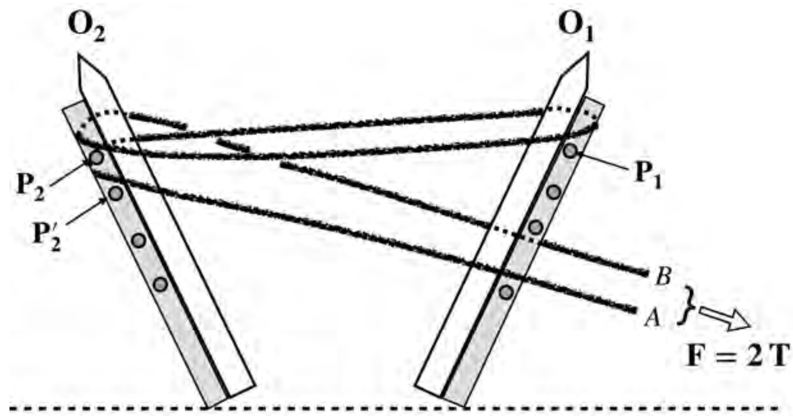


Figure 47. Passing a rope around the long round poles (colored grey) of the carriers.

3) Let also long poles (denoted Q_1 and Q_2 in Figure 46) act as pulleys like Figure 47: $A \to O_2 \to O_1 \to O_2 \to B$, where the rope first passes around the two long poles behind the obelisk O_2 between P_2 and P_2', then around O_1 above P_1, and goes back again to O_2 passing around the long poles above P_2. Since these long poles are not rotatable, they should be taken care of lubrication or bronze tube like the case of R in the above (2). Note that the horizontal poles P_1, P_2, P_2' are just for the rope to keep its position.

6. An Alternative Way to Erect a Pair of Obelisks, Using Wooden Framework

In the method of Section 5 we first inclined a pair of obelisks about 30 degrees using a mound of sand. But such a mound of sand occupies somewhat wide circular space as noted in Section 5. Though this was probably no problem at the beginning age of High Obelisks when the erection spot was not crowded with other buildings, it would become problematic as the erection spot became tighter. Recall that in the Great Temple of Amun, Karnak, there were about 20 many obelisks in ancient Egyptian times. So, we believe the ancient Egyptians needed new ideas to get around this difficulty. Here in this section, we next propose an alternative simple way to erect a pair of obelisks from the horizontal position, which uses wooden framework instead of a mound of sand and need not occupy a wide space. Enclose each obelisk with a wooden framework as illustrated in Figure 48, built by piling up the basic structure ABC as in the quote bubble, which looks like a double sided stepladder. Then a pair of obelisks can be raised in the way of Figure 49, similar to Figure 39, where one end of the rope is fixed to the framework enclosing O_1 and the other free end is pulled down (so, here we may attach some counterweights). Note that the framework provides lots of poles for ropes to pass around so that we would be able to use many ropes effectively in many ways. The great advantage of this method is that obelisks can be raised from the horizontal position, and consequently, we can place the bottom of the obelisk in the best position w.r.t. the pedestal (see Section 8).

A bit simplified force diagram of Figure 49 is shown in Figure 50, where S_i,

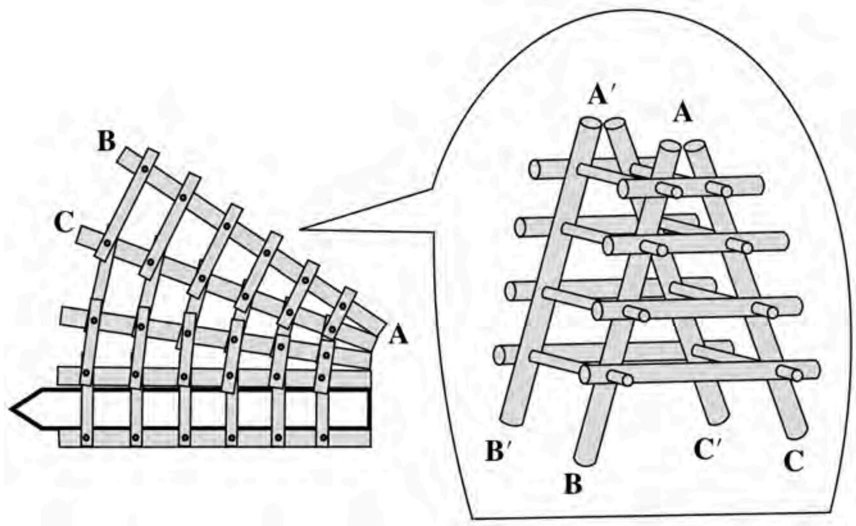


Figure 48. Wooden framework making an obelisk easier to be raised.

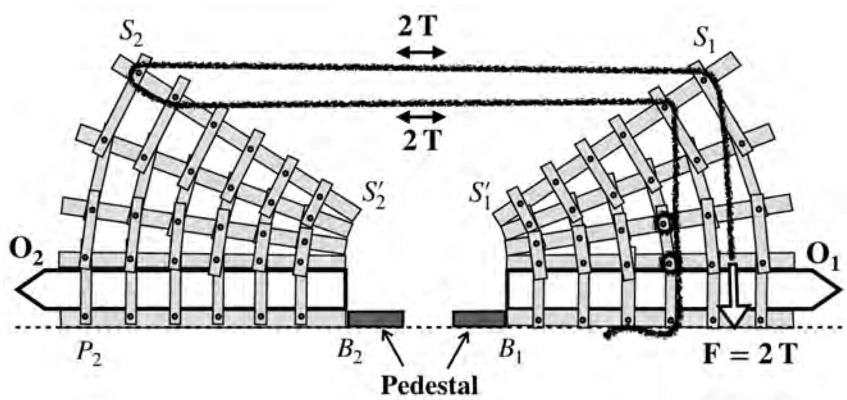


Figure 49. How to raise O_2 stabilizing O_1, using the wooden frameworks of **Figure 48**.

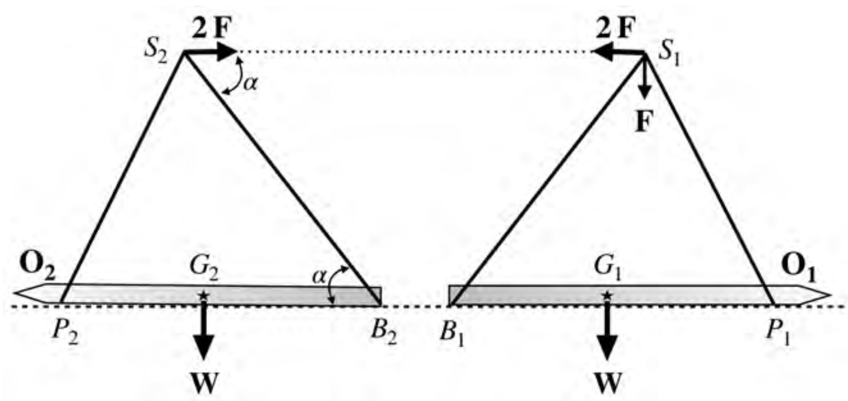


Figure 50. Force diagram of **Figure 49**.

for $i = 1, 2$, denotes the position of the highest horizontal pole of the framework of O_i, and we put $\angle S_i B_i G_i = \alpha$. Let $\tilde{O}_i$ denote the obelisk O_i together with its framework, and let us do a rough estimation of $M\left(B_2; \tilde{O}_2\right)$, the moment of clockwise turn of $\tilde{O}_2$ about B_2. We treat $\tilde{O}_i$ as a "rigid body," and neglect the weight of framework since the wooden framework would be light enough compared with the heavy obelisk. We also assume that $\overline{S_2B_2} = \overline{P_2B_2} = l, \overline{G_2B_2} = l/2$. Then,

$$M\left(B_2;\tilde{O}_2\right) = 2Fl\sin\alpha - W\left(l/2\right).$$

So, the condition $M\left(B_2;\tilde{O}_2\right) > 0$ to raise $\tilde{O}_2$ or O_2 is

$$\frac{F}{W} > \frac{1}{4\sin\alpha}.$$

For instance, let us consider the case that the elevation angle of the highest long pole S_2S_2' is 45˚, and assume that $\alpha = 45^\circ + 10^\circ = 55^\circ$. Then we have

$$\frac{F}{W} > 0.3051\cdots.$$

Though this is a quite rough estimation, it would be safe to conclude that the power to raise O_2 with the framework is at most $W/3$. This advantage is not so bad as an erection from the horizontal position, comparing with the same conclusion $W/3$ about the case of erection of O_1 in **Figure 41** from the position $\alpha = 30^\circ$. Note that the rope setting of **Figure 49** corresponds to **Figure 39**, and so, more advantage we can get if we utilize more effective rope setting like **Figure 41** instead of **Figure 39**.

Summary of Section 6:

A pair of obelisks can be raised effectively from the horizontal position using wooden framework. Enclose each obelisk with a high wooden framework extending the carrier. Passing many ropes high around the two frameworks and essentially utilizing the mechanism of "movable pulley," we can raise the pair "almost simultaneously" from the horizontal position with the great advantage, more than $W/3$. Many counterweights can be hung on these frameworks.

7. Erection of a Single Obelisk

Now we consider a single obelisk, how to raise it. All obelisks were erected in pairs until the commission by Tuthmosis III: (Blyth, 2006) "For his fifth sed-festival, the king (Tuthmosis III) commissioned the single "Lateran" obelisk, but it would appear that he died while it was still being decorated, and it was left to Tuthmosis IV to erect it at the spot intended for it by his grandfather." This became the first case of a single obelisk being erected. Though the motivation of erection of high obelisks would be mainly for king's dignity, we believe that their erection had great effects in leading high technology in ancient Egypt, so that it can be well compared with launching space rockets in modern times. So, we suspect that one of many reasons why Tuthmosis III commissioned a single obelisk is to inspire a technical challenge for architects, as he observed that hitherto method of erection of obelisks somehow took an advantage of "being a pair." Though we do not know the true solution by Tuthmosis IV who did accomplish the erection of the single "Lateran" obelisk, we propose here our feasible solution when we can find and utilize some high building near the spot of erection.

For example, in case we can find a pylon near the erecting spot, we can utilize it. Recall the fact that pylons are very high, for example, at the entrance of Luxor Temple an obelisk of 25 meters high stands just before the pylon of 24 meters high. So, assume that we want to erect an obelisk just before a pylon high enough. Then we can utilize it as in **Figure 51** to raise the obelisk O_2. On the top of the pylon were rockers with grooves, as illustrated in the quote bubble, which act as simple pulley to redirect the pulling force. Of course, the grooves of the rockers should be well greased, and about the use of such a semi-cylindrical device see (Isler, 2001: p. 262). It should be noted that, even if we can see nowadays an obelisk just before a pylon, that does not mean the pylon was utilized since the obelisk might be erected before the pylon was built. When we can not find a pylon or its substitute near the erecting spot, instead we may need to construct some high simple building. Note that the wooden framework in **Figure 48** is itself a high building so that we may utilize it as in the way of **Figure 52**, which is

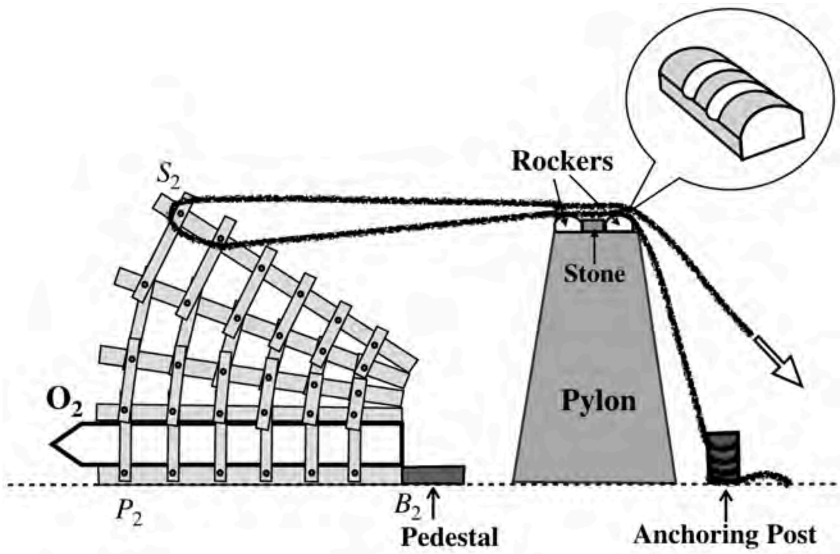


Figure 51. Use of pylon to raise an obelisk. rockers on the top of the pylon shoud have grooves as in the quote bubble.

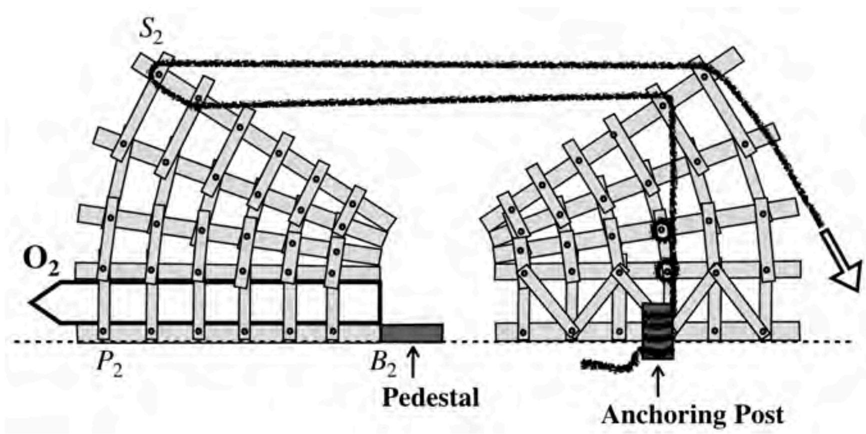


Figure 52. The wooden framework for raising a single obelisk.

almost the same as **Figure 49** except that the obelisk O_1 is deleted. In either case of **Figure 51** or **Figure 52** the calculation of the moment of clockwise turn of O_2 about B_2 is almost the same as the case in Section 6 so that the power to raise O_2 is about $W/3$.

Summary of Section 7:

The method of Section 6 can be easily transferred to the case of erection of a single obelisk, just by replacing one framework (enclosing one obelisk) in Section 6 with some suitable high building or scaffolding. Some scaffolding like the wooden framework on the right side of **Figure 52** might be possible to be built even at a tight spot.

8. How to Set an Obelisk Precisely on Its Pedestal

Finally, we explain an important task how to place an obelisk onto its pedestal precisely. Recall that a narrow groove (also called "notch" or "slot") always runs along one side of the surface of the pedestal for obelisk, and it may be used as a turning groove to pivot on, placing the edge of an obelisk so as to engage in this groove. About this groove, Engelbach noted that:

(i) (Engelbach, 1922: p. 52) "In all the other pedestals (i.e., other than the obelisk of Hatshepsowet) I have examined, where the obelisks have apparently come down so as to bear on the inner edge of the slot, the edge is very distinctly crushed."

(ii) (Engelbach, 1923: pp. 67-68) "The obelisk of Hatshepsowet at Karnak has come on to its pedestal askew, and has never used the notch at all, as its edge is quite sharp and unburred. This shows that the notch was not an essential for the ancient method."

Though the assertion (ii) is a bit contrasting to the fact (i), we can see at least from (i) and (ii) that in most obelisks the groove on the pedestal was used as a turning groove to pivot on, but some new way, not to use the groove heavily, was employed in the case of the obelisk of Hatshepsowet. This means the way of erection of obelisks had evolved over time. As explained before in Section 5, we believe they first tried the method of Section 5, a traditional way to use slope to incline obelisks about 30 degrees and used the groove as a turning groove. But this method caused some severe damage to the edge of the base of obelisk or the inner edge of the groove of the pedestal due to the heavy weight of the obelisk as stated in the above (i), and this was of course not desirable for the artefact obelisk. So, to improve this defect, we believe they have invented another way like the method of Section 6 of wooden framework and some alternative way to avoid the heavy use of the groove. Even they might have combined the two methods, first inclining obelisks a bit and then affixing the framework.

Here we propose an alternative way of placing an obelisk onto its pedestal which utilizes rockers and does not depend heavily on the groove. Affix four rockers R_1, R_1', R_2, R_2' to the bottom surface of an obelisk as in **Figure 53** like the case of **Figure 32**. This attachment need not be so tight, and can be done by

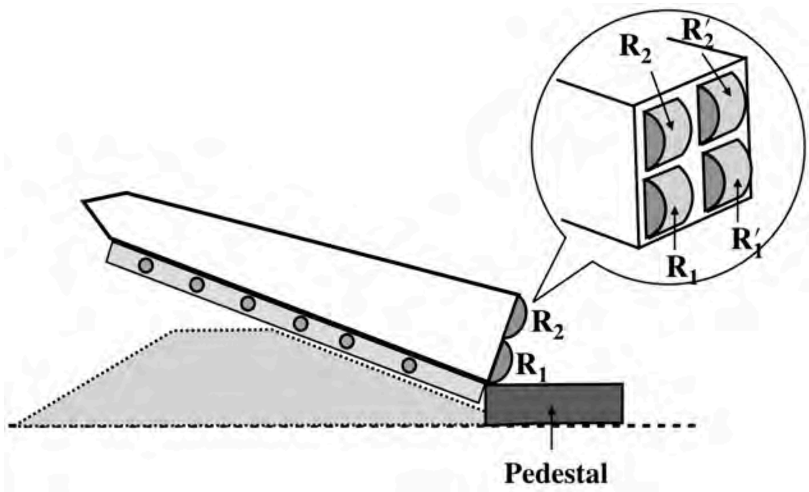


Figure 53. Attaching rockers on the bottom of an obelisk.

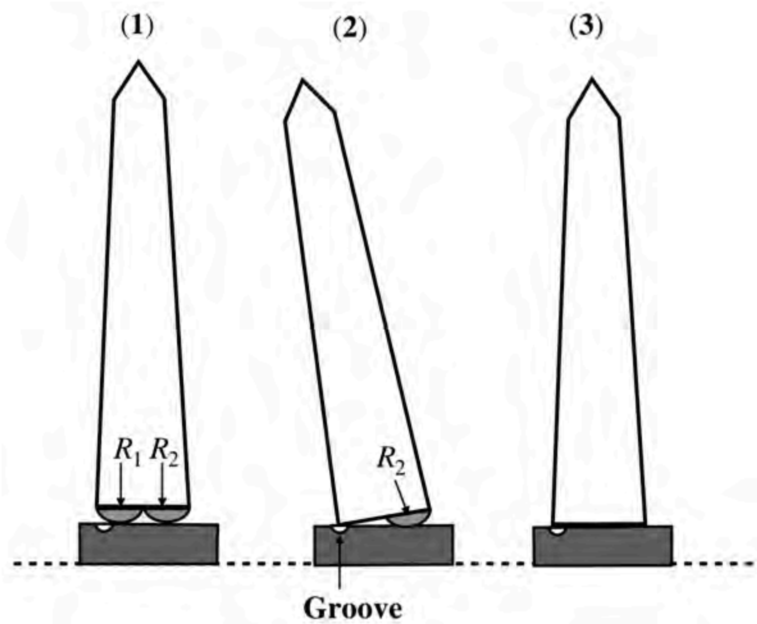


Figure 54. How to remove the rockers to complete the setting of an obelisk onto the pedestal.

using ropes with some wooden frame work around the bottom of the obelisk. (Instead of attaching, it may even be possible to place the rockers at the proper positions on the pedestal.) Then the rockers R_1, R_1' (precisely, the contact points of the rockers and the pedestal) become pivot points for erection of the obelisk. Now suppose the obelisk stood upright on the four rockers as shown in (1) of **Figure 54**, which reminds us Theodosius' obelisk in Istanbul supported by four bronze cubes (Favro, 2018: p. 24). (In case of the erection of Theodosius' obelisk such four bronze supports in spaced relation from the top of the pedestal were necessary in order to withdraw the lowering slings (Isler, 1976: p. 32).) Then we can take away those four rockers in the following way. First, remove R_1, R_1' by inclining the obelisk slightly rightwards, and descend the corresponding edge of the obelisk into the groove as in (2). Next, remove R_2, R_2' inclining the obelisk slightly leftwards pivoting on the edge at the groove. Finally, let the obelisk land softly onto the pedestal to settle down it upright as in (3). We want to point out additionally that we better use some chocks at the pedestal to prevent it from sliding due to the heavy weight of the obelisk. This precise placing of obelisk on the pedestal completes the erection of the artefact obelisk.

Summary of Section 8:

In order to place an obelisk onto its pedestal precisely, the ancient Egyptians first used the groove on the surface of the pedetal as a turning groove to pivot on. But this caused severe damage to the edge of the base of the artefact obelisk so that later they would have found a new improved method to utilize rockers which does not depend on the groove heavily.

9. Concluding Remarks

In Section 5 and Section 6, we proposed two new kinds of methods to raise obelisks. As explained in Section 8, we believe, the ancient Egyptians first tried the method in Section 5 which is essentially the raising from the inclination of 30 degrees assisted by a mound of sand, and later found the more effective alternative way in Section 6, an erection from the horizontal position assisted by a wooden framework. These two methods may look different, but mechanically they are quite similar in the following sense. Both intended to get around the difficulty of raising an obelisk directly from its horizontal position. The mound of sand inclined the carrier in Section 5, while the wooden framework in Section 6 extended the carrier to get the inclined upper part, that is, S_2S_2' in **Figure 49**. As is well known, Queen Hapshepsut remarkably pioneered the architectural techniques, so we suspect that the effective method of Section 6 was already found during her reign. (Engelbach's note (ii) in Section 8 indicates that Queen Hapshepsut tried some new method of erection of obelisk.) Use of wooden framework is generally quite effective since we can increase its power by extending it to use more ropes whenever needed. Recall that we utilized wooden framework also for moving the pre-obelisk **Figure 14**.

Most of our ideas in this article stem from our former paper (Kato, 2020), where the ideas of "forerunner of pulley, rocker, and plumb" were already introduced to explain the construction of the Great Pyramid. It should be well observed that it is quite natural to accept some simple kind of power-multiplying principle such as "forerunner of pulley," facing up the vast quantity of stones used for the Great Pyramid and the immense weight of the Unfinished Obelisk (over 1000 tons). We believe the ancient Egyptians *knew empirically* various methods, but they did not abstract from them some concept or principle like "pulley." We hope this article with the former one could "excavate" the architectural techniques in ancient Egypt buried in the passage of time.

Let us finally observe the essential features of the following three principal means employed in this article.

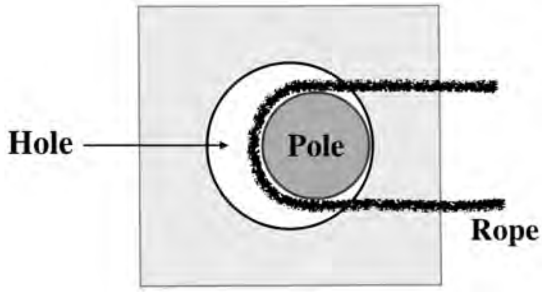


Figure 55. Simple device of a pole rotating in a hole, or "plain bearing" (side view).

1) *System of Round Poles compounded with Ropes and Anchoring Posts*:

The main reason we have introduced the wooden frameworks like Figure 11, Figure 31 and Figure 48 is to provide many round poles in order to employ this system. A round pole can rotate if it is inserted into a hole loosely like Figure 55 (or supported by some simple towers like Figure 3). This device of a pole rotating in a hole can be viewed as a simplest example of "plain bearing," a shaft rotating in a hole, which is also called "sliding bearing" or "sleeve bearing." Since the pole does not have an apparent axis of rotation, it would be appropriate to call such a system "forerunner of pulley."

2) *Sand*: This we used as one of means in order to raise an obelisk from the bedrock up to the ground level as seen in Figure 9 and Figure 10, or to raise an obelisk from the ground to the top of mound as shown in Figure 33 and Figure 34. This way can be viewed as the "buoyancy" of sand:

Moving sand behaves like a fluid to float a stone.

In general, the aggregation of sand or any particles tends to behave like a fluid while its particles keep moving. Such knowledge about sand would be gained by ancient Egyptians through their rich experience with sand, and we believe that the "rolling" technique as in Figure 9 and Figure 10 was already used in the construction of pyramids. Note that the "buoyancy" of sand is great due to its high bulk density.

3) *Rockers*: We employed "rockers" to maneuver an obelisk. When placed properly under an obelisk, rockers can induce various movements of the obelisk, e.g., "rolling" (Figures 22-24), "pitching" (Figure 33) and inclination (Figure 54). "Yawing," i.e., turning the obelisk of Figure 32 horizontally, would be also possible using only the rockers R_1, R_1' under the center of mass of the obelisk. As noted before in case of the pre-obelisk, the force couple for "yawing" or "pitching" works effectively for a long object like an obelisk. A quite different usage of rocker can be seen in Figure 51 as a forerunner of simple pulley, just for the redirection of force.

Summarizing, we can conclude that the above three means cope very well with the gravity to "lighten" a heavy obelisk.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Prasat Sambor as a Prototype of the Pyramidal State-Temple in Khmer Temple Construction

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Abstract

Sambor Prei Kuk is the site of an ancient city called Īçānapura, which flourished as the capital of Chenla in the late 6th early 7th century. This capital was home to several Hindu temples that marked the start of a process of architectural evolution culminating in the spectacular architecture of the Khmer civilization, as exemplified in Angor Wat. During pre-Angkorian times before the foundation of Khmer Empire in the beginning of 9th century, religious places generally consisted of a single brick shrine, in contrast to the large and varied temple complexes that emerged later. However, current comprehensive field research in the archaeological site of Sambor Prei Kuk recorded a number of unknown brick structures and diverse temple layouts by composing several structures. Among these, three temple complexes stand out for their distinctive features: Prasat Sambor, Prasat Yeai Poeun, and Prasat Tao. These temple complexes consisted of square enclosures with a central shrine at the center and numerous other structures in the adjacent precinct, and were the prototype of the three different types of temple complexes in the Angkorian period. This article focuses on the layout of these three temple complexes to reveal the fundamental components and principle layout of temple complexes in the early stage of development and illustrate the progression to more complexities in temple construction in the later period. Based on the precise analysis of the dimensional layout of Prasat Sambor, along with findings from archeological surveys, it was revealed that this temple complex embodied the features of the pyramidal state-temples that served as the central religious facility of their respective periods. Additionally, from an analysis of their dimensional layout, the planning techniques for the temple complex, as well as the unit of construction measure used for planning this temple, were identified.

Keywords

Sambor Prei Kuk, Chenla, Angkor, Cambodia, Southeast Asia, Hindu Temple

1. Introduction

During the 900-year period between the 7th century which formed the early kingdom in the pre-Angkorian period and the demise of the Khmer empire in 1431, around 15 pyramidal state-temples were built in Yaśodharapura, presently known as the Angkor monument site, and other locations. A representative structure of these pyramidal temple is Angkor Wat, which was constructed in the early 12th century, and another is Bayon, which was constructed during the late 12th early half of 13th century. These state-temples were constructed by the transcendent kings who were particularly successful in consolidating their authority and maintaining a unitary state. The kings who could realize the construction of these temples were limited to about 10 rulers in the pre-Angkorian period and about 30 rulers in Angkorian period.

The kings who succeeded the throne of Khmer empire had many different duties to discharge to preserve and enhance the state, but three royal duties were considered particularly crucial: executing public works such as water management and transport infrastructure, building temples to ancestral deities including the ruler's predecessors, and building state-temples that symbolized royal authority.

When it came to state-temples, however, few rulers ever built them due to the sizable labor force required for their construction. Among the series of state-temples, Prasat Bakong, built in the late 9th century, is notable for being the first to fully adopt a large, pyramidal structure. However, this design was already present, albeit on a smaller scale, in Ak Yum, which was built in the 8th century. Even earlier examples appear in the site of Sambor Prei Kuk, which served as a royal capital in the early 7th century. Several temple complexes were consisted of multiple shrines and square enclosures around a main shrine in the center of the precinct.

The Sambor Prei Kuk complex is located within Kampong Thom Province, Kingdom of Cambodia, about 140 km southeast of Angkor Wat (**Figure 1**). The eastern part of the site forms a temple zone consisting of clusters of brick structured temples. The western part forms a moated city zone that is bordered by a moat running around its north, west, and south sides. The site in and around the city zone preserved many still-standing brick structures and remnants of civil engineering works. In 2017, the temple zone was inscribed in the UNESCO World Heritage list in recognition of the historic value. This ancient city was identified as Īçānapura, the capital of Chenla, based on Chinese sources and inscriptions which were discovered in this archaeological site. These inscriptions, along with the aesthetic style of the deity statues and brick architecture, and the various archeological evidence, suggest that most of the main temples predate the Angkorian period and had remained in use during later periods (Shimoda & Shimamoto, 2012; Shimoda et al., 2015). Many brick temples are well preserved in the temple zone, including three temple complexes situated close together: Prasat Sambor (M20), Prasat Yeai Poeun (M24), and Prasat Tao (M26). In addition,

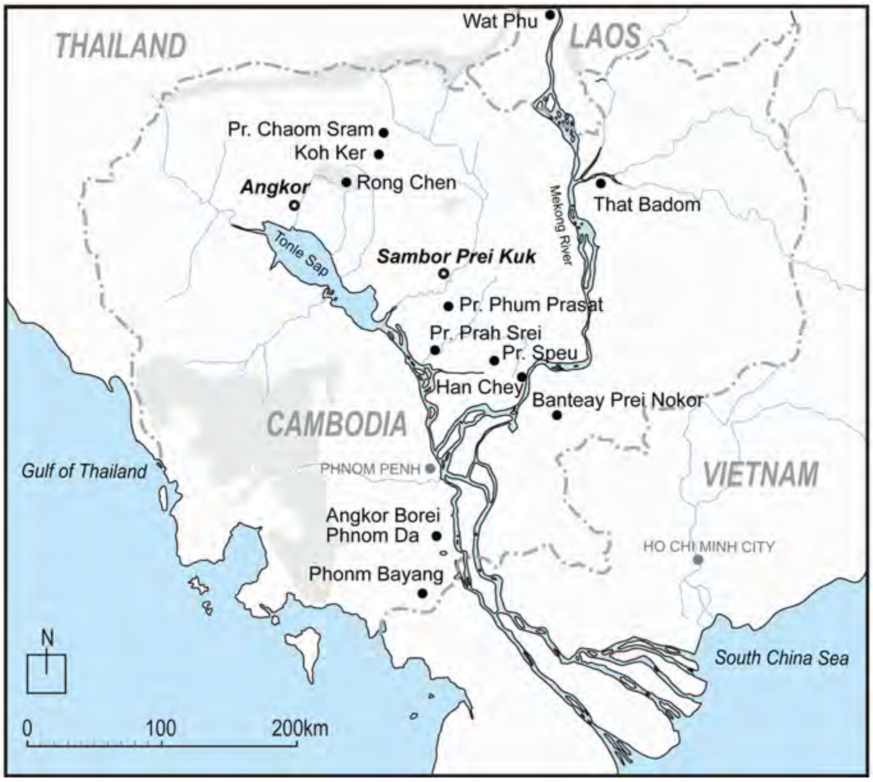

Figure 1. Location of the Sambor Prei Kuk and major Pre-Angkorian temple sites.

many temple complexes which were composed of multiple brick structures were recorded in the Sambor Prei Kuk archaeological site. Prasat Sambor features the most expansive temple precinct complex, and has been the focus of many archeological and measurement surveys.

The objectives of this article are to clarify several issues by analyzing the composition of the temple complex in the pre-Angkorian era as follows:

1) To clarify the diversity of the composition of the temple complex in pre-Angkor which was the earliest stages of the classical Angkor period.

2) To clarify the differences and features of three large temple complexes which were composed of multiple shrines and enclosures in Sambor Prei Kuk.

3) To clarify the significant status of Prasat Sambor as the prototype of pyramidal state-temples which were representing each period of the classical Angkor.

4) To identify the planning technique and the unit of construction measurement used for designing Prasat Sambor based on a precise survey.

5) To discuss the role of the temple complexes in the pre-Angkorian period for establishing the typology of significant number of subsequent temples and illustrating the chronological development of temple complexes in the later Angkorian period.

2. Pre-Angkorian Temple Complexes

Pre-Angkorian temples typically consisted of a single brick building. While many were built on flatlands, many others were situated in distinctive natural environments such as on hills and caves, reflecting the indigenous beliefs in each region. Although it was rare for a temple to consist of a cluster of structures in the pre-Angkorian period, there are some examples of complex temple compounds or adjacently situated shrines as described below.

Two temple sites, Preah Theat Thom and Preah Theat Toch in Banteay Prei Nokor are enclosed in a large square moat, consist of adjacently situated brick shrines (Parmentier, 1927) (**Figure 1**). In Preah Theat Thom, today there remain two brick shrines arranged on a north-south axis. A third shrine once stood along this axis suggesting that the complex originally formed what is known as an "architectural triad." In Preah Theat Toch, only one shrine still stands today, but this location was likely home to a temple complex given that the lower part of several structures are present nearby along with mounds of sandstone and brick material. Prasat Speu and Thnom Pdei both feature a pair of adjacent brick shrines. The best preserved of the pre-Angkorian brick shrines, Prasat Prah Srei and Prasat Phum Prasat, are dotted with brick mounds and sandstone elements around the brick shrines suggesting they were once part of a temple complex comprising multiple shrines.

A relatively large number of the structures are situated near the banks of Mekong River, and thought to have been a key trading route in the pre-Angkorian period. One of these sites is Han Chey, located about 20 km northeast of Kampong Cham. This site features pre-Angkorian brick and sandstone structures, both located on a small hill and composing a complex. Another example is That Badom, located in Stung Treng. This site was likely home to a temple complex consisting of a cluster of 15 shrines.

Additionally, the remains of six brick buildings were identified among the ruins of the ancient city of Shreshtapura on the west bank of the Mekong River. This location lies on the east side of Vat Phou, once a pre-Angkorian capital city (Santoni & Hawixbrock, 1998). A further example is Angkor Borei, serving as a stronghold of Funan, and is the Chinese name for the pre-Angkorian polity. This site features a habitation zone enclosed by an embankment and a water channel. Thirty-five mounds have been identified in this zone. Fifteen of these were brick structures (Miriam, 2003), suggesting the existence of a complex religious site. Just south of Angkor Borei lies Phnom Da which also features remnants of structures. These structures were stone and rock-cut temples rather than brick ones, but they provide another example of a cluster of sacred buildings in the pre-Angkorian period.

However, none of these pre-Angkorian sites consist of a cluster of structures arranged in a clear geometric pattern within walled enclosures. An apparent exception is Phnom Bayang in Takeo Province. Situated on a plateau 310 m above sea level, this temple has a walled enclosure containing a central shrine and several other structures. However, this temple complex experienced multiple construction periods, and modified as many as six times from the 7th to 11th century, and the early stage in the pre-Angkorian period has yet to be defined (Mauger, 1937).

Among the examples of pre-Angkorian temples, Sambor Prei Kuk is a distinct site with densely clustered temple complexes. Within the 134 sites which have been identified thus far, most of these are stand-alone brick structures. However, a small number of sites are complex temple arrangements with multiple structures. The layout of these complexes varies as follows (Figure 2):

a) Temples consisting of multiple shrines and other structures within two or three enclosures (M20, M24, M26)

b) Temples consisting of multiple shrines and other structures arranged in an irregular pattern within a single enclosure (M52, M78/79, M103)

c) A temple consisting of seven shrines arranged along an approximate north-south axis with a water tank northeast of the line (M9)

d) A temple consisting of six shrines arranged along an approximate north-south axis (M104)

e) A temple consisting of five shrines arranged in a quincunx position (M39)

f) A temple consisting of four shrines arranged along an approximate north-south axis (M11)

g) Temples consisting of an architectural triad (three shrines arranged in an approximate north-south line) within a rectangular enclosure (M27, M75)

h) Temples consisting of an architectural triad (M13, M57, M66, M93, M94)

i) A temple consisting of three shrines arranged in a flying wedge formation within an enclosure (M31)

j) Temples consisting of two parallel shrines within an enclosure (M47/48)

k) Temples consisting of two parallel shrines (M71, M72, M82, M105)

l) Temples consisting of a single shrine in a walled or moated enclosure (M10, M45, M88, M99, M108)

In many cases, the upper part of the brick structures has been destroyed making it difficult to determine when the structures were constructed. However, it is reasonable to assume they were built during the pre-Angkorian period because

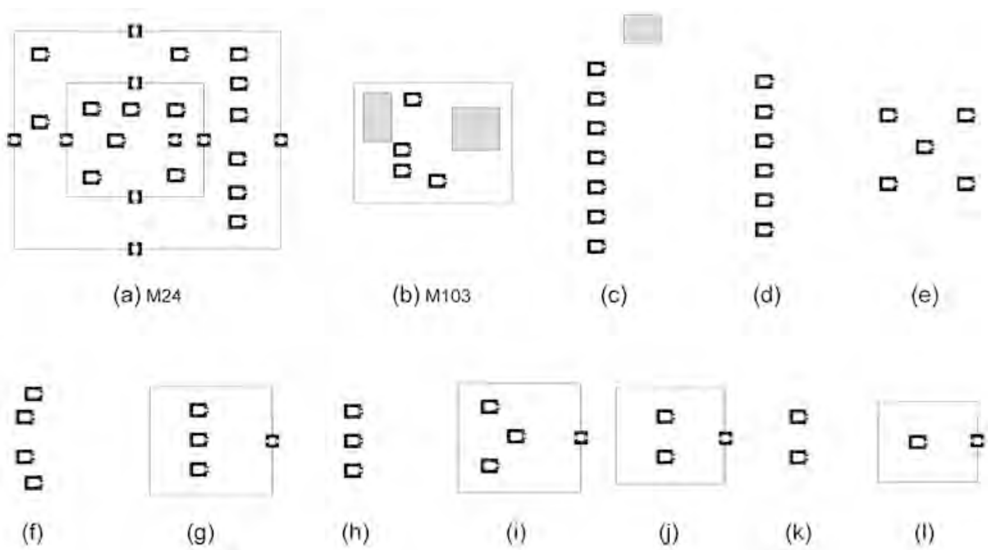

Figure 2. Types of temple complexes in Sambor Prei Kuk.

most of the inscriptions which were found in these sites and style of the remaining part of architecture are indicative of the pre-Angkorian period. While some temple sites in particularly those located in the city zone are severely damaged, it is highly possible that a future archeological survey will discover the remains of other associated structures in the proximity of some temples. By the recent archaeological surveys, several sites, M45 and M78/79, were unearthed and consisted of brick and/or stone building and enclosure where no artifacts and structures were previously observed on the ground (Chhum et al. 2013, Kubo et al. 2016).

In summary, while the construction of temple complexes is rarely realized during the pre-Angkorian period, various type of temple complex including the large precincts with several structures appeared abundantly in Sambor Prei Kuk in the late 6th early 7th century. As such, Sambor Prei Kuk was an experiment in innovation and Khmerization that created various standard styles of the temple complex that would appear in subsequent periods in Khmer history.

3. The Three Temple Complexes in Multiple Rectangular Enclosures in Sambor Prei Kuk

The three large temple complexes which have two or three rectangular enclosures and several smaller scale of temples were constructed in the temple zone of Sambor Prei Kuk (**Figure 3**). The temple complexes feature a variety of architectural styles and ornamental shrines, in marked contrast to the brick shrines of the Angkorian period which were more generic in design with a standardized form (Shimoda & Nakagawa, 2015). Regarding the layout of three large temple complexes, the northernmost temple is Prasat Sambor, the southernmost one is Prasat Yeai Poeun, and Prasat Tao lies between the two. Prasat Tao is offset to the west with the northeast and southeast corners of its outer enclosure adjacent to the other two complexes. This arrangement suggests that there was no initial plan to build the three complexes; instead, the two parallel complexes were constructed first and then the third complex in the center were planned and constructer later. This hypothesis is consistent with past research which derived the chronological order of the temple construction from an analysis of the chemical composition and size of the bricks (Shimoda et al., 2019). At first glance, the three complexes appear to have a similar layout, but closer inspection reveals differences between them. In this section, the composition of each complex and their features are discussed in detail.

3.1. Composition of Prasat Sambor

Prasat Sambor is the largest of the three main temple complexes with three enclosures. The outer enclosure forms nearly square with each side measuring approximately 389 m. However, the outer enclosure is possibly constructed in a later period than other elements of this complex because the outer enclosure is in a poor state due to the low quality of construction work and the square plan is

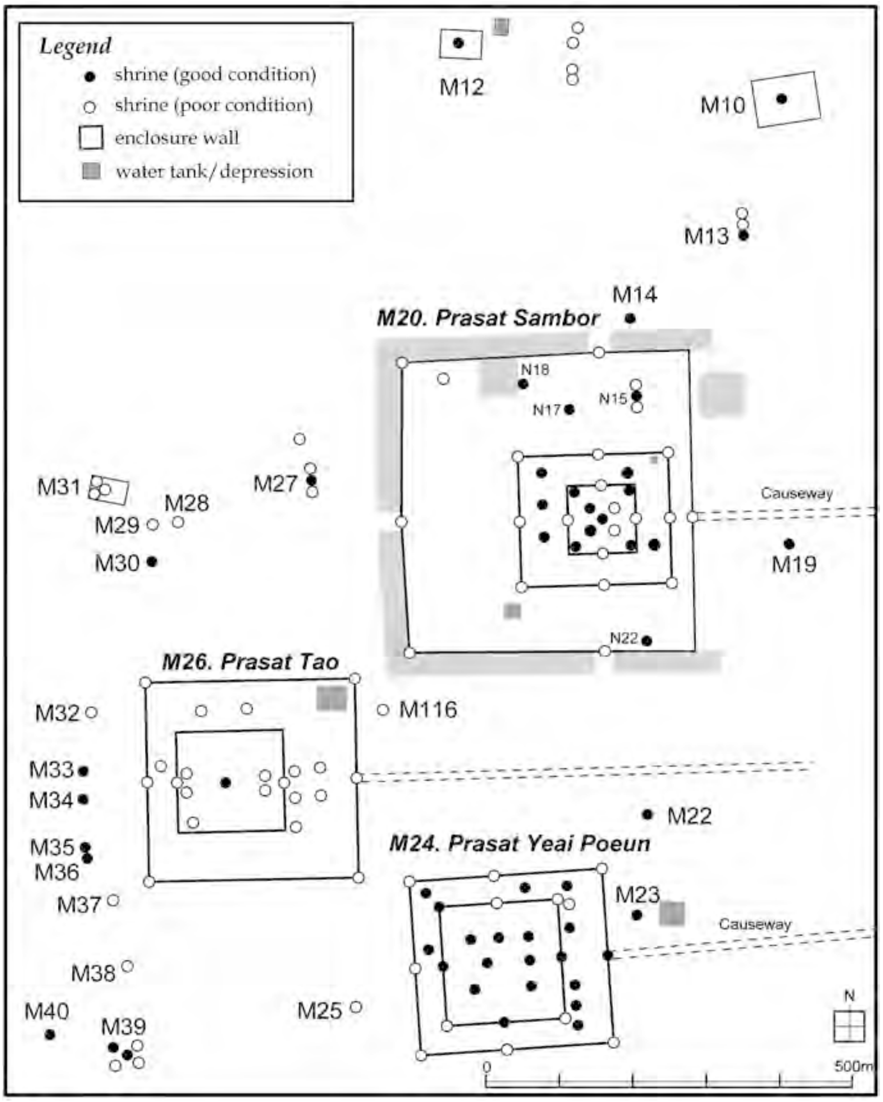

Figure 3. Distribution map of the three large temple complexes and surrounding structures in the temple zone.

markedly deformed when compared with the middle and inner enclosures. A moat measuring 45 m in width at the outside of the north, west, and south sides of the outer enclosure is also considered to be additional work.

Inscriptions in Prasat Sambor bear the names of two kings: Isanavarman I (r. 616-637) and Rajendravarman II (r. 944-968). Consistent with the date of these inscriptions, the style of the deity statues found in this temple are of 7th-century or 10th-century. This evidence suggest that the temple complex was founded in the beginning of 7th century and underwent major alterations in the 10th century.

Architectural features of each element in this complex are described below, starting from the center outward of precinct. The central shrine (N1) is standing on the central terrace forming a square plan and has door openings on all four sides (**Figure 4**, **Figure 5**). To the best of our knowledge, this is the only pre-Angkorian

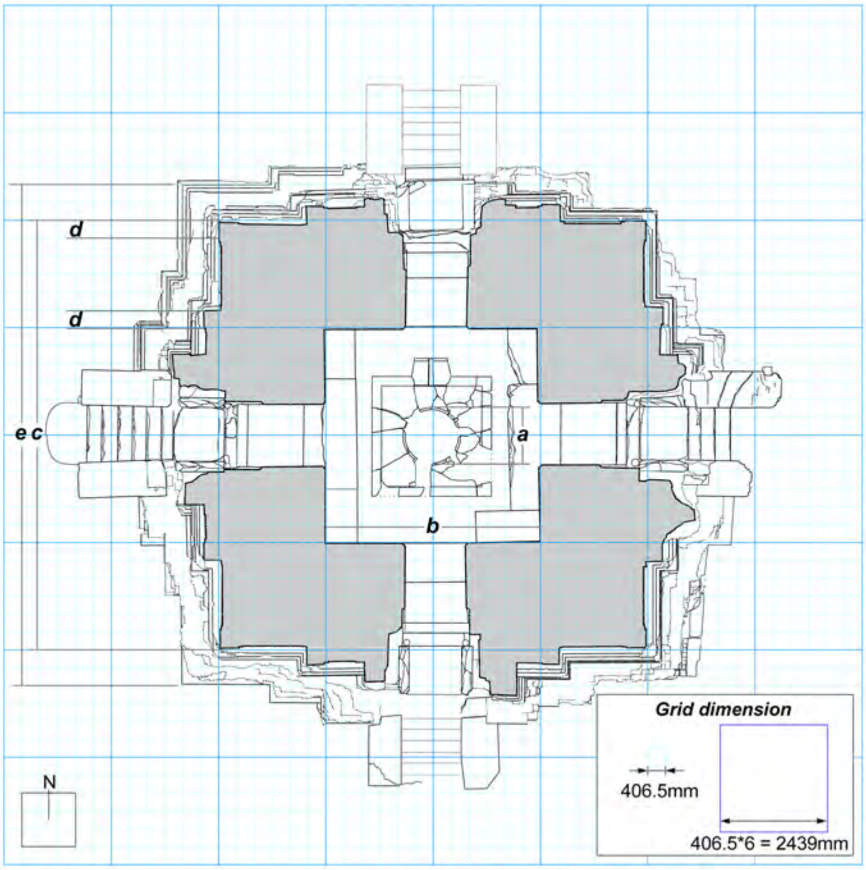

Figure 4. Plan of the central shrine (N1) of Prasat Sambor.

Figure 5. Central shrine (N1) standing on the central terrace of Prasat Sambor (view from north).

temple with openings on four sides. Research of scattered stone fragments revealed that a square pedestal measuring 2.7 m in length was installed in the chamber (Figure 6). At the center of this pedestal, a round mortise was observed. The diameter of this mortise is 121.5 cm, and this mortise likely held a lingam, an aniconic form of Shiva. The main deity of the initial stage of this temple is unrevealed as of this date, but an inscription mentions that Gambhiresvara was worshipped here at the time of the additional constructions in the 10th century; Gambhiresvara probably referred to the lingam.

The central terrace surrounding the central shrine consists of a square platform elevated 1.5 m in height. The four sides measure roughly 40 m, and the center of each sides has a stairway (Figure 7, Figure 8). Small four shrines (N2 - N5) were probably constructed at each corner. These were likely later additional structures because the stone elements of the door frame were reused materials and the quality of brickwork is inferior to other structures. Gargoyle-like stone drainage channels are distributed around the edges of the central terrace at 24 points (six on each side). These drainages channels were made from sandstone and functioned as outlets for channeling rainwater down to the level below. This drainage system formed the prototype for the drainage system of the later pyramidal temples. A paved brick walkway, 2.1 m in width, was excavated around the terrace. This elevated central terrace with a staircases and drainage on all four sides and sub-shrines on all four corners is the obvious initial features of a pyramidal temple even though the height of the terrace is limited at this stage.

Eight large square pedestals were installed around the central terrace (Figure 7). Large mortises were observed on the top surface of these pedestals for holding statues in place. However, no statues, or fragments of statues, have been found for these pedestals. In many of the early-Angkorian pyramidal temples, eight subsidiary shrines of a similar design have been installed around the central

Figure 6. Reassembled pedestal in the chamber of central shrine (N1) of Prasat Sambor.

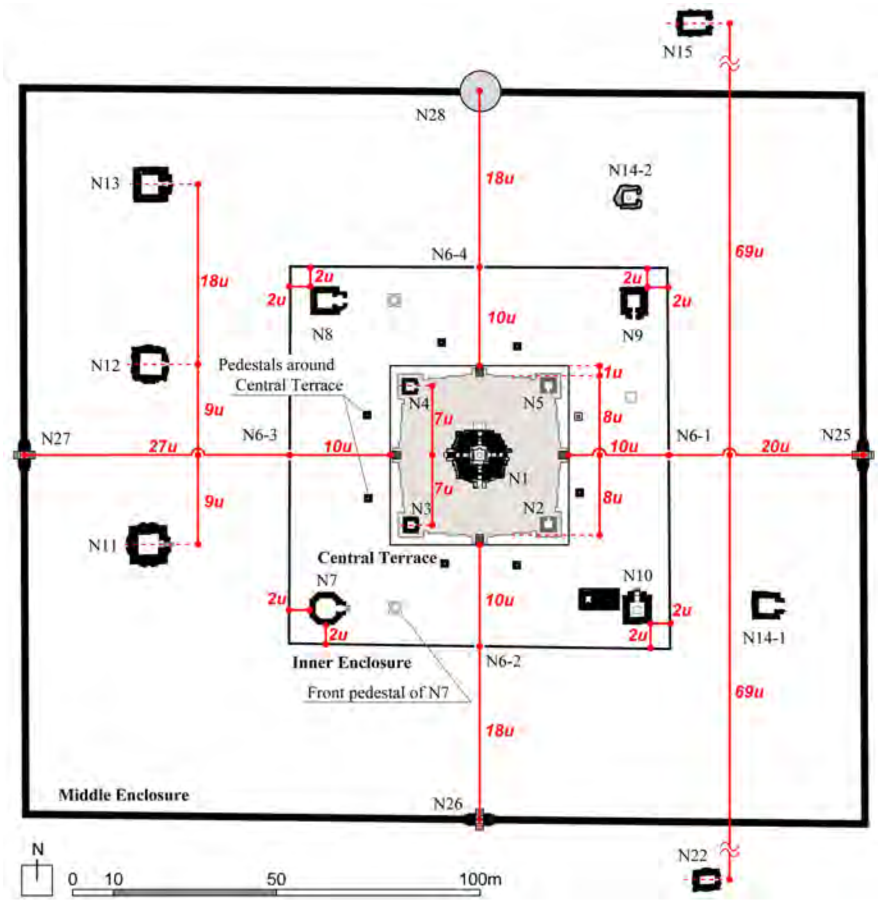

Figure 7. Plan of Prasat Sambor within middle enclosure with dimensions in each part (1 u = 6 hasta = 2439 mm).

Figure 8. Central shrine (N1) and northwest corner shrine (N4) on the central terrace of Prasat Sambor during the archaeological excavation survey (view from northwest).

components. These shrines would have been dedicated to the eight murti (embodiments) of Shiva in the form of the sun, moon, fire, earth, water, wind, and ether, and the king himself (Cœdès, 1965). The eight pedestals distributed around the central terrace of Prasat Sambor closely resemble this early-Angkorian configuration and arguably represent the first known example of these components.

The central terrace stands in the center of the inner enclosure. The inner enclosure forms a square demarcated by four walls. At the center of each side, gateways were constructed and worshippers could access from every sides. An archeological survey around the center of the eastern side revealed that the opening is 2.8 m wide (**Figure 9**). However, no traces of any gopura (monumental gateway) were found. This entranceway is typically rather basic; an entrance with sandstone side posts. In the inner enclosure, a brick pavement 1 m in width was excavated. The paving likely formed part of a walkway running along the inner enclosure perimeter (Shimoda et al., 2006). It is possibly to consider this walkway structure as the origin of the gallery which was a common component of the temple complexes in the Angkorian period.

Shrines N7 to N10 are located at the four corners within the inner enclosure. Of these, the eastern two shrines, N9 and N10, face each other. Shrines N9 would have contain a statue of Durga, while Shrine N10 would have contains a statue of Harihara. An archeological survey on the western side of N10 uncovered a brick structure which has two chambers. The main chamber had a pillared open-air structure. A fragmented statue of Ganesh was found in a pit in the center of this chamber (Shimoda & Shimamoto, 2012). This structure may constitute the first example of a "Library" (a name given by French scholars for a specific-type of building; usage unknown) which was typically constructed in Angkorian temples. The western shrines, N8 and N7, face to the east. In front of these shrines lie large stone pedestals. A statue of Vajimukha (a deity also known as Kalkin), of a 10th century style, was found in the N7 shrine. Due to the style

Figure 9. Excavated gateway (N6-1) at the center of eastern side of the inner enclosure (gateway was excavated only north half of the structure).

of this statue, this statue would have replaced the original deity statue. It is unclear what statue would have stood on the pedestal in front of the shrines N7 and N8, but it is hypothesized that it was the Vahana (mount) of the deity to whom both shrines were dedicated. Currently, a set of octagonal shaped pedestal was reconstructed in front of the shrine N7 (**Figure 10**). All the deities enshrined in the inner enclosure are closely related to Shiva. This configuration mirrors the cosmological layout depicted in a mandala in which the main deity Shiva appears in the center of cosmological grid.

The middle enclosure forms a rectangle; its east-west sides are slightly longer than those of the north-south sides. The west space between inner and middle is larger than east space, and three brick shrines (N11, N12 and N13) are located within this larger space. Two smaller shrines stand in this enclosure, one in the eastern space (N14-1) and the other in the northern space (N14-2). Gateway structures, gopura, were located on each sides of the middle enclosure. These structures were exactly located on the axis lines from the central shrine. Through the archaeological excavation survey, two floor levels were identified at 80 cm and 2 m below the present ground level nearby the eastern gopura. The evidence of these earlier paving indicates that the present gopura was a reconstructed structure in a later period (Shimoda et al., 2006). This finding implies that the level of the outer area from inner enclosure was originally lower than the present level, and the temple complex was formed like a stepped pyramid even though the height of these steps is limited.

As mentioned earlier, the outer enclosure has been poorly preserved, and only a few parts remain above ground level. On the western side, a part of the gopura is still preserved where the wall intersects the main axis. It is likely that the north and south gopuras were also constructed because mounds of the structures were

Figure 10. Southwest shrine (N7) and a reconstructed front pedestal in the inner enclosure of Prasat Sambor.

confirmed on the northern and southern sides of this enclosure where the walls intersected the north-south axis. Regarding the eastern side, an archeological survey revealed the remains of a sandstone stepped terrace. The earthen causeway structure stretches eastward and is 1.9 km long from this terrace.

The western and northern space between the outer and middle enclosures are relatively larger than the eastern and southern space. Five shrines were identified in the northern space. Of these, N15, N16-1, and N16-2 are situated adjacent and parallel, forming an architectural triad. The middle shrine in this triad, N15, is exactly in symmetrical position to N22 relative to the main axis of this complex. A statue of Brahma was found near N22, and is proposed to be the original enshrined deity of this shrine because the pedestal found in this shrine fits this statue. It is unclear what deity was enshrined in N15, but it may well have been Vishnu, which would mean that the temple complex housed all three members of the Trimurti, the triple deity in Hinduism. Based on this hypothesis, Vishnu was enshrined in the north shrine N15, Shiva and his attendants were enshrined in the shrines at central part of the complex, and Brahma was enshrined in the south shrine N22. Such a configuration emerges later in Angkorian temples. For example, Phnom Bok which was founded in AD 910 is a realization of the configuration of the Trimurti by architectural triad. Three main shrines were dedicated to each of the three members of the Trimurti. If the above hypothesis in Sambor Prei Kuk is correct, then it would mean that this Hinduism configuration was already manifested in a temple complex in the pre-Angkorian period.

3.2. Composition of the Prasat Yeai Poeun

Prasat Yeai Poeun has two enclosures with several shrines within (**Figure 11**). The outer closure measures approximately 258 m along the east-west axis and 244 m along the north-south axis. An inscription found in the temple complex bears the name of Isanavarman I, who likely ordered the construction of this temple in the early 7th century the same as Prasat Sambor. The central shrine (S1) is the largest structure in this group of monuments and measured 22 m high. A severely damaged large pedestal has been reconstructed inside the shrine. An inscription on this pedestal indicates that the shrine was dedicated to "Smiling Shiva." Each component in this temple complex is described below, starting from the center outward.

The central shrine forms a rectangle oriented lengthways along the east-west axis. It has only one entrance, on its eastern side. This shrine stands on a terrace with staircases in the four cardinal point sides. However, it functions more as the base of a shrine rather than forming a spacious upper level like the central terrace of Prasat Sambor (**Figure 12**).

The inner enclosure forms a square. All four sides of the enclosure have a gopura. The gopura on the northern and southern side s (the lateral gopura) are located slightly west from the midpoint. The outer door opening of these lateral gopura were closed by brickwork, making them impassable for access into the

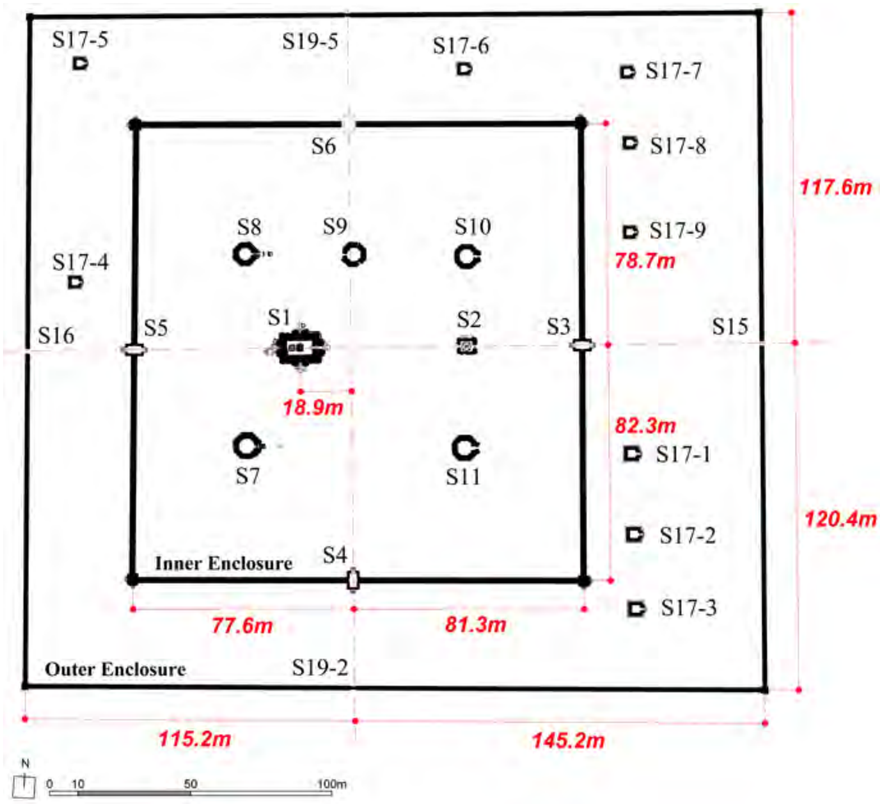

Figure 11. Plan of Prasat Yeai Poeun with dimensions showing asymmetrical composition.

Figure 12. Central shrine (S1) of Prasat Yeai Poeun (view from east).

enclosure (Figure 13). This false door would be originally closed because the brickwork in the door frame is well constructed same as other initial brick structures. A series of circular bas-relief decorative elements, medallions, 107 cm in diameter adorned both sides of this inner enclosure. Each medallion seems to

Figure 13. Closed door opening of the south face of south gate (S4) in Prasat Yeai Poeun (view from south).

depict a different mythical scene, but most are incomplete and the story of these mythical scene has been unrevealed. Much of the wall lies buried beneath a mass of fallen bricks, and further surveys may uncover more panels of medallions. No examples can be found in later periods of a wall being adorned by decorative medallion curving. However, in the late of the Angkorian period, some temple complexes were depicting mythical epics on the walls of galleries, and the medallions in Prasat Yeai Poeun can be identified as a forerunner of this practice.

The central shrine (S1) is aligned with the east and west gopura, but it is positioned slightly west of the lateral gopuras, creating a larger space in front of the shrine. In this front space, a structure called a mandapa (shrine S2) is positioned (**Figure 14**). This structure contains a decorative pedestal which consists of a platform and roof element supported by four pillars. An inscription on the stone plate on the platform indicates that this structure was dedicated to Nandin the bull, who was Shiva's vahana. In the Angkorian period, the adjunctive praying chamber was adjoined directly in front of main chamber, but in this case the front chamber was separately constructed in the front space. Lines of laterite columns were excavated in a past excavation survey, and a walkway may have connected these two structures.

Besides the mandapa, there are five octagonal shrines (S7 - S10) that still stand in the inner enclosure. In addition, a past archaeological excavation survey uncovered a base of the square structure in front of the entrance to S7 (Goloubew, 1927). Four of the five octagonal shrines are arranged symmetrically. The fifth shrine, S9, is asymmetrical with the others, and its entrance faces west while the others all face east. The layout of this shrine represents a distinctive feature of Prasat Yeai Poeun; no analogous examples appear in later temples. Shrine S9

Figure 14. Alignment of three structures on the main axis line in Prasat Yeai Poeun; east gate of the inner enclosure (S3), mandapa (S2), and central shrine (S1).

stands on the north-south axis line, such that anyone standing at the point where the east-west main axis and north-south vertical axes intersect would find their northerly line of sight obstructed. Thus, whereas Prasat Sambor has a design that clearly radiates out from the center evenly in square-wise fashion, Prasat Yeai Poeun extends only lengthways and restricts the width way line of sight and travel, thus emphasizing frontal perspective and depth.

The outer enclosure is made of laterite, and is slightly rectangular along the major axis. All four gopuras on all sides are in a poor state of conservation, but it is obvious that both doors of the east and west gopura are open and door of north gopura was closed. Although the south gopura was severely damaged, the door would be closed the same as the north gopura. Thus, the door of north and south gopura might be closed the same as the gopura in the inner enclosure. Remnants of an earthen causeway appear intermittently along a 2.6 km stretch leading out from the eastern gopura. Nine shrines are distributed between inner and outer enclosures. Those in the southeast corner (S17-1, S17-2, and S17-3) are brick structures while the rest are made of laterite. The architects probably intended to build an equal number of shrines on each side by brick but were forced to modify and abandon the plan during construction.

3.3. Composition of Prasat Tao

Prasat Tao has an inner and outer enclosure (**Figure 15**). The outer enclosure measures 283 m along the east-west axis and 274 m along the north-south axis. With exception of the central shrine (C1), which stands 22 m high, all components within this complex are severely damaged and thick layer of sedimentary soil is covered entire precinct area. This situation, coupled with the lack of prior

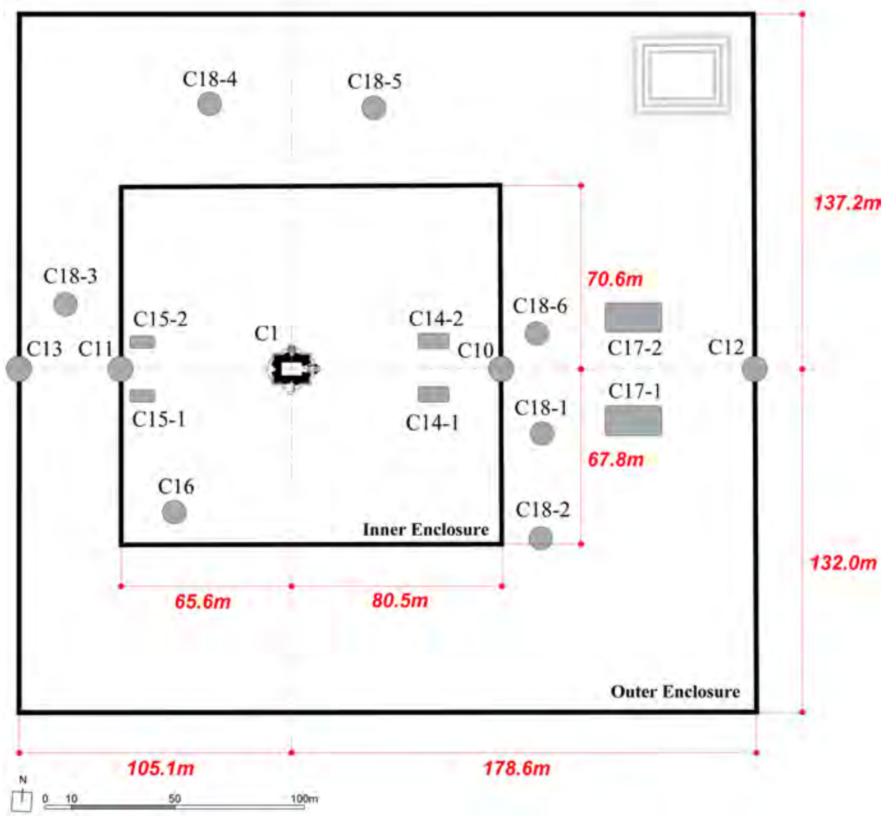

Figure 15. Plan of Prasat Tao with dimensions showing asymmetrical composition.

archeological surveys, limits what is known about the composition of this temple complex.

The central shrine is rectangular and has a front door opening (Figure 16). The door opening is adorned with a decorative lintel and colonnette that have been well preserved. These decorative elements are classified to the Kompong Preah style, which is attributed to a relatively late stage of the pre-Angkorian period. Carved lion figures adorn the sides of three of the four stairways.

The inner enclosure forms a rectangle oriented lengthways along the major axis. There are two gopuras on the east and west sides. The central shrine is positioned slightly westward of the enclosure center the same as Prasat Yeai Poeun. Apart from the central shrine, five other structures were constructed in the inner enclosure. The layout of these structures differs from that in Prasat Sambor and Prasat Yeai Poeun where the shrines are arranged in the four corners.

The outer enclosure, likewise, is rectangular, with the long side to the east and west and with gopura only on the eastern and western sides. The walls are made of laterite, but the gopura are brick constructions. Remnants of eight structures appear in this enclosure. Four are symmetrical with a horizontal axis while the other four have an irregular layout. Lacking any lateral gopura, Prasat Tao has a longitudinal composition that emphasizes depth to an even greater extent than does Prasat Yeai Poeun.

The straight causeway would be extended from the east gate of the outer

Figure 16. Central shrine (C1) of Prasat Tao (view from northeast); front door is opened and accessible to the chamber but other three sides are only decorated with false doors and steps.

enclosure, the same as Prasat Sambor and Prasat Yeai Poeun, but only limited earthen evidence is observed today. Many artifacts were excavated in the previous excavation surveys along this causeway 200 m east from the outer enclosure (Groslier, 1981, Shimamoto et al., 2008, Kubo et al., 2012). It was estimated that the front space of this temple was occupied by some form of wooden facilities supporting the religious activities of the temples around here.

To the west of the outer enclosure lies a group of shrines (M32 - M36) (**Figure 3**). It is unclear whether these shrines formed an integral part of the temple complex. However, it is worth noting that Prasat Sambor has three shrines toward the rear space in the middle enclosure. Likewise, the shrines west of Prasat Tao, though situated outside of the enclosure, may have served as satellite shrines to this temple complex.

3.4. The Three Temple Complexes: Prototypes of Two Architectural Lineages

The three temple complexes described above all have multiple enclosures and several shrines, but each complex has its own distinctive layout. Fundamentally, however, whereas the layout in Prasat Yeai Poeun and Prasat Tao are not so dissimilar, the Prasat Sambor layout is markedly different from the other two. This layout is distinctive in three respects:

1) The Prasat Sambor central shrine is square with door openings on all four sides while the central shrine of the other two complexes are rectangular and have single door opening on the front side.

2) The Prasat Sambor central shrine is situated in the center of the inner enclosure, while the central shrines of the other two complexes are positioned rearward of the inner enclosure.

3) In Prasat Sambor, lateral gopuras are aligned with the central shrine, while in the other two complexes the lateral walls either have a gopura that are not aligned in this way or have no lateral gopura at all.

These distinctive features possible reflected the different designing concepts for these temples; Prasat Sambor has a layout that radiates outward evenly in all four directions from the central shrine, by contrast, the layout of the other two complexes extends along one axis, emphasizing the frontal line of sight. Differences in religious significance and their alignment should also be considered.

These two layouts would be the prototypes of two architectural lineages delineating the numerous temples built in the Angkorian period (**Figure 17**). Prasat Sambor pioneered the pyramidal design that characterized the state-temple. As mentioned in the introduction, the more powerful rulers only constructed pyramidal shaped state-temples (**Figure 18**). After the initial state-temple of Prasat Sambor, subsequent kings constructed the following pyramidal state-temples as follows: Ak Yum (8th century), Rong Chen (early 9th century), Prasat Bakong

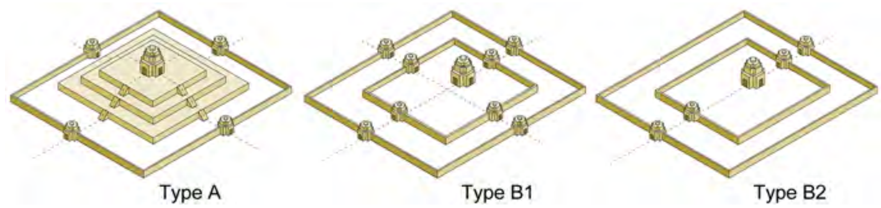

Figure 17. Diagram of major three compositions of Khmer temple complex; (A) Type of pyramidal state-temple derived from Prasat Sambor, (B1) Type of flat complex derived from Prasat Yeai Poeun, (B2) Type of flat complex derived from Prasat Tao.

Figure 18. Pyramidal structure (Prasat Prang) in the Prasat Thom (view from northeast); steep staircase was constructed only front face and other three sides are not accessible.

(881), Phnom Bakheng (900), Prasat Thom (928), East Mebon (952), Pre Rup (961), Ta Keo (c. 1000), Phimeanakas (late 10th to early 11th century), Baphuon (c. 1060), Angkor Wat (1113-c. 1150), and Bayon (late 12th century to early 13th century).

These temples have a stepped tiers elevation, and central shrines which enshrined the deity statue associating the king and deity were constructed at the uppermost level of these mountain temples. These central shrine opens on all four sides with a square plan, and the prestige of the nation god would be equally extended radially. With exception of Prasat Thom, staircases and gopura are positioned along the horizontal and vertical axes extending from the central shrine, creating unbroken lines of travel in the cardinal directions.

Regarding the exception noted above, it is debatable that Prasat Thom should be classified as a state-temple. This pyramidal temple was built in Chok Gargyar (now known as Koh Ker), was briefly the capital in the early 10th century. The temple complex of Prasat Thom is divided into western and eastern sections. The western section, known as Prasat Prang, consists of a tall pyramidal structure (**Figure 18**). The eastern section has a cluster of shrines and other structures on flatland within a walled and moated enclosure. Both sections have a shrine at the center, but neither has openings on all four sides. In addition, neither section has straight routes to a shrine at the center from four sides. However, it has been decided to nonetheless classify this complex as a state-temple based on the work of Cœdès (1965): Cœdès argued that Prasat Thom played a crucial role in the development of the pyramidal temple in that it pioneered the idea of having a highly symbolic pyramid that was separate from the other compositions in the complex. Another reason for treating Prasat Thom as a state-temple is this complex obviously served as the most significant temple in the relocated capital Chok Gargyar in the 10th century.

Besides the temples shown in **Figure 19**, Prasat Chaom Sram, located in Preah Vihear Province, is also a pyramidal temple complex (**Figure 20**). Although this temple is not as familiar to researchers as other temples, the composition of this temple is strikingly comparable to Pre Rup and East Mabon. However, this temple stands apart from the other examples in that it lacks a key feature of pyramidal state-temples as it has no lateral gopura. Additionally, unlike all other state-temples, it is located some distance away from a political center of the kingdom. Therefore, this pyramidal temple is not classified as a state-temple, on the other hand, it was possibly an important regional temple.

As for the other architectural lineage, as exemplified in its prototype, Prasat Yeai Poeun, this temple was composed by several structures on flat ground and layout emphasizes frontal perspective and depth of precinct. The central shrine is rectangular and it is positioned slightly rearward in the space of the enclosure. This architectural lineage in the early-Angkorian period is further divided into two subcategories. Regarding the first subcategory, as in Prasat Yeai Poeun, lateral gopura are positioned roughly at the midpoint of the line such that they are

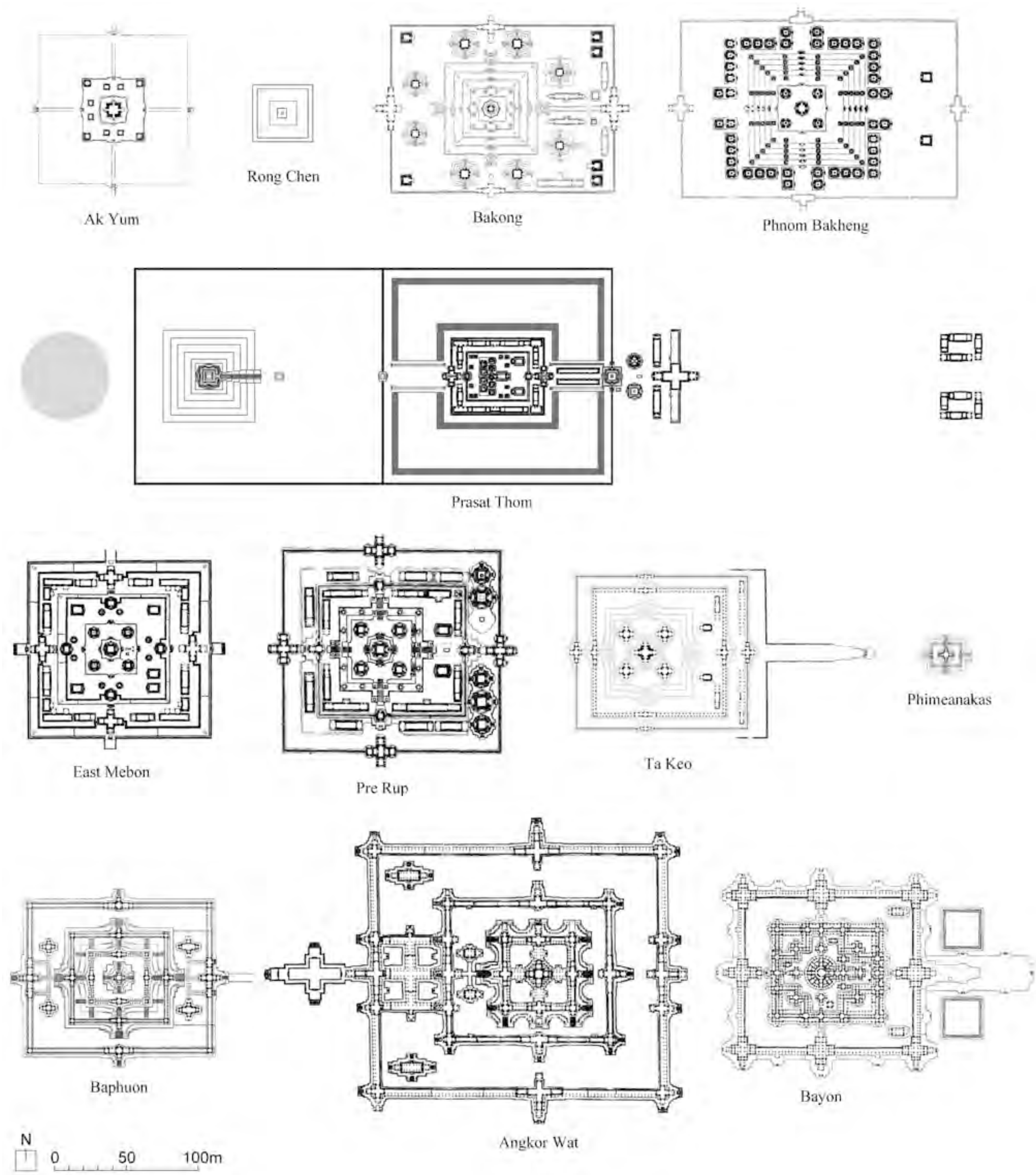

Figure 19. Plans of the pyramidal state-temple in Angkorian period (source: École française d'Extrême-Orient).

out of alignment with the central shrine. Strictly speaking, the lateral gopura of Prasat Yeai Poeun is slightly rearward from the midpoint of the wall; the both gopuras are positioned about 1.5 m rearward from the midpoint of the longitudinal wall that is about 159 m long, such that it lies 81.3 m from the eastern end the wall and 77.6 m from the western end. In the second subcategory, there are

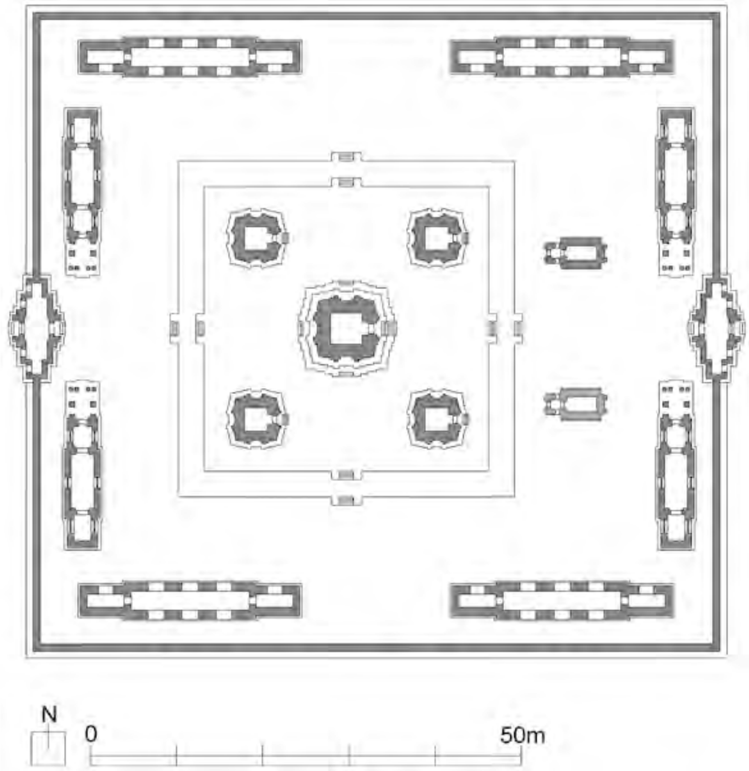

Figure 20. Plan of Prasat Chaom Sram (central part of the complex).

no lateral gopura, as is the case with Prasat Tao. An example of the first subcategory, Prasat Yeai Poeun style, in early-Angkorian period is Phnom Krom (9th century) (**Figure 21**), and an example of the second category, Prasat Tao style is Preah Ko (879) (**Figure 22**).

From the middle of the Angkorian period onward, this lengthways layout blended with the pyramidal temple resulting in a new style of temple complex. This new style retained some features of the lengthways layout; the central shrine is a rectangular plan with an antechamber positioned at the rear space in the enclosure. However, it combined these features with the pyramidal temple; the central shrine has door opening on all four sides and is aligned with the lateral gopura. While remaining clearly distinct from the pyramidal state-temple in that the overall temple complex has a flat layout rather than having elevated stepped tiers structure, this style manages to fuse two theretofore separate lineages of temple design. Examples of this hybrid genre include the Bayonesque temples of Ta Prohm, Preah Khan, and Banteay Kdei. These temples mark a shift to a larger, more intricate temple design; one that required as many personnel and monetary resources as were required for a state-temple construction.

3.5. Asymmetric Composition of the Three Temple Complexes

In the earlier descriptions of the three temple complexes, it was briefly noted that the central shrine is positioned in the center or slightly to the rear of the center of the inner enclosure. However, the result of detailed survey reveal that

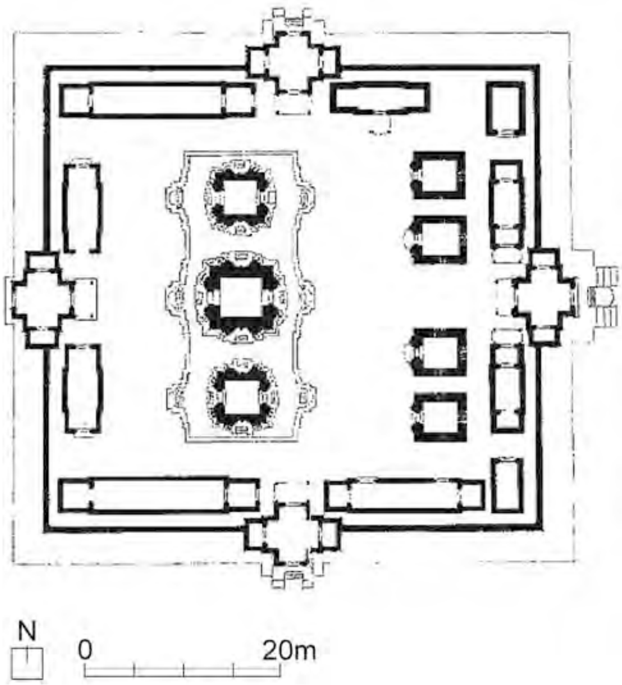

Figure 21. Plan of Phnom Krom (source: École française d'Extrême-Orient).

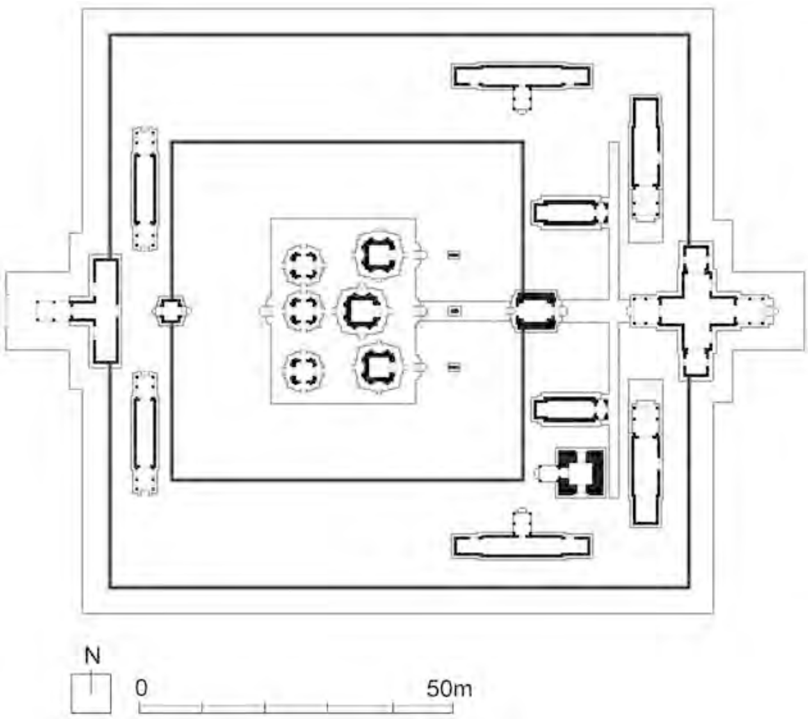

Figure 22. Plan of Preah Ko (source: École française d'Extrême-Orient).

the three complexes differ in terms of the special relationship between the enclosures, and the main axis running through the central shrine and east/west gopuras. In the case of Prasat Sambor, the main axis line splits the inner and middle enclosures into precisely even northern and southern sections. By contrast, in Prasat Yeai Poeun, the major axis is offset slightly to the north, creating a larger space in the southern parts of the enclosures than in the north. This asymmetric layout is also confirmed in Prasat Tao, except the north and south are reversed.

The layout of Prasat Sambor enclosures is less accurate than are those of the other two temple complexes. Specifically, in both the inner and middle enclosures, the southeastern corner of the perimeter is too far skewed outward from where it should be for the enclosure to form an exact square or rectangle. Likewise, the northwestern corner of the middle enclosure perimeter is too far skewed outward (Table 1). However, in terms of distance from the vertical axis, which intersects the main axis, the inner enclosure northern and southern walls are equidistant at 46.7 m from the center of the central shrine. Similarly, the middle enclosure lateral walls are equidistant from the central shrine at 89.3 m (Figure 7). These measurements imply that a main axis was deliberately plotted to evenly divided the space in the two enclosures.

In Prasat Yeai Poeun, the inner enclosure's eastern wall is 161 m long, but the point where the main axis intersects the center of the eastern gopura is situated 78.7 m northward and 82.3 m southward, putting it about 1.8 m north of the true midpoint of the wall. Regarding the outer enclosure, the eastern wall measures

Table 1. Measurement value and corresponding value to the unit value from the center of central shrine to each points of inner and middle enclosures in Prasat Sambor.

		Measurement value		Corresponding value (hasta × 6 = 2439 mm)		Theoretical corresponding value	
		X (east direction)	Y (north direction)	X (east direction)	Y (north direction)	X (east direction)	Y (north direction)
Inner Enclosure	Center of east side	0.000	46.627	0.0	19.1	0	19
	Northeast corner	46.120	46.286	18.9	19.0	19	19
	Center of north side	46.284	0.000	19.0	0.0	19	0
	Northwest corner	46.465	−46.584	19.1	−19.1	19	−19
	Center of west side	0.000	−46.766	0.0	−19.2	0	−19
	Southwest corner	−46.285	−46.927	−19.0	−19.2	−19	−19
	Center of south side	−46.959	0.000	−19.3	0.0	−19	0
	Southeast corner	−47.650	46.953	−19.5	19.3	−19	19
Middle Enclosure	Center of east side	0.000	94.351	0.0	38.7	0	39
	Northeast corner	88.283	93.701	36.2	38.4	37	39
	Center of north side	89.332	0.000	36.6	0.0	37	0
	Northwest corner	90.181	−112.200	37.0	−46.0	37	−46
	Center of west side	0.000	−111.709	0.0	−45.8	0	−46
	Southwest corner	−87.919	−111.398	−36.0	−45.7	−37	−46
	Center of south side	−89.348	0.000	−36.6	0.0	−37	0
	Southeast corner	−90.217	94.702	−37.0	38.8	−37	39

238 m in length, and the points where the wall intersects the main axis lie 117.6 m northward and 120.4 m southward, thus deviating from the midpoint by 1.4 m (**Figure 11**). In Prasat Tao, the length to northern wall of inner enclosure is 70.6 m from the central shrine, while the length to southern wall is 67.8 m, denoting that the main axis line is passing 1.4 m south of the center of inner enclosure. Likewise, the length to northern wall of outer enclosure is 137.2 m from the central shrine while the length to southern wall is 132.0 m, meaning that the main axis line is passing 2.6 m south of the center of precinct in the outer enclosure (**Figure 15**).

A well-known feature of classic Khmer temples is the main axis line is offset from the center of the enclosure. Typically, the main axis line is offset north, making the southern part of the enclosure more spacious than the northern part. However, in the case of Angkor Wat, whose front faces to the west, the main axis line is offset south, making the northern part of the enclosure more spacious. Similarly, in Preah Vihear, whose front faces north, the eastern segment of the enclosure is more spacious than the western segment. Thus, in most cases, if standing at the entrance of the temple complex and looking inward, the more spacious side of the enclosure would appear to the left. An anomaly is Prasat Thom. The main axis line passing the center of pyramid in the rearward enclosure is offset to the south. However, the main axis line in the frontward enclosure which contains several smaller shrines is offset to the north.

Mizoguchi et al. (2010a) has identified three approaches toward this offset-axis design. The most common technique is to place the main axis line slightly north of the true center of the complex. Banteay Samre exemplifies this technique. The second technique involves an indirect approach. Specifically, the northern side of the complex is cropped off to bring the axis northward. An example of this technique is seen in Thommanon. The third technique is similarly indirect: the axis is brought northward by extending the enclosure southward. This technique is rare and Prasat Pram, in the ruins of Koh Ker, is one of the few examples. These results were derived from the detailed analysis of the layout of components based on the construction unit for planning the temple complex.

In the case of Prasat Yeai Poeun and Prasat Tao, they can be clearly confirmed offset of the main axis lines. However, it has not been possible to conduct a detailed analysis of the temple layout, because precise measurements of the location of each component is difficult due to the thick sedimentary soil accumulated in the precinct. It is nonetheless notable that, whereas the main axis in Prasat Sambor has not been offset, the main axis of the other two complexes has, implying the offsetting practice was first introduced during the time when these complexes were designed and it later became widely accepted practice in ancient Khmer architecture. The offsetting practice of the pyramidal temple of Angkor Wat and Bayon is widely recognized, and were precisely surveyed by the Japanese Government Team for Safeguarding Angkor. Additionally, other research teams surveyed Takeo and Pre Rup temples (Kojima & Shigeeda, 2019). Further evidence comes from a plan of Phnom Bakheng drawn by the French School of the Far East (École française d'Extrême-Orient); the data confirms the main axis line is offset to the north. It remains unclear which state-temple was the first to adopt this practice as we currently lack precise data on earlier temples such as Bakong and Ak Yum. However, it is significant that this asymmetrical layout is not observed in the first state-temple, Prasat Sambor. The state-temple would be designed as the central axis of the state, and this concept was expressed by the true symmetrical composition of the temple complex at the beginning.

4. Analyzing the Planning Technique behind Prasat Sambor

In this section is discussed the planning technique of the layout in Prasat Sambor, and is based on the result of plane surveying. Detailed surveys of each component in Prasat Yeai Poeun and Prasat Tao are still difficult due to thick sedimentary soil accumulations, but in the case of Prasat Sambor, comprehensive data on the layout of every component is available because to past archaeological excavations and clearance (Shimoda et al. 2006; Shimoda & Shimamoto, 2012). This data is sufficient to carry out an analysis of the planning technique of this temple complex.

Position of each structure were surveyed using a total station. In addition, manual measuring with a tape measure was also used for individual structures. After combining this measurement data, the precise plan of the temple complex was prepared by CAD system. In reality, the main axis of the temple complex is rotated about 2˚10" counterclockwise, **Figure 4** and **Figure 7** rotate the axis back to fit the dimensions of the paper.

To understand the planning technique behind the temple layout, it is necessary to infer the construction unit which architects used designing this temple. For this task, we turn to a century of research on the construction units used in the ancient Khmer architecture beginning with Georges Cœdès. He estimated that 1 "hasta" is equal to 0.45 m based on the study of an inscription derived from a pyramidal structure Prang in Prasat Thom (Cœdès, 1924). This research was later continued by others. At the end of the last century, Eleanor Mannikka supposed the approximate length of a hasta to be either 450 mm or 436 mm (Mannikka, 1996). Drawing on these knowledges, Mizoguchi et al. conducted a series of analyses on the classic Khmer architecture in eastern Thailand, Angkor monuments, Koh Ker, and the isolated temples of Beng Mealea and Preah Vihear. The current results by his team indicated that the true length of a hasta was 412 mm (Mizoguchi et al., 2007, 2009, 2010a, 2010b, 2012). Based on the analysis of each shrine in Sambor Prei Kuk, the construction unit for individual shrines were estimated to be around 407.5 mm (Narui et al., 2019). The authors suggested that the construction unit varied between monuments, even though these monuments belong to the same temple complex. There is therefore some room for debate on their hypothesis. However, the conclusion of this article is coincident that the length of the construction unit was approximately 407 mm.

The exact dimension of construction unit was calculated 406.5 mm through the analysis on the layout of the temple complex. This measure likely constituted 1 hasta. However, this scale would have been too small to design the entire temple complex, therefore it is likely that a measure of at least 6 hasta, or 2439 mm, was widely used as the main unit for planning. Thusly, a 6-hasta length was defined as 1 unit (1 u) in this article. Mizoguchi previously surmised that 4 hasta, or 1vyama, was used as an upper measurement unit in multiple temples. Such a scale does not fit in this case. Based on this construction unit, each dimension of the components in the middle enclosure were designed as shown below. For the central shrine, measurement values are presented along with the hasta and unit value. For other areas, however, measurement values are not presented because the dimension of four sides of components or each direction are not always precisely the same value. Table 1 shows the measurement value of each dimension of the inner and middle enclosures together with the corresponding unit value. The value of the outer enclosure was not presented in this article because this additional component to the original construction was from a later period, and would be constructed imprecisely.

- Diameter of the lingam in the central shrine (dimension of this principal object of worship was evaluated by the reconstructed pedestal): 1215 mm or 3 hasta.
- Length of the interior space of the central shrine: 4871 mm = 12 hasta = 2 u
- Full width of the exterior wall of the central shrine: 9686 mm = 24 hasta = 4 u
- Width of the exterior pilasters of the central shrine: 1 hasta
- Full width of the exterior base of the central shrine: 11,436 mm = 28 hasta
- Full width of the central terrace: 16 u
- Width of the central terrace base: 1 u
- Distance from foot of the central terrace base to perimeter of inner enclosure: 10 u
- Distance from centers of N3 and N4 to main axis line: 7 u
- Distance from wall of the corner shrines (N7 - N10) to perimeter of inner enclosure: 2 u
- Distance from east wall of the inner enclosure to east wall of the middle enclosure: 20 u
- Distance from west wall of the inner enclosure to west wall of the middle enclosure: 27 u
- Distance from north/south wall of the inner enclosure to north/south wall of the middle enclosure: 18 u
- Distance from centers of N11 and N12 to main axis line: 9 u
- Distance from center of N13 to major axis: 27 u
- Distances from centers of N15 and N22 to main axis line: 69 u (both are situated 50 u away from the north/south wall of the inner enclosure)

The dimensions derived from the construction units were identified in the various parts of the layout as above, and it is apparent that the basic framework of each components was designed using this unit. Although the previous researches by Mizoguchi identified the simple dimensions such as 10 times unit length to the full width of each enclosure, the dimensions in Prasat Sambor were not designed by the simple number of units. It is likely that locations of each component were emplaced from the center outward in this temple, and they carefully allocated the necessary religious space and visitor route among each facility. Thereby, the dimensions of the enclosure elements of Prasat Sambor would not be simplified the same as the temple complexes of Angkorian period which were previously studied by Mizoguchi.

As described above, the construction unit of Prasat Sambor was identified as 406.5 mm based on the precise plane survey. The longer dimension six times of the standard unit, 2439 mm, would be used largely for practical planning and construction for the larger scaled temple complex. The unit length 406.5 mm is a similar dimension to the construction unit of 412 mm identified in multiple Angkorian temples. It was estimated that this standard length was authorized from the beginning of the pre-Angkorian period.

5. Conclusion

The temple during the pre-Angkorian period has been appraised as a primitive stage in the long history of classical Angkor architecture by Parmentier, who was the authoritative scholar in archaeological and architectural studies (Parmentier, 1927). Most of the pre-Angkorian temples were simple compositions consisting of a single building. However, current studies revealed that the diverse temple layouts which were developed in the later period were inherited from this earliest stage. In particular, various types of temple complexes were recorded in the royal city of Sambor Prei Kuk.

Within several temple complexes in this ancient city, the three large temples complexes were identified as the significant prototypes for the design and construction of later Khmer temples. These three temples with multiple enclosures have similar layout with multiple shrines and enclosures. However, closer inspection reveals notable differences in terms of the positioning of the central shrine within the enclosure, the design of the central shrine, and position of lateral gopura in the enclosure wall. These features were maintained in the main streams of the architectural lineage of the Angkorian period.

Prasat Sambor, with its layout that distributes symmetry out evenly in four directions from the central shrine which was elevated by central terrace, was the prototype of the pyramidal state-temple of later periods. Prasat Yeai Poeun and Prasat Tao are prototypes of a series of temple designs that extend lengthways to emphasize the frontal perspective and depth of the precinct. This latter series is further divided into two subcategories delineated by the criterion of whether the enclosure walls have lateral gopura. Prasat Yeai Poeun is the prototype of the temple with lateral gopura and Prasat Tao is the temple without lateral gopura. These three temple configurations continued to develop as separate architectural genres for many years until the late Angkorian period when they fused together creating an even more complex design.

These three temples have another difference feature in the layout of the main axis line. The main axis of Prasat Sambor splits the space in enclosures evenly, while the main axis of Prasat Yeai Poeun is offset to the north to create extra space in the southern part of the enclosures, and main axis of Prasat Tao is offset to the south. Asymmetric layout the same as Prasat Yeai Poeun would be commonly seen in many temples in later periods. Prasat Sambor would be designed as the state-temple which is the omphalos of the ruled territory, and the central shrine was constructed at the exact center in the precinct as the symbolic monument of kingdom and rule.

From the enshrined deity statues of several shrines, this state-temple epitomized the representation of integrated Hinduism cosmology, Trimurti; the central area of Prasat Sambor was dedicated to Shiva and his dependents, and a shrine at the south of this temple, N20, was dedicated to Brahma. The enshrined deity at the north, N16, has not been identified, but it was highly possible the house of Vishnu. This state-temple would be the most significant facility for national religious worship, and Hindu deities were gathered here as a pantheon of gods to bestow their blessings across the entire Khmer kingdom. Thus, it was clearly identified the different concept and status between Prasat Sambor and Prasat Yeai Poeun. Under king Isanavarman I the earliest temple complex with multiple enclosures were located in proximity to each other. It is estimated that one was constructed as a state-temple for symbolizing royal authority and the other was constructed as temple to ancestral deities including the king's predecessor and king himself. This functional division would be inherited by the early stage of Angkorian state temples. A prime example of such inheritance is a pair of temples identified as Bakong and Preah Ko in Hariharalaya.

The dimensional analysis revealed that the construction unit of Prasat Sambor was a length of 406.5 mm. This is not too different from the hasta (approximately 412 mm) that was identified in the various temples in the Angkorian period. It also revealed that the dimensions for the various parts of the complex were designed based on a measure amounting to six multiples of 406.5 mm. Furthermore, each component would be placed from the center outward for allocating the necessary space of each facility and route for the religious ceremonies.

An important task for historians of Khmer architecture is to contextualize the developments in temple design within a broad span of history that encompasses pre-Angkorian times to the end of the Angkorian period. A plethora of ruins have been recorded, but owing in part to regional variation in these ruins, it is far from easy to consolidate the information into a linear timeline that shows the phases of development. However, among all the various ruins, the state-temple stands out in that it represents a highly canonical style, one that best exemplified each period. It can therefore be seen that the state-temples were key historical waypoints that help us trace the broad trajectory of this architectural history. Prasat Sambor marked the starting point in this canonical architectural lineage.

As such, the layout of this temple complex became an important template that guided future architectural developments. Therefore, when it comes to the research of Angkorian architecture from perspective points of views, it is essential to include the original composition and appearance of Prasat Sambor. In addition, the comparison analysis between earliest and later state-temples will contribute to our further understand of the chronological and genealogical development of Angkorian architecture.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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