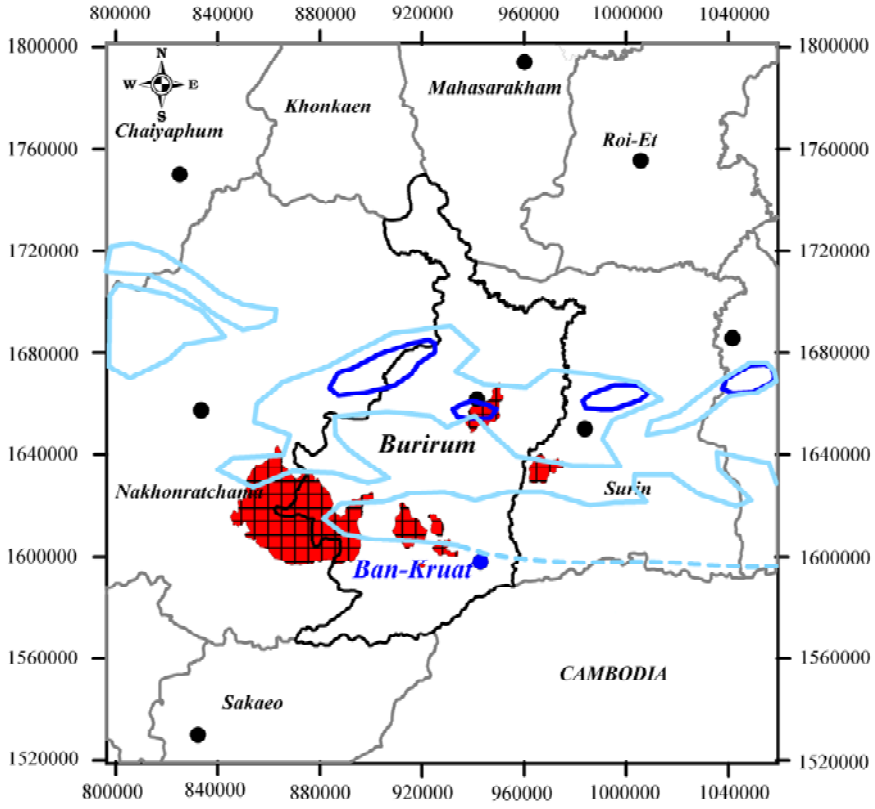
เป็นที่สังเกตว่าในบริเวณพื้นที่ซึ่งปกคลุมด้วยหินบะซอลต์ (bs) เช่น ที่เขากระโดง และเขาพนมรุ้ง สนามแม่เหล็กผิดปกติจะมีค่าต่ำกว่า -136 nT และมีแนวโน้มว่าจะเป็นเช่นนั้นที่ภูพระอังการด้วยแต่ไม่ชัดเจน (รูปที่ 4-16) อย่างไรก็ตามเราอาจสรุปได้ว่าพื้นที่ซึ่งมีค่าสนามแม่เหล็กผิดต่ำกว่า -136 nT สัมพันธ์กับหินบะซอลต์ (bs) หรือหินที่มีค่าสภาพความเป็นแม่เหล็กสูง เช่น ศิลาแลง โดยปกติสภาพความเป็นแม่เหล็กของหินบะซอลต์จะมีพิสัย 0.0002 ถึง 0.175 (SI) และมีค่าเฉลี่ยเท่ากับ 0.07 (SI) ในขณะที่สภาพความเป็นแม่เหล็กของหินตะกอนหรือดินตะกอนจะมีพิสัย 0 ถึง 0.018 (SI) และมีค่าเฉลี่ยเท่ากับ 0.0009 (SI) (Telford et al., 1990) ดังนั้นขอบเขตของหินบะซอลต์หรือหินอื่นที่มีค่าสภาพความเป็นแม่เหล็กสูง เช่น ศิลาแลง สามารถกำหนดได้ด้วยพื้นที่ซึ่งมีค่าสนามแม่เหล็กผิดปกติ ต่ำกว่า -136 nT เช่น เส้นวงปิดสีน้ำเงินในรูปที่ 4-16 เป็นต้น



รูปที่ 4-16 แสดงขอบเขตของบริเวณสนามแม่เหล็กผิดปกติ (วงปิดสีฟ้าและสีน้ำเงิน) และตำแหน่งของหินบะซอลต์

4.2.5 สรุป

การศึกษาด้านธรณีฟิสิกส์ครั้งนี้สามารถกำหนดบริเวณของสนามแม่เหล็กผิดปกติในพื้นที่ศึกษาที่สัมพันธ์กับหินบะซอลต์หรือหินอื่นที่มีค่าสภาพความเป็นแม่เหล็กสูง เช่น ศิลาแลงที่มีปริมาณของเหล็กสูง ผลการศึกษาครั้งนี้ควรได้รับการตรวจสอบยืนยันในสนามต่อไป

บทที่ 5
การพัฒนาสารสนเทศและสารคดีเพื่อการศึกษา

5.1 บทนำ

ในขั้นตอนการสำรวจและการศึกษาในโครงการวิจัยค้นหาและพัฒนาสารสนเทศของราชมรรคาสมัยพระเจ้าชัยวรมันที่ 7 (Living Angkor Road Project) ในระยะที่ 1 นั้นได้มีการเก็บบันทึกภาพการสำรวจในรูปแบบของวิดีโอและภาพนิ่ง อันเป็นผลให้โครงการวิจัยในระยะที่ 2 นี้ได้มีการพัฒนาฐานข้อมูลในระบบมัลติมีเดีย เพื่อให้บริการข้อมูลทางการสำรวจแก่ประชาชนผู้ที่สนใจโครงการฯ ในลักษณะของ Video Streaming บนระบบเครือข่ายอินเทอร์เน็ต

5.2 ความรู้เบื้องต้น

5.2.1 Video Streaming[1]

เป็นการให้บริการข้อมูลในระบบ Digital Video ผ่านเครือข่ายอินเตอร์เน็ต ทำให้ผู้ให้บริการสามารถรองรับการใช้งานของผู้ใช้จำนวนมากเมื่อเทียบกับระบบ Video Conference ตามปกติ และมีการลงทุนน้อยกว่า นอกจากนี้ยังมีความยืดหยุ่นในการใช้งาน สามารถให้บริการได้ทุกที่ที่มีระบบเครือข่ายอินเตอร์เน็ต รวมทั้งอุปกรณ์เคลื่อนที่ทั้งหลาย เช่น โทรศัพท์เคลื่อนที่ เป็นต้น โดยที่ระบบ Video Streaming สามารถที่จะปรับขนาดของการส่งข้อมูลให้เหมาะสมกับความเร็วอินเตอร์เน็ตของผู้ใช้

5.2.1.1 ประเภทการให้บริการวิดีโอผ่านอินเตอร์เน็ต

- แบบ Download ในกรณีที่ Web Server ไม่มี Streaming Server ให้บริการ เมื่อผู้ใช้คลิกหน้าเว็บเพื่อดูวิดีโอ Server จะส่งไฟล์วิดีโอทั้งไฟล์ไปให้กับผู้ใช้ ผู้ใช้ต้องรอจนการ download ข้อมูลสมบูรณ์จึงจะดูได้ วิธีนี้จะมีการเก็บแฟ้มวิดีโอไว้ในเครื่องผู้ใช้ และไม่สามารถดูการถ่ายทอดสดได้

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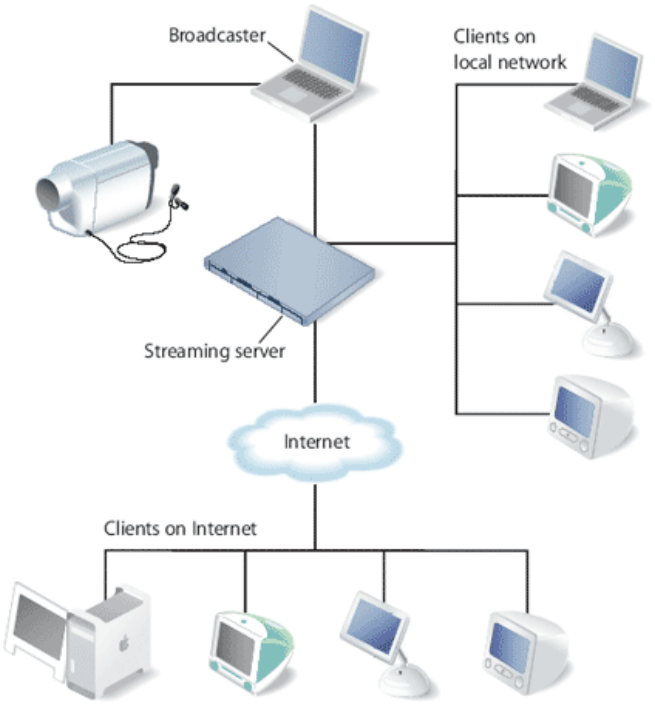
[1] Video Streaming. [ออนไลน์] เข้าถึงได้จาก :
http://r-radio.vec.go.th/htx/rtemplate/doc_news/video_stream.doc
(วันที่ค้นข้อมูล : 10 พฤษภาคม 2550)

- แบบ Video Streaming เป็นแบบที่ Web Server มี Streaming Server การให้บริการแบบนี้ เมื่อผู้ใช้หน้าเว็บแสดงความจำนงที่จะดูวิดีโอ Video Streaming Server ก็จะส่งข้อมูลที่แบ่งออกเป็นชิ้นเล็กๆ พอเหมาะกับความเร็วของอินเตอร์เน็ตของผู้ใช้ไปให้กับผู้ใช้ และเมื่อส่งไปจนเต็ม buffer ของผู้ใช้แล้วก็จะแสดงผลวิดีโอในหน้าจอผู้ใช้ ปกติแล้ว Buffer เป็นการใช้หน่วยความจำขนาดเล็กในการเก็บชิ้นส่วนข้อมูลวิดีโอเพื่อการแสดงผล โดยในขณะที่ผู้ใช้ดูวิดีโออยู่ server ก็จะทยอยส่งข้อมูลให้ไปเรื่อยๆ จนจบ เนื่องจาก buffer มีขนาดเล็ก ดังนั้นวิดีโอที่ server ส่งไปแทบจะแสดงผลทันทีที่ผู้ใช้ขอดู และวิธีนี้จะไม่มีการบันทึกข้อมูลในเครื่องผู้ใช้จึงมีความปลอดภัยมากกว่า



รูปที่ 5-1 ภาพแสดงการทำงานของ Video Streaming Network

ที่มา : http://r-radio.vec.go.th/htx/rtemplate/doc_news/video_stream.doc

5.2.2 Red5

เป็น Open source Flash Server (OSFlash) ซึ่งทำหน้าที่ในการกระจายสัญญาณต่างๆ ทางด้านวิดีโอ เสียง หรือข้อมูล โดยสามารถนำมาพัฒนางานทางด้าน

- Streaming Audio/Video (FLV and MP3)
- Recording Client Streams (FLV only)
- Shared Object

- Live Stream Publishing
- Remoting (AMF)

5.2.3 Flash Video (FLV)

FLV เป็นรูปแบบหนึ่งของไฟล์ Flash ซึ่งใช้สำหรับการทำ Streaming บนเว็บ เพื่อให้การส่งข้อมูลวิดีโอบนระบบอินเตอร์เน็ต ซึ่งในโครงการนี้จะใช้ JW Player (สามารถดาวน์โหลดได้ที่ http://www.jeroenwijering.com) ในการเล่นไฟล์วิดีโอ

ข้อดีของไฟล์วิดีโอในรูปแบบของ Flash คือ สามารถนำมาใช้ร่วมกับ Component ของ Flash รวมทั้งไฟล์ที่ถูกบีบอัดแล้วจะมีขนาดเล็กและยังคงรักษารายละเอียดของไฟล์ต้นฉบับได้เป็นอย่างดี

5.3 แผนการดำเนินงาน

การดำเนินงานเกี่ยวกับการพัฒนาสารสนเทศและสารคดีเพื่อการศึกษานั้น จะแบ่งหัวข้อในการศึกษาออกเป็น 3 ส่วนคือ

- การนำเสนอสารคดีเพื่อการศึกษาผ่านเครือข่ายอินเตอร์เน็ต
- การนำเสนอข้อมูลผ่านทาง e-Learning
- การนำเสนอสารคดีตอนสั้น

5.3.1 การนำเสนอสารคดีเพื่อการศึกษาผ่านเครือข่ายอินเตอร์เน็ต

การนำเสนอสารคดีเพื่อการศึกษาผ่านเครือข่ายอินเตอร์เน็ต โดยการทำ Video streaming นั้นจะแบ่งการทำงานออกเป็น การตัดต่อวิดีโอ และการนำเสนอสารคดีผ่านเครือข่ายอินเตอร์เน็ต

- การตัดต่อวิดีโอ
  - นำวิดีโอการสำรวจทั้งหมดมาจัดแยกออกเป็นหมวดหมู่
  - นำวิดีโอการสำรวจมาจัดเก็บในรูปแบบของไฟล์ดิจิตอล โดยการนำม้วนวิดีโอที่ได้จากการสำรวจมาทำการ capture ในโปรแกรม Adobe Premiere ซึ่งจะได้ไฟล์วิดีโอที่มีนามสกุล wav
  - นำไฟล์วีดีโอที่ได้มาตัดแบ่งตามหัวข้อการสำรวจ โดยการใช้โปรแกรม Adobe Premiere

- นำไฟล์วีดีโอที่แบ่งตามหัวข้อการสำรวจมาจัดการแปลงเป็นไฟล์ flash video ต่อไป

- การแปลงไฟล์ในรูปแบบของ Flash Video
  - เมื่อได้ไฟล์วิดีโอที่ต้องการแล้ว หลังจากนั้นนำไฟล์วิดีโอที่ได้มาแปลงให้อยู่ในรูปแบบของ Flash Video (FLV) เพื่อใช้ในสำหรับการทำ Video Streaming บนเครือข่ายอินเตอร์เน็ต โดยใช้โปรแกรม Cucusoft Ultimate DVD + Video Converter Suite เพื่อแปลงจากไฟล์ในรูปแบบของ wav ไปเป็น flash
  - ข้อดีของการแปลงเป็น Flash Video ก็คือ ขนาดของไฟล์มีขนาดเล็กและยังคงรักษารายละเอียดของไฟล์ต้นฉบับได้เป็นอย่างดี

- การนำเสนอคดีผ่านเครือข่ายอินเตอร์เน็ต
  - รายละเอียดซอฟแวร์

    Web Server
    - Apache Web Server เวอร์ชั่น 2.0.59
    - PHP Script Language เวอร์ชั่น 4.4.7
    - MySQL Database เวอร์ชั่น 5.0.45
    - phpMyAdmin Database Manager เวอร์ชั่น 2.10.2

    Streaming Media Server
    - JDK เวอร์ชั่น 1.6 อัพเดต 6
    - Red5 เวอร์ชั่น 0.6.2 (Streaming Media Server)
    - JW Player

  - ในงานวิจัยนี้จะใช้ RED5 เป็น Streaming Media Server เนื่องจากเป็นโปรแกรมประเภท Open Source Flash Server (OSFlash) ขั้นตอนแรกให้ติดตั้งโปรแกรม JDK ก่อนเมื่อเสร็จแล้วติดตั้ง RED5 สามารถ ดาวน์โหลดโปรแกรมได้ที่ http://www.osflash.org/red5
  - นำไฟล์วิดีโอที่ในรูปแบบของ flash video มาใส่ไว้ในโฟลเดอร์ Red5\ webapps\oflaDemo\streams

- ในการแสดงภาพวิดีโอบนหน้าเว็บเพจให้ใส่ script ดังนี้

```
<div id="container"><a href="http://www.macromedia.com/go/getflashplayer">Get the Flash Player</a> to see this player.</div>
<script type="text/javascript" src="swfobject.js"></script>
<script type="text/javascript">
 var s1 = new SWFObject("mediaplayer.swf","mediaplayer","350","300","8");
 s1.addParam("allowfullscreen","true");
 s1.addVariable("width","350");
 s1.addVariable("height","300");
   s1 . addVariable("file","rtmp://localhost/oflaDemo/larp_video/<?=$_REQUEST[videotype_id];?>/&id=<?=$_REQUEST[video_id];?>.flv");
 s1.write("container");
<script>
```

จากข้อมูล Video Streaming ข้างต้น ในโครงการวิจัยนี้จะใช้การแสดงข้อมูลระบบ Video Streaming Server ให้บริการในลักษณะของ Video on Demand ซึ่งผู้ใช้ไม่จำเป็นต้องบันทึกข้อมูลลงในเครื่อง โดยใน Web Server จะมีการบันทึกไฟล์วิดีโอ (สารคดี) การสำรวจไว้บนเครื่อง Server และให้ผู้ใช้เลือกชมวิดีโอ (สารคดี) การสำรวจที่ต้องการผ่านระบบเครือข่ายอินเตอร์เน็ต ซึ่งสามารถออกแบบระบบฐานข้อมูลในการทำวิจัย ได้ดังต่อไปนี้

ตารางที่ 5-1 ตารางแสดงรายละเอียดฐานข้อมูลภาษาที่ใช้แสดง (Language)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
lang_id	char	2	รหัสภาษาที่แสดง
lang_name	varchar	255	ชื่อภาษาที่แสดง

ตารางที่ 5-2 ตารางแสดงรายละเอียดฐานข้อมูลประเทศ (Country)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
country_name	varchar	255	ชื่อประเทศ

ตารางที่ 5-3 ตารางแสดงรายละเอียดฐานข้อมูลจังหวัด (Province)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
province_name	varchar	255	ชื่อจังหวัด

ตารางที่ 5-4 ตารางแสดงรายละเอียดฐานข้อมูลอำเภอ (District)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
district_id	char	2	รหัสอำเภอ
district_name	varchar	255	ชื่ออำเภอ

ตารางที่ 5-5 ตารางแสดงรายละเอียดฐานข้อมูลตำบล (Commune)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
district_id	char	2	รหัสอำเภอ
commune_id	char	2	รหัสตำบล
commune_name	varchar	255	ชื่อตำบล

ตารางที่ 5-6 ตารางแสดงประเภทของข้อมูลวัฒนธรรม (CultureType)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
culturetype_id	char	2	รหัสประเภทของข้อมูลวัฒนธรรม
lang_id	char	2	รหัสภาษาที่แสดง
culturetype_name	varchar	255	ชื่อประเภทของข้อมูลวัฒนธรรม ภาษาอังกฤษ

ตารางที่ 5-7 ตารางแสดงข้อมูลทางวัฒนธรรม (Culture)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
culture_type	char	2	รหัสประเภทข้อมูลวัฒนธรรม
culture_id	char	2	รหัสข้อมูลวัฒนธรรม
culture_name	varchar	255	ชื่อข้อมูลวัฒนธรรม
culture_detail	text		รายละเอียดข้อมูลวัฒนธรรม
culture_ref	varchar	255	อ้างอิง

ตารางที่ 5-8 ตารางแสดงข้อมูลภาพ (Filelist)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
culture_type	char	2	รหัสประเภทข้อมูลวัฒนธรรม
culture_id	char	3	รหัสข้อมูลวัฒนธรรม
file_id	char	2	รหัสรูปภาพ
file_filename	varchar	255	ชื่อไฟล์
file_detail	text		คำอธิบายไฟล์

ตารางที่ 5-9 ตารางแสดงฐานข้อมูลวัฒนธรรมของประเทศกัมพูชา (cCulture)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
culture_type	char	2	รหัสประเภทข้อมูลวัฒนธรรม
culture_id	char	3	รหัสข้อมูลวัฒนธรรม
culture_name	varchar	255	ชื่อข้อมูลวัฒนธรรม
culture_detail	text		รายละเอียดข้อมูลวัฒนธรรม

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
culture_ref	varchar	255	อ้างอิง

ตารางที่ 5-10 ตารางแสดงรายละเอียดฐานข้อมูลหมู่บ้าน (Village)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
district_id	char	2	รหัสอำเภอ
commune_id	char	2	รหัสตำบล
village_id	char	2	รหัสหมู่บ้าน
village_name	varchar	255	ชื่อหมู่บ้าน

ตารางที่ 5-11 ตารางแสดงรายละเอียดฐานข้อมูลหัวข้อข้อมูลการสำรวจ (Villagetype)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
vtype_id	char	2	รหัสหัวข้อในการสำรวจ
lang_id	char	2	รหัสภาษาที่แสดง
vtype_name	varchar	150	ชื่อหัวข้อในการสำรวจ

ตารางที่ 5-12 ตารางแสดงรายละเอียดฐานข้อมูลการสำรวจหมู่บ้าน (Village_survey)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
district_id	char	2	รหัสอำเภอ
commune_id	char	2	รหัสตำบล
village_id	char	2	รหัสหมู่บ้าน
vtype_id	char	2	รหัสหัวข้อในการสำรวจ
village_name	varchar	255	ชื่อหมู่บ้าน

ตารางที่ 5-13 ตารางแสดงรายละเอียดฐานข้อมูลรูปภาพจากการสำรวจ (Village_gallery)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
province_id	char	2	รหัสจังหวัด
district_id	char	2	รหัสอำเภอ
commune_id	char	2	รหัสตำบล
village_id	char	2	รหัสหมู่บ้าน
culture_id	char	3	รหัสข้อมูลวัฒนธรรม
file_id	char	2	รหัสหัวข้อในการสำรวจ
filename_name	varchar	255	ชื่อไฟล์รูปภาพ

ตารางที่ 5-14 ตารางแสดงฐานข้อมูลจากการสถานที่จากการสำรวจของหมู่บ้าน (vCulture)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
country_id	char	2	รหัสประเทศ
lang_id	char	2	รหัสภาษาที่แสดง
province_id	char	2	รหัสจังหวัด
district_id	char	2	รหัสอำเภอ
commune_id	char	2	รหัสตำบล
village_id	char	2	รหัสหมู่บ้าน
culture_id	char	3	รหัสข้อมูลวัฒนธรรม
culture_name	varchar	255	ชื่อข้อมูลวัฒนธรรม
culture_type	char	50	ชนิดของข้อมูล
culture_detail	text		รายละเอียดข้อมูลวัฒนธรรม

ตารางที่ 5-15 ตารางแสดงฐานข้อมูลหมวดหมู่ในการจำแนกวิดีโอ (video_type)

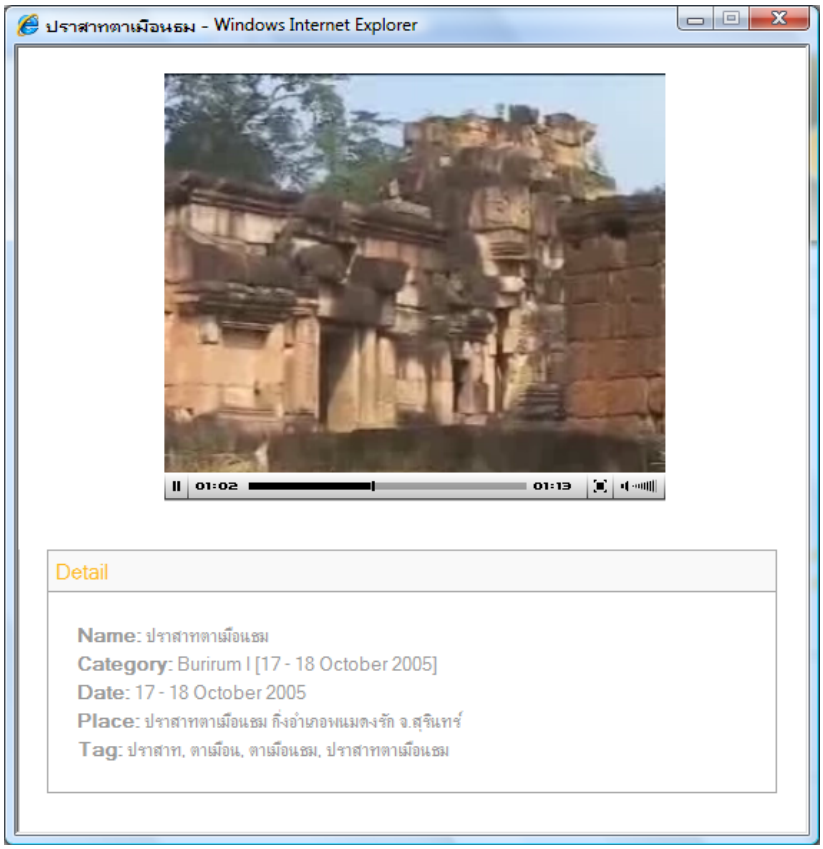
ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
videotype_id	char	3	รหัสหมวดหมู่ของวิดีโอ
videotype_name	varchar	255	ชื่อหมวดหมู่ของวิดีโอ

ตารางที่ 5-16 ตารางแสดงฐานข้อมูลการจัดเก็บไฟล์วีดีโอ (video)

ชื่อฟิลด์	ชนิดข้อมูล	ขนาดข้อมูล	คำอธิบาย
videotype_id	char	3	รหัสหมวดหมู่ของวิดีโอ
video_id	char	2	รหัสวิดีโอ
video_name	varchar	255	รหัสภาษาที่แสดง
video_date	varchar	50	รหัสจังหวัด
video_file	varchar	50	รหัสอำเภอ
video_place	varchar	255	รหัสตำบล
video_tag	varchar	255	รหัสหมู่บ้าน

รูปที่ 5-2 หน้าเว็บเพจแสดงรายชื่อวิดีโอ

รูปที่ 5-3 ภาพเว็บเพจเมื่อเลือกหัวข้อ “Burirum I [17-18 October 2005]”

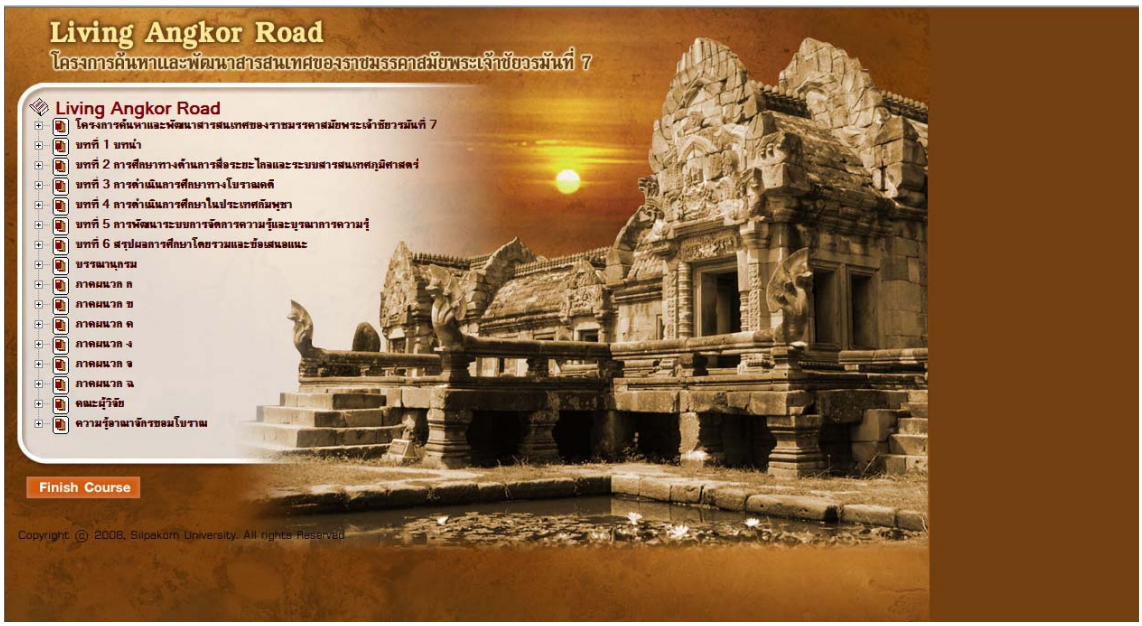


รูปที่ 5-4 ภาพแสดงวิดีโอบนหน้าเว็บเพจ

5.3.2 การนำเสนอข้อมูลผ่านทาง e-Learning

ในส่วนนี้เป็นการนำเอารายงานการวิจัย “โครงการวิจัยค้นหาและพัฒนาสารสนเทศของราช-มรรคาสมัยพระเจ้าชัยวรมันที่ 7 (Living Angkor Road Project) ระยะที่ 1” มาจัดทำใหม่ในลักษณะของสื่อการเรียนรู้ หรือที่เรียกว่า e-Learning เพื่อเผยแพร่งานวิจัยให้ประชาชนทั่วไปหรือบุคคลที่สนใจได้เข้าใจถึงเนื้อหาของเอกสาร การทำ e-Learning มีขั้นตอนการทำ ดังนี้

- การเก็บข้อมูล ข้อมูลที่นำมาใช้ได้มาจาก “เอกสารรายงานการวิจัยฉบับสมบูรณ์ของโครงการวิจัยฯ” และข้อมูล “ความรู้อาณาจักรขอมโบราณ” ประกอบกับรูปถ่ายทางวัฒนธรรมและทางโบราณคดี
- นำข้อมูลที่ได้มาวิเคราะห์เพื่อสร้าง Story Board ประกอบด้วยเนื้อหา ดังนี้
  - ลักษณะรูปแบบการนำเสนอ
  - หัวข้อที่ใช้ในการนำเสนอ
  - การเชื่อมโยงไปยังข้อมูล รูปภาพ หรือเว็บไซต์
- สร้าง Template ของ Background
- นำข้อมูลจากเอกสารมาจัดวางตาม story board
- ทดสอบการใช้งาน



รูปที่ 5-5 แสดงระบบ e-Learning ของโครงการฯ ระยะที่ 1

รูปที่ 5-6 แสดงระบบ e-Learning ของโครงการฯ ระยะที่ 1 (ต่อ)

รูปที่ 5-7 แสดงระบบ e-Learning ของโครงการฯ ระยะที่ 1 ในส่วนของบทคัดย่อ

5.3.3 การนำเสนอสารคดีตอนสั้น

จุดประสงค์ในการทำสารคดีตอนสั้น เพื่อเผยแพร่ข้อมูลเกี่ยวกับการดำเนินงานวิจัยของโครงการฯ ต่อประชาชนและบุคคลที่สนใจได้เข้าใจถึงความเป็นมา เนื้อหา การเชื่อมโยงกันของแต่ละสถานที่ การนำความรู้ในหลายๆแขนงมาประยุกต์ใช้ร่วมกัน และขั้นตอนการดำเนินงานวิจัยโดยผ่านทางวิดีโอสารคดี โดยมีขั้นตอนการดำเนินงาน ดังนี้

- จัดทำบทสารคดีที่มีเนื้อหาครอบคลุมงานวิจัย
- นำบทสารคดีที่ได้มาจัดแบ่งเป็นหมวดย่อยเพื่อใช้ในการทำ story board
- วางแผนและจัดหาภาพวิดีโอการสำรวจทั้งภาพเคลื่อนไหว ภาพถ่ายและดนตรีที่สอดคล้องกับ เนื้อหาใน story board
- จัดการลำดับภาพ, ตัดต่อภาพและบันทึกเสียงตามเนื้อหาใน story board
- นำสารคดีที่ได้มาตรวจสอบความเรียบร้อยก่อนนำเสนอผ่านเครือข่าย Internet

5.4 ผลการดำเนินงาน

จากการดำเนินการงาน ทำให้ได้ระบบพัฒนาฐานข้อมูลวัฒนธรรมซึ่งแบ่งออกเป็น 2 ส่วน คือ

5.4.1 ฐานข้อมูลวัฒนธรรมในส่วนของ Video Streaming บนเครือข่ายอินเตอร์เน็ต ซึ่งจะมีรายละเอียดดังต่อไปนี้

- วีดีโอการออกสำรวจภาคสนาม การขุดค้นทางโบราณคดี และการสำรวจทางธรณีฟิสิกส์
- วีดีโอการบรรยายในส่วนของ Tele conference ของโครงการวิจัยจากหลุมขุดค้นทางโบราณคดีไปยังต่างประเทศ
- วีดีโอการบรรยายสัมมนางานวิจัยที่สำนักงานกองทุนสนับสนุนการวิจัย (สกว.) จัดขึ้น
- วีดีโอการบรรยายสรุปโครงการวิจัยต่อคณะสื่อมวลชน เจ้าหน้าที่ของ สกว. และ ผู้ที่สนใจ
- วีดีโอการจัดงานโครงการสืบสานวัฒนธรรมไทย - กัมพูชา ตามแนวเส้นทางโบราณจากเมืองพระนครถึงเมืองพิมาย
- วีดีโอสารคดีของโครงการวิจัยโดยสรุป

5.4.2 ฐานข้อมูลวัฒนธรรมในส่วนของ e-learning

- อธิบายรายละเอียดของโครงการวิจัย
- อธิบายขั้นตอนและวิธีการทำงานวิจัยในส่วนต่างๆ เช่น การขุดค้นทางโบราณคดี การสำรวจทางธรณีฟิสิกส์ เป็นต้น
- รายงานผลที่ได้จากการสำรวจต่างๆ
- เป็นสื่อการเรียนรู้ในเรื่องของอาณาจักรขอมโบราณ

5.5 สรุป

ในส่วนของการพัฒนาสารสนเทศและสารคดีเพื่อการศึกษานั้น จะเน้นในเรื่องการเผยแพร่ข้อมูลความรู้ ขั้นตอนวิธีการในการทำงานวิจัยชิ้นนี้ผ่านทางระบบเครือข่ายอินเตอร์เน็ตในรูปแบบของ Video Streaming และสื่อการเรียนรู้ e-learning ซึ่งผู้ที่สนใจสามารถศึกษาถึงรายละเอียดของโครงการ วิธีการสำรวจ วิธีการวิเคราะห์ผลที่ได้จากการสำรวจนั้น รวมถึงการใช้ความรู้ในหลายแขนงๆ มาวิเคราะห์ผลที่ได้

บทที่ 6
รายงานการวิจัยจากทีมวิจัยกัมพูชา

6.1 Introduction

It is a study on historic roadway, communication links and human settlement of Khmer Empire from Angkor to Phimai. The research work had been conducted along the axes in Cambodian side for more than hundred kilometers. The archaeological and ethnographical are systematically surveyed by the Cambodian team. The cultural data collection from the study is certainly the most valuable information for the current study and for future research work on the region. The Advance Technologies are also applied in the field research for collecting and analyzing archaeological and cultural information.

6.1.1 Objectives

The research work aims to identify communication network, human settlement structures along the ancient road and ancient manmade structures along the axes: stone bridges, rest-houses which Louis Finot (1925) supposed to be called *Dharmashala*, hospitals written in Ta Phrom's inscription as *Arogyashala*, ancient agglomerations/communities, water structures, water works, etc. The results from this integrated studies revealed the knowledge about this ancient road in the form of physical evident, geographic property, and archaeological information of the ancient road and its surrounding area.

6.1.2 Data Resources

The studies based on existing resources as following:

- **Ancient written texts**: inscriptions mainly Sdok Kak Thom, 11th century and Preah Khan, 12th century. The first one has also written about the territory and public infrastructure development to west region of Angkor. The second is most important information which mentioned about the "rest-houses" built along the roads from capital city Angkor linked to provincial cities and neighboring kingdoms, particularly, the building along the royal road from Angkor to Phimai.

- **Chinese records of Tcheou Ta-Kouan**: a Chinese envoy to Angkor Royal Court in late 13th century who recorded Khmer daily life, royal court, infrastructure, etc.

- **Archaeological remains** are the most important resources of the study: vestige of roads which are mostly still visible in Cambodian side, stone bridges, water structures, building of rest-houses, chapel of hospitals, temples, ancient agglomerations, etc...

- **Old maps**: different old maps drawn by French dated from late 19th century (Bastian, Aymonier, etc.), early 20th century (Lunet de Lajonquère) and following until current date (see more detail at Remote Sensing and GIS survey).

- **Remote Sensing**: old aerial photos taken by French in 1930's, 1940's, 1950's, 1990's and 2000's. Satellite images (Spot, Landsat, Ikonos, etc...) are also used for this study. This will develop in detail at Remote Sensing and GIS study as below.

6.1.3 Methodology/Research Approach

The study is primarily based on three main approaches: archaeological survey, anthropological survey and remote sensing and GIS survey. The archaeological and anthropological surveys are based on data-collection form that was developed out of earlier studies conducted by the APSARA Research Unit. The APSARA team has developed this survey form and trained its members in its use to collect archaeological and cultural data from the fields. Four local people from each village are selected for interviewing: the village's chief or his deputy, a senior citizen, a monk or a spiritual leader of the village.

The Archaeological Research Form consists of five main points:

- **Location of the site**: its UTM and where is it located in village, commune, district and province; and its orientation?

- **Archaeological Typology**: Was it a temple, water structure, dike, ceramic kiln, metallic site, mound, road, bridge?

- **Archaeological Structure**, its layout, its art style

- **Inventory number**: old and new number will be marked on each site

- **Current Status**: Is it in good, fair, threat, looting, and vandalism condition?

The Cultural Research Form consists of five main points:

- **Geography and Statistics:** the location of the village, its UTM, heritage protected zone, data collection date and a brief description.

- **Village Location and its Structure**: for example, whether on an ancient man-made structure, a dike of a water reservoir, a road or an ancient site. Some villages preserve a traditional layout, concentrated around a central point.

- **Village Infrastructures:** the village may be characterised by its own infrastructures which could be classified as: Familial; Public; Ancient; Religious; Education and Health.

- **Customs and Belief:** This is a significant component of the data form and aims to collect comprehensive information about the traditions associated with each of the Khmer villages. We are surveying two main aspects: the first is concerned with *rites of passage*, and with rituals associated with a fixed annual calendar or with special occasions (which can occur at any time). *Rites of passage* are special events in an individual's life and are an ancient tradition of the region (Ang 2007). Rituals that are associated with particular set dates encompass a series of ceremonies that occur throughout the traditional yearly calendar. These are complemented by rituals that can be performed at any time of the year – they are usually held to coincide with an auspicious time, as identified by the officiant. The second aspect is concerned with customs and performing arts, which are also considered to have a ritual component, and which contribute as part of collective events such as dances and theatre.

- **Economic Resources:** we did a very quick survey regarding the economic activities within each village. The resources can be traditional crafts and handicraft production; agricultural production; basket, mat and broom dressing; weaving; alcohol production from rice or sugar palm, and foods.

6.1.4 Task Works

For the phase I, we designed a working zone for the field research which is covered 2km away to each side from the supposed axes. That field survey covered on area of 4km wide by 125km long from Angkor to the current borders of both countries. This zoning preliminarily includes 54 villages of the 8 districts and of the 2 provinces, Siem Reap and Uddor Meanchey. Four phase works of the ground operation have been successively taken place in the field due to

geographical condition of regions and seasons (Fig. 6-1). The ground operation has been taken from its departure of road at Angkor Thom to Prasat Ta Mean at border for more than 18 months.

Following up the previous phase, the Phase II of the Project is formally designed into six step works as below:

- Continuing the ground survey at the border region, Prey Veng village, Udor Meanchey Province. The survey will be used archaeological and cultural anthropological approaches.

- Mapping of an ancient provincial city which presently named "Kol Village" where situated close to the Royal Road. This is a study of an ancient city structure which composed ancient temples dated different periods, chapel of hospital, rest-house, stone bridges and water structures.

- Cross Section of Royal Road and Analyzing its Structure

- Ceramic Studies, physical and scientific analyzing

- Archaeological and Cultural studies and Analysis the data collected

- GIS Analysis from data collection for better understanding the ancient structures situated along the road axis.

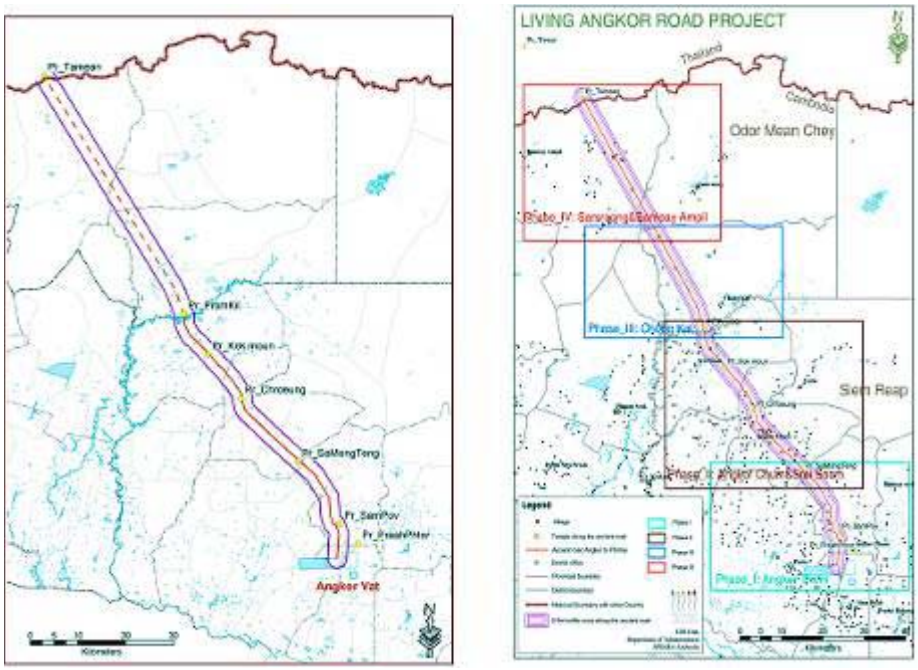


Fig. 6-1 Field Work Plan

6.2 Cultural Study

This is a Socio historic study conducted on communities living along the Royal Road in Cambodia and Thailand sides. The ethnographic survey has consisted of two sub-phases: Location of all communities living along royal road, and field survey to each community that has relation with the royal road, i.e. the community that has exist for long period of time, not newly established, with the buffer zone of 2 km. from each side of the predicted location of the royal road (4 km. buffer zone).

6.2.1 Development on Existing Cultural Research Form

LARP has developed from the existing Cultural Research Form which created by APSARA's Cultural Studies Unit, and translated it into English. The summary of the Research Form's Structure:

a- Location & Statistics:

- Village code #; Village; Commune; District; Province
- UTM; Data collected / Updated
- Location (Map)
- Statistics: Year; Houses; Families; Population; Males; Females
- Location’s brief description

b- Infrastructures:

- Familial: Well; Pond and other water reservoir; Pipe; rivulet
- Public: Road, trail, path; Bridge; Well; Pond and other water reservoir; Pipe; rivulet
- Ancient: Temples; Ancient structure; Road, trail, path; Bridge; Pond and other water reservoir; Pipe, rivulet
- Religious: Buddhist monastery; Rest-house; Spirit’s hut
- Education: Nursery, primary school; Secondary school; Junior high school; Monastery school

- Health: Health center; Mobile health unit; Medium (spirit possession); (Traditional) midwife; (Traditional) healer

c- Resources:

- Agriculture:
  - . Rice-field:
    - . Irrigated rice-field
    - . Dry season rice-field
    - . Slash-and-burnt rice-field
    - . Receding rice-field
    - .Water-mounting rice-field
  - . Other cultures:
    - . Sugar-palm trees
    - . Fruit trees
    - . Vegetables
    - . Plantation, orchard
  - . Animal breeding:
    - . Familial consumption
    - . Commercial
- Fishing: Fishing concession; Fishermen community; other
- Services: Labour; Commerce; Public administration; Private sector; personnel; Other
- Supplementary incomes: Natural resources; Crafts; Other

d- Traditions and Beliefs:

- Types of ceremonies:
  - . With fixed dates
  - . With no fixed dates
  - . Rites of passage
  - . Other Customs
- Ceremony code #

- Number of images
- Ceremony's name ; Data collected in
- Short description; Recording
- Detailed description

6.2.2 Field Survey on Villages situated along the Royal Road

The survey has been done during nearly two years on communities living within the zoning along royal road. There are 54 villages found situated in the zoning study along the axes where located in eight different districts of two provinces, Siem Reap and Udor Meanchey. 39 villages situated in 5 different districts in Siem Reap province where there are 4 villages located in World Heritage site Angkor. 15 villages situated in 3 different districts in Uddor Meanchey province.

6.2.2.1 Findings of the Survey

*** Village Location and Structure**

Most of the village settlements are often associated with ancient occupancies that date back to different periods of Cambodian history. As a result, the structure of each village has accrued its own character and value. Some villages reflect the discernible ancient landscape along the historic road, and continue to use the road as a central feature and communication arterial. Some villages exist harmoniously with nearby ancient temples or Buddhist monasteries, for example *Nokor Krao, Nokor Pheas, Kol, Kok Spean* villages. Several villages are significant for their relationship with ancient water structures or irrigation systems. These include *Kandol, Srah, Loboek, Tonle Sar* villages, etc. Others are distinguished as a result of their settlement within Angkorian industry nodes, such as the ceramics production centre: for example *Khnar, Srah Srang, Prei, Prey Veng* villages.

These villages have gradually developed in a cluster around a central Buddhist monastery, most of them built on an ancient temple or ancient structure. The villages are surrounded by rice fields, vegetation or the forest of their communities. Some villages are isolated

from other by rice fields. The seasonal changes reflected in the surrounding landscape also act to create a changing environment.

The settlement histories and stories of the villages are often reflected in their names. Several villages share a popular tale, which they consider to be a common history that creates a linkage between their communities. Another historical theme relates to the first man who came and cleared land for developing that community (e.g. *Tasom, Don miev,* etc). Other villages have histories relating to natural, cultural or historical events of the region (*Nokor Krao, Nokor Pheas, Chum Nom Reach*, etc). Most stories of this type relate to nature and are concerned with a specific plant grown in the area (*Ta Trao, Kok Beng, Khchas, Makak*). Most of these histories can probably be dated to after the fall of Angkor. They have been told from one generation to the next and exist primarily as oral traditions, although a few stories have been published.

*** Village Landscape**

A variety of village landscapes have been identified on the basis of their settlement structure and environment. Many villages are situated on ancient infrastructure (for example, dikes, water structures, ancient roads), and reflect one set of changing environments. Other villages are found close to ancient temples or clustered around a temple, which gives a different character to the village landscape.

The village landscape reflects the different seasonal changes. The rainy season in particular can give much beauty to villages surrounded by rice paddy and seasonal vegetation. At this time of year the villagers are all busy with agricultural work, and their activities can be observed from dawn until night during half the year.

The traditional house is built on stilts, where people live upstairs and animals (such as a cow) are stabled underneath with an ox-cart. Houses are surrounded by a natural fence of small trees (sometimes fruit trees or medicinal trees) or different kinds of flowering plants. The roof is covered by traditional ceramic tiles, usually in a brown colour. Some households have a small garden around the house; a water pond is often found in front of the house. In some places, rice fields are situated next to or in front of the house.

*** Tradition and belief**

Some main traditional and ceremonial events have been identified in most of 54 villages in Cambodia and some villages investigated during short survey in Buriram and Surin, Thailand. As mentioned above, there are two main categories of ceremony. The first is concerned with *Rites of Passage*, and with rituals associated with either the fixed ceremonial calendar or with special occasions (which can occur at any time). The second aspect is concerned with customs and performing arts, which are also considered to have a ritual component, and which contribute as part of collective events (Ang 2007 & Im 2008b).

Rites of Passage encompass a series of ritual practices performed through a circle of an individual's life, from the stage of new birth to death: they are manifest in eight different rituals (Ang 2007 & Im 2008b). This series of rituals can be summarised and literally translated in English as the following:

a- Ritual concerning Birth *Kat Sak Bankok Chmob* or *Sray Khsae Tanlak Chankran* is performed a few days after delivery, and aims for the recognition by the community of the newborn, to pass on the family's gratitude to the midwife, and to drive away any misfortunes in that future that may be caused by the mother's blood during delivery, which is considered to be unclean. The Midwife has ritually shaped the newborn to make the baby into a new human being of our world. This ritual is performed throughout all along the *Royal Road villages* in Cambodia, and some Buriam and Surin villages situated close to the border.

b- Keeping and Cutting of the Topknot *Kor Chuk* or *Kat Sak* marks the human age of pre-adolescence. Traditionally a child in a family is made to grow a long central tuft of hair, often from birth. Around the age of 13, and always at an odd-numbered age, a ceremony is performed symbolising the passage into puberty – and rivalling the marriage ceremony in importance – during which the tuft is removed. The ritual is still practised in a large number of *Royal Road villages* and very few found in Buriram and Surin within the zoning study.

c- Buddhist monk Ordination *Bous Neak* for a male celebrates a new step of life to the study age. Young adult men prepare for ordination as novices in the Buddhist order. These events are also observed commonly in the *Royal Road villages*, but not for all young men. For a girl of

this life stage, there is a ritual called *Mlob* (literally meaning 'entering to shadow'). The girl stays inside her room for a period of time and is banned from talking with strangers or with a man. She learns from an old woman sage how to be a good housewife. This ceremony is no longer practised in the villages inside zoning study, but it still survives in a few villages of the Siem Reap region, Kompong Thom, Kompong Cham, Koh Kong.

d- Marriage *Reap Kar* is a conjugal step between a man and a girl who has passed through the adolescence step of life. There is a diversity of ritual during marriage events noted in the *Royal Road villages*. While the concept and objective of the ceremony is the same from one village to another, the form of the ritual is usually slightly different. We have no information from Buriram and Surin.

e- Ritual concerning delivery which marks the transition from a housewife to being a mother. The ritual is practised across the whole *Royal Road villages*.

f- The ceremony of Prolongation of Life has several names: *Chansok Kiri Sout, Chhark Toch, Chhark Thom* or *Chhark Maha Bangsakol, Tor Ayuk,* etc. The ritual practices are associated with elderly people. The ceremony aims to prolong the life of the person concerned, by simulating a cycle of death–gestation–rebirth. Meditation is practised by the elderly, notably older women, to assist the mediator to envisage his or her own self as a corpse, presumably in preparation for death. The ritual is widely practised in the *Royal Road villages*.

g- Funerary rite *Bochea Sap* or *Chamroeun Phloeung* or *Banches Bukul* is composed of three major ceremonial components: First burial, Exhumation and Definitive burial. The two major ritual components are exhumation followed by cremation of the remains. The rite is still practised in many *Royal Road villages*, mostly in the villages situated in Siem Reap province.

h- Burying of the ashes from incineration *Banchus Theat* is the final stage of the human life circle. This is a testimony to the continuation of an ancient tradition in the villages of Siem Reap province.

The Ceremonies of the fixed annual calendar can be observed as the following: *Traditional Ceremonies over twelve months* as written in the traditional calendar; *Agrarian rites*, and *Practices of Animism* – a homage to *Neak Ta*, an important spiritual village protector (see detail Ang 2000).

The traditional ceremonies over the calendar period are performed similarly elsewhere in the Kingdom. The difference lies in the way the ceremony is practised from one place to another.

The Ceremony of homage to *Neak Ta* is widely performed in every village along the Royal Road and in Buriram and Surin within the zoning study.

Agrarian rites are the most practised in the *Royal Road villages*. This reflects the importance of agriculture as the main economic activity of the region. A series of rituals concerning rice paddy celebrates the beginning of the agriculture season through to the time the rice is stored. The agriculture season commences after the *Royal Ploughing Ceremony*, which is conducted by the King or his representative.

Ceremonies that are not tied into specific calendar events include those that are observed in the ritual of inauguration of a *Vihara*, Buddhist monastery, or any public building; rituals relating to the asking for rain; rituals to divert misfortune in a family or village or community; rituals at the beginning of house construction and house warming. This series of ceremonies is also widely performed throughout the region. Any ritual of this type can be performed on an auspicious date, determined by the officiant.

*** Customs:**

The kinds of performing arts that are considered to be of a ritual nature have contributed as a part to various collective events. Popular dances are indigenous forms relating to the chasing of evil, bad spirits and wild animals that can provoke misfortune over the communities. *Trot* is performed only during the New Year celebration for chasing away bad luck, misfortune and for begging the rain. *Tug-of-war* is also played during the New Year Day celebrations. The aim of the latter is to ensure rain for the coming agriculture season (Im 2008b).

*** Economic Resources:**

The *Royal Road villages* stretch along the road from the downstream plain on the south toward the Dang Rek Range on the north, which covers an area of several thousand square kilometres. Based on geographical and environmental factors in the context of a long history of human occupancy, the region can be distinguished by several types of village community. Each type occupies one of the main ecological sub-zones of the region and is differentiated by socio-cultural characteristics (Ang 1995).

These communities consist basically of traditional subsistence rice farmers whose livelihood principally depends on one crop a year of rain-fed or irrigated rice paddy. In addition to the paddy, the population cultivates fields prepared by slash and burn techniques where they grow rice and other vegetables.

Typically, a number of traditional varieties of rice are grown. Each variety is adapted to different soil types and, particularly, to differing water conditions. Traditional farming techniques are used, such as the swing plow pulled by oxen or buffalo. Up to the north region, each family generally cultivates a field prepared by slash and burn techniques, where rice and many vegetables are grown.

The daily life of the Khmer villages has not changed considerably. Traditional crafts, such as weaving, are still practised in the village. Other activities include basket, mat and natural broom dressing; weaving silk or cotton; ox-cart production, and alcohol making.

6.2.2.2 Discussion on Cultural Study

Most of the village settlements are often associated with ancient occupancies that date back to different periods of Cambodian history. These villages have always been a spiritual landscape, inhabited by protector spirits, *Neak Ta* who live in temples and villages. The veneration of a god, Buddha or *Neak Ta* is a central element in the retention of village identity and memory of the Khmer people. Hindu gods and other element of ancient structures all also have spiritual power. Natural stones and Hindu or Buddhist icons have been appropriated as the embodiment of certain *Neak Ta* (Ang 2000 & Im 2008b).

Praying to the Hindu or Buddhist gods and the N*eak Ta*, and organising ceremonies and rituals is a continuing practice that reinforces both the sacred landscape and community identity.

Within the landscape, certain 'special' places are commemorated through ritual, and their importance remembered and passed on within and between village communities (Im 2008b).

Myths and legends and oral histories commonly reflect collective knowledge and can be derived from historical memory, myth, legends, folktales and beliefs. Through these surveys, there are a number of myths that serve to reinforce our understanding for the future studies, and of course, elaborate local understandings of the sacredness of certain sites, linking elements in the stories to local practices (Im 2008b).

Royal Road communities are continuing of living in the same spaces, within which there are inherited memories of ancestors' experiences and beliefs, overlain with the new generation's memories and experiences – and these all remain closely associated with particular places and localities within the wider landscape. Continuing practices also include story-telling, playing New Year games, dances, music and theatre.

Temples, ancient roads, bridges, forests, and the rice fields, lakes and ponds, have the names of ancestors attached to them or are surrounded by legends remains as important landmarks for local people. The names of villages are similarly reflective of local and natural elements and markers, or of shared history with other villages[1].

A word to confirm that, what we found from Cultural Studies, is well matching with the title given to this research project as "Living Angkor Road". A significant outcome of this project is that it reinforces the research from a number of other projects supporting a historical continuity in various community traditions and practices. This is important in understanding the wider heritage significance of Ankorian Civilization. While contemporary practices and ways of life are themselves an important component of the heritage of the region, it is equally significant that these maintain connectivity with the past and with the Khmer civilisation. *Preah Kunlong* is the home of multiple village communities which are considered also as *living heritage* in the sense that the village way of life itself – although constantly evolving and changing – reflects a continuation of practices, beliefs and traditions.

[1] see Im 2008b

6.2.3 *Kuy* Study

During the intensive cultural survey in both sides Cambodia and Thailand, we have found a huge interesting information regarding a strong connection between Khmer and ethnic *Kuy* communities. But this is not a new discovery. The relationship was generally studied by scholars on the field of Khmer Study. For LARP, this is extremely important information and new perspective for studying on a culture which is on the way to lose for ever: *Elephant Hunting* and *Iron Smelting*.

Of course, there are many ethnic *Kuy* communities settled in Cambodia and Thailand. But this study has mainly made on two communities: Hunting Elephant and Metallic production communities which their settlement some situated along the road and other parts of the countries. The survey is not focus only to the subjects regarding Hunting Elephant or Iron Smelting stories, but their tradition and customs are very important information to be studied as well.

6.2.3.1 Findings of the Survey

a. Hunting Elephant Communities[2], *Kuy Damrei*

Several surveys have been conducted inside Cambodia at Srae Noy *in* Siem Reap province and at Samrong, Udor Meanchey province, and others inside Thailand at Ban Taklang and Ban Dong Bang, Surin. We found these communities are relative and still in contact each others. The great elephant hunter, *Mho Kamloung* named *Mho Mak*, great elephant hunter at Ban Taklang is cousin of the *Mho Kamloung* named *Mho Tha*, 92 years old (at the date of interview 2007), living here in Srae Noy. And *Mho Tha* is close friend with *Mho Kamloung* named *Mho Keo* at Ban Dong Bang.

Kuy communities at Samrong, Uddor Meanchey province, and at Srae Noy are recognized by authority as Cambodian nationality and legally settled on their land. Through interview with old generation, we are told that they were migrated down from Surin and Burirum

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[2] Actually, there was not only ethnic Kuy who was skill in hunting elephant and was an ethnic group of elephant hunter. But Laotian, Khmer and many other ethnics settled in Cambodia, Laos, Vietnam and Thailand were also known as elephant hunter. Here the study aims to find relationship between this ethnic and Khmer regarding the Royal Road.

to Cambodia roughly in second quarter of 20th century for seeking land for agriculture and elephants.

Through several interviews conducted in Cambodia and Thailand, we learnt that previously, there was no administrative boundary. They could freely go down and go up beyond the chain of Dangrek range. And even in our modern day, from time to time, they pass through the current administrative border for seeing their relatives here and there. This means the circulation space of these communities are free of limit. Their destinies are linked, certainly lasted very long time ago (Fig. 6-2).

b- Metallic Making Communities, *Kuy Dek*[3]

Eight iron smelting sites are found along the axis and at two huge sites situated close to road at Uddor Meanchey. And 67 sites are identified in Thailand. None of local people living on sites or close to the sites remembered about this work. Once we asked Khmer at Ban Kruad and here in Cambodia, they said: It was *Kuy* who was skill to smelt and to produce the metal. With this reason and based on the previous studies, leading us to go further in search on Iron Smelting history.

With kindly supporting from our Thai partner, we went to Chomprak. We met with an Kuy family who is a black smith. When we asked him about the smelting history. He said, the ancient time was Khmer and *Kuy* who did the smelting. No body remembers how to smelt any more. But, he knows how to produce different kind of tools from metal/iron. Two kinds of tools which he is currently still producing are: a kind of sword and knives (such cutting tools using in daily life). This is very important thing to learn. The forms of these tools supposedly look similar to what sculpted on temple walls. But, this needs to do check and more work.

We conducted seven field researches into four different Kuy settlements located in Cambodia. These settlements situated near the iron mine, natural hill, called *Phnom Dek*, litteraly means "Hill of Iron".

First at *Bakan* temple complex, called *Preah Khan Kompong Svay* , a city of Jayavarman VII, where many Iron smelting sites found inside. Local people still remembered the stories told from generation to next about *Kuy* who produced the metal.

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[3] For information see Dupaigne 1992.

Second we did survey at *Prey Sanlong* site was a former ethnic minority *Kuy* settlement, located in Srei Snom district, Siem Reap province. And in the same time, we also did survey at *Chhok* situated in Chong Kal district, Uddor Meanchey province, where we found about five remained furnaces. Third the survey is conducted at *Chanrot* where was a former Kuy village, Kompong Thom province. We found here more than 10 sites. Fourth was *Phnom Dek* area where was the fame of *Kuy* settlement of iron smelting, currently situated in Preah Vihear province (see Dupaigne 1992 for more detail). We surveyed three different sites: O Por village, Rumchek Village and Boeng village. The first two villages are descendant from iron smelting family. We did in deep interview with the old men and women, aged 75 to 90 year olds, who participated/involved to the daily smelting activities. No more *Kuy* lives at Boeng village. But, here are very important sites where about twenty sites have been identified.

There is important information, found at *Kuy Dek* living in current Cambodia, which should be thinking to develop this topic further. Firstly, it is about a kind of "dance of war" called *Pravay*[4] *Khael*[5], which performed by *Kuy* during the New Year Day or sometime after just the harvest. Even within Khmer communities, living at Thalaporivat, Stun Treng province, has also invited *Kuy* for performing *Pravay Khael* inside the compound of *Preah Ko* temple, Pre-Angkorian brick temple, during the New Year Day. Of course, this perform consists art of war, magic and using warrior tools.

Second evident has been found within these *Kuy* communities as well. It is a ritual concerning iron tools, *Iron Tools Oblation*. During three days of ritual, all kind of metal tools using in everyday life are displayed on the altar of their houses. These tools are considered as the sacred objects for them. We don't know exactly the ritual date which have been performed previously. But, we observed within out survey that it is performed during the festival of death (Fig 6-3A and B, 6-4, 6-5).

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[4] To fight

[5] Shield


Fig. 6-2 *Kuy Damrei* at Surin and Siem Reap


Fig. 6-3A *Kuy Dek* , Black Smith at Chomprak



Fig. 6.3B *Kuy Dek* at Phnom Dek, Preah Vihear province

Fig 6-4 *Pravay Khael* at Veal Veng, Kompong Thom

Fig 6-5 *Iron Oblation at* Kuy Veng, Kompong Thom

6.2.3.2 Discussion on Kuy Study

- *Sanlong*, a Kuy dialect define iron smelting site. This term found using in any *Kuy Dek* communities.

- We observe that these two communities worship their different divinities. Sacred object of *Kuy Damrei*, Hunting Elephant, is certainly *Prakam*, a kind of buffalo hid rope used for hunting and tying elephant. For *Kuy Dek*, their own divinity is *Sanlong*.

- According to cultural point of view, *Kuy* was and is an ethnic minority close to Khmer. They know and well performed Khmer traditions and beliefs for their daily life.

- Relative abundance of literature related to *Kuy people* because of their production the metallic quality and their genius on elephant hunting. They were masters of Iron and Fires; and master of Elephant Hunting.

- Observing the sculptures of Angkorian temple walls, we find elephants, scene of combats, war tools. This is not mean that were from *Kuy*, but at least *Kuy* has paid their contributions to Royal Services.

- Khmer words abundantly loaned by *Kuy* for using in all aspects of rituals, tradition and customs

- And the function of Royal Road linked also to the development of Iron smelting and Elephant use.

- The study on *Kuy* communities is given more values to the fold of Cultural Studies which is well matching to the research project entitled "Living Angkor Road".

6.2.4 Initiate Cultural Database

We developed the Excel format for cultural information from field survey collection. The structure is designed as following:

- Village Code: LARP code and national code
- Village name: Khmer and Romanisation
- Village location: Administration location and its UTM
- Date of Registration
- Statistic: Family and Population

- Public Infrastructure: Road (ancient and new); Bridge (ancient and new); Water structure (ancient and new); Water way

- Religious Infrastructure: Temple (ancient and new); Rest-houses (ancient and new); Spiritual protector, Neak Ta

- Health infrastructure: Health Center; Home cure

- Resources: Agriculture; Farming; Livestock; Fishing; Services; Craft

- Traditions and Beliefs: Rite of Passage; Fixed date rituals; unfixed date rituals; minor rituals.

6.3 Archaeological Survey

6.3.1 Royal Road

This is the identification on road's vestige remained on spot and its orbit from the departure point till Dangrek. Road is all visible within Siem Reap province and mostly seen in Uddor Meanchey province. Generally, Royal Road was a straight line, but it was deviated in some areas on its orbit. For example:

- It was deviated its direction when it was reach to a temple called *Preah Khan* located about 20km on the northwestern of Angkor Thom.

- It was turned its direction to East about 20 degrees when it was reach Kol village situated about 35 km on the northwest of Angkor.

- It was deviated its direction again when it arrived to a village named *Kok Spean,* etc.

- Royal Road was often crosscut with local roads where were linked to ancient agglomerations, provincial city and temples, for example at about 5km on the north from Angkor Thom, Kol village and some other places at Uddor Meanchey.

- Road was built up with high elevation, as dike, when it runs on lower plain and becomes lower when it passes through on upper plain.

- It was structured by water draining and shoulder at each side and covered by a large crown from 6 meters to 14.50 meters wide. Water draining was canal flanked the road, average measuring about 6 meters.

- Generally, Royal Road measures about 30 meters wide (included crown, shoulder, edge and water draining)

- Total distance of Royal Road from Angkor to Dangrek is about 125 km long which is around 65 km in Siem Reap province and 60 km in Uddor Meanchey province.

- It was built up by different five compact soil layers (see detail work at Cross-section point)

- Road was rehabilitated from time to time in ancient period (see detail below).

6.3.2 Passage through Dangrek

Two passages have been identified through Dangrek: *Ox-cart* passage called "Phlov Prahok" (literally means "Road of fish-paste or fermented fish) and a walking passage through a laterite stairway structure called "Phlove Romkel Sap" (literally means "Road of moving royal dead body"). *Phlov Prohok* was used for Ox-cart, elephant and heavy transportation. *Phlov Rokel Sap*, a laterite stairway was used for pedestrians and palanquins means (Fig. 6-6, 6-7, 6-8).

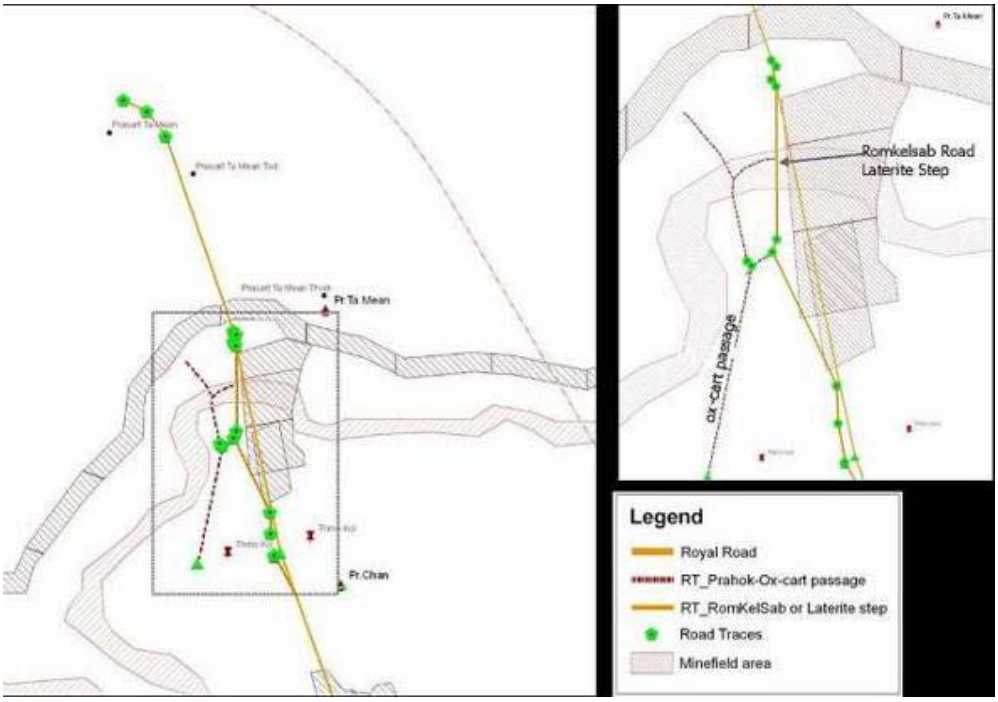

Fig. 6-6 Passages through Dangrek

Fig. 6.7 Ox-cart passage

Fig. 6.8 Laterite Steps

6.3.3 Cross-Section on Royal Road

The work is taken place within the Kol village situated on the Royal Road 40km away from Angkor. The Road is clearly visible in the area where three ancient stone bridges remained. Two operations have been conducted: Excavation the main section of road and Hand augering to the both side of road extension (Fig. 6-9 Kol Village).

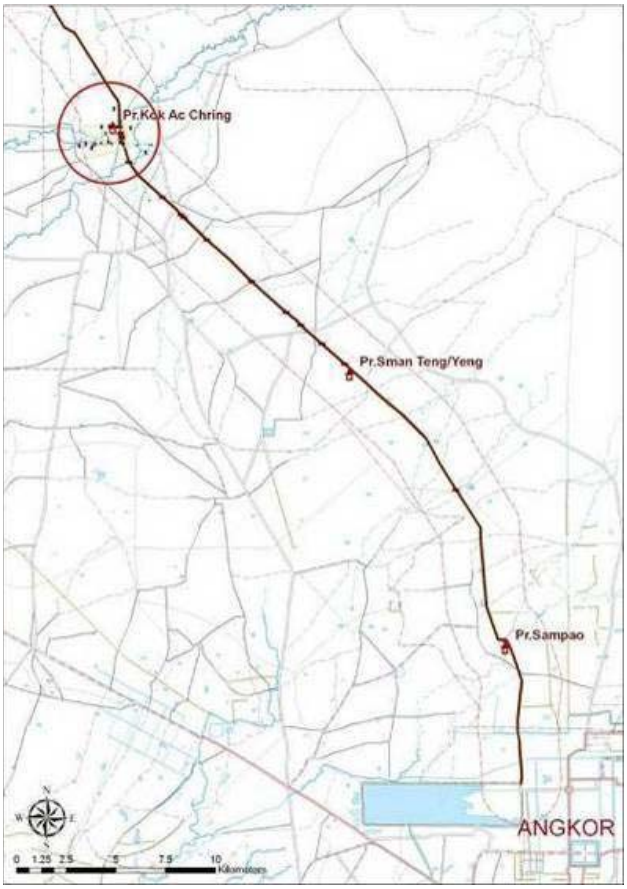

Fig. 6-9 Kol village_Cross-section Location

6.3.3.1 Objective

The excavation aims to study about: Road's Structure; Construction Technique of Road; History of Road's use and making a comparative study to the road's structure which has been previously done in Thailand by the Thai partner.

6.3.3.2 Excavation

- Excavation pit is selected at the most damage part of road structure because it's better to avoid more cut. The original level of road might be higher than current level about one meter high.

- Setting up work plan for excavating and recording.

6.3.3.3 Stratigraphy (Soil Texture)

Road's Structures were thoroughly compacted by clay, sand and coarse laterite/granular laterite (?). Four soil layers have been identified (Fig. 6-10, 6-11, 6-12 and 6-13):

- Layer I: A sandy loam; fine; organic soil because of common roots; slightly hard; light gray at central pit and becomes dark at extremities pits.

- Layer II: A loamy sand; Light brown; Granular and coarse soil composed with sand and clay are identified by red spot when they absorbed water; slightly hard soil layer; Tree roots found.

- Layer IIIa: A mixed clay with coarse sand layer; Light brownish gray at dry area and becomes dark brown at wetting area; Very coarse and granular; Hard; clay's composition is much more than Layer II but it not well stuff as previous layer; big tree roots found in some parts of the layer.

- Layer IIIb: Similar to previous layer but it's more wetting, softer and browner than layer IIIa.

- Layer IV: A mixed clay and coarse sand layer; clay's composition is less stuff than Layer IIIa (sandy loam); light brown; It's flaking when it's grated; less sticky than layer IIIa; Coarse sand became dark red spot at wetted area, considered as manganese layer (Mg).

Fig. 6-10 Cross-Section Pit

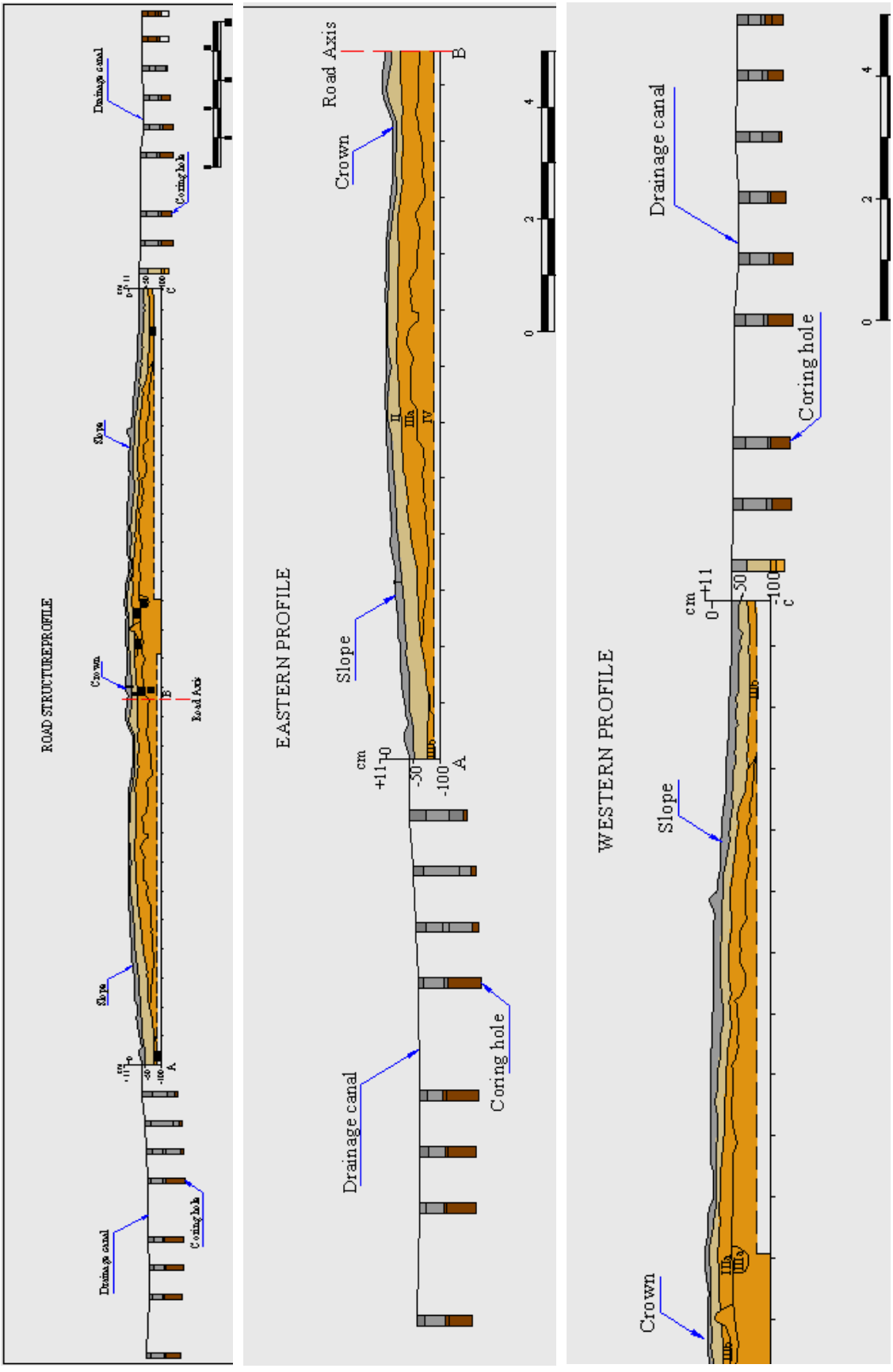

Fig. 6-11, 6-12 and 6-13 Road structure profile

6.3.3.4 Object found

4 small ceramic pieces discovered during the excavation which could be identified as 3 Chinese pieces and 1 Khmer piece (see detail report below).

6.3.3.5 Hand Coring

We extended the research work into the both side of extremities pits. Coring work into each side was covering into 10m away from the excavation pit. We did a coring hole in every 1m for seeking the edge and drainage canal of the road.

A- Soil recording at Eastern part (E + number = coring hole location and number):

- **E-1** is a coring hole 1m away from excavation pit to East side. Here's below the soil description:

* 0cm-30cm: A sandy loam, gray, sediment soil, Fine, soft and well stuffed

* 30cm-70cm: A loamy sand, light gray, sediment, soft, coarse sand found and ground water infiltrated at this level

* 70cm-100cm: Loamy sand, light gray, sediment, hard, coarse sand and its grains became dark red spots due to ground water infiltrated in this level, a small piece of charcoal found

* 100cm-110cm: Loamy sand, grayish mixed with dark red spots, harder, much more coarse sand, natural sediment.

- **E-2** is 1m away from **E-1** coring hole:

* 0cm-20cm: Sandy loam, light gray, Fine, soft and well stuffed, sediment

* 20-80cm: Loamy sand, light gray, sediment, soft, coarse sand found and ground water infiltrated.

* 80cm-110cm: Loamy sand, light gray, sediment, hard, coarse sand and its grains became dark red spots due to ground water infiltrated in this level.

* 110cm-120cm: Loamy sand, grayish mixed with dark red, harder, much more coarse sand, natural sediment.

- **E-3** is 1m away from **E-2** coring hole:

* 0cm-20cm: Sandy loam, light gray, Fine, soft and well stuff, sediment

* 30-50cm: Loamy sand, light gray, sediment, soft, coarse sand found and ground water infiltrated.

* 50cm-60cm: Loamy sand, light gray, sediment, hard, ground water infiltrated in this level.

* 60cm-100cm: Loamy sand, light gray, harder, coarse sand, natural sediment.

* 100cm-120cm: Loamy sand grayish mixed with dark red spots, harder, much more coarse sand, natural sediment.

- **E-4** is 1m away from **E-3** hole:

* 0cm-20cm: Sandy loam, light gray, Fine, soft and well stuff, sediment

* 20-50cm: Loamy sand, light gray, sediment, soft, coarse sand found and ground water infiltrated.

* 50cm-60cm: Loamy sand, light gray, sediment, hard, coarse sand with dark red

* 60cm-110cm: Loamy sand, grayish mixed with dark red spots, harder, much more coarse sand, natural sediment.

- **E-5** is 2m away from **E-4** hole (6m away from excavation pit):

* 0cm-20cm: Sandy loam, light gray, Fine, soft and well stuff, sediment

* 20-50cm: Loamy sand, grayish mixed with dark red spots, sediment, hard, coarse sand found and ground water infiltrated.

* 50cm-60cm: Loamy sand, gray mixed with dark red, sediment, hard, coarse sand with dark red

* 60cm-110cm: Loamy sand, grayish mixed with dark red spots, harder, much more coarse sand, natural sediment.

- **E-6** is 7m away from excavation pit and has a similar soil texture to **E-5**

- **E-7** is 8m away from excavation pit and its textures are:

* 0cm-20cm: Sandy loam, light gray, Fine, soft and well stuff, sediment

* 20cm-50cm: Loamy sand grayish mixed with dark red spots, coarse sand, hard, natural sediment

* 50cm-60cm: Loamy sand, grayish mixed with big dark red spots, coarse sand, hard, natural sediment

* 60cm-100cm: same texture as layer above

- **E-8** is 10m away from excavation pit and here the soil texture:

* 0cm-20cm: Sandy loam, light gray, soft and well stuffed

* 20cm-50cm: Loamy sand, grayish mixed with dark red spots, coarse sand, hard, natural sediment

* 50cm-60cm: Loamy sand, grayish mixed with big dark red spots, coarse sand, hard, natural sediment

* 60cm-100cm: same texture as layer above

B - Soil recording at Western part (W + number = coring hole location and number):

- **W-1** is a coring hole 1m away from excavation pit to West side. Here's below the soil description:

* 0cm-30cm: Sandy loam, gray, sediment soil, Fine, soft and well stuffed

* 30cm-60cm: Loamy sand, grayish mixed with dark red spots, coarse sand, hard, sediment soil

* 60cm-70cm: Loamy sand, grayish mixed with dark red spots, coarse sand, harder, natural sediment

* 70cm-90cm: Loamy sand, grayish mixed with dark red spots, coarse sand, harder, natural sediment

- **W-2** is 1m away from **W-1** hole:

* 0cm-20cm: Sandy loam, gray, sediment soil, Fine, soft and well stuffed

* 20cm-50cm: Loamy sand, grayish mixed with dark red spots, coarse sand, hard, sediment soil

* 50cm-60cm: Loamy sand, grayish mixed with dark red spots, coarse sand, harder, natural sediment

* 60cm-100cm: Loamy sand, grayish mixed with dark red spots, coarse sand, harder, natural sediment

- **W-3** is 1m away from **W-2** hole and has the same texture as **W-2**

- **W-4** is 5m away from excavation pit and has the same texture as **W-3**

- **W-5** is 1m away from W-4 and has the same texture as **W-4**

- **W-6** is 1m away from **W-5** hole:

* 0cm-20cm: Sandy loam, dark gray, sediment soil, Fine, Soft and well stuffed

* 20cm-50cm: Loamy sand, light grayish mixed with dark red spots, coarse sand, hard, sediment soil

* 50cm-60cm: Loamy sand, grayish mixed with dark red spots, coarse sand, harder, natural sediment

* 60cm-100cm: Loamy sand, grayish mixed with dark red spots, coarse sand, harder, natural sediment

- **W-7** is 1m away from W-6 and has the same texture as **W-6**.

- **W-8** and **W-9** have the same textures as **W-6**.

C- Soil recording at the inside excavation pits (S + number = coring hole location and number). The work is looking the soil structures underneath of excavation pit where we could not go deeper because of infiltrating of underground water.

- **S-1** is a coring hole 0.5m away from the Eastern bank of excavation pit:

* 0cm-20cm: Sandy loam, light gray, Fine, Soft, coarse sand found, sediment

* 20cm-50cm: Loamy sand, light gray mixed with dark red spots, coarse sand found more than previous layer, hard, natural sediment

* 50cm-90cm: Loamy sand, grayish mixed with dark red spost, coarse sand found much more that previous layer, harder, natural sediment

- **S-2** is 13m away from the Eastern bank of excavation pit:

* 0cm-20cm: Sandy loam, grayish mixed with dark red spot, coarse sand, hard, natural sediment

* 20cm-110cm: Loamy sand, light gray mixed with dark red spots, more coarse sand than previous layer, harder, natural sediment

- **S-3** is 1m away from Western bank of excavation pit:

* 0cm-50cm: Loamy sand, grayish mixed with dark red spots, hard, natural sediment

* 50cm-110cm: Loamy sand, grayish mixed with dark red spots, harder, natural sediment.

6.3.3.6 Result from the Analyzing

Based on the studies on soil layers found in excavation pits and soil textures found at coring holes, we could summarize the result as below:

- Royal Road was flanked by two drainage canals, one at each side
- Royal Road measures at this excavation pit 23.50 meters (included crown and its two edges/slopes)
- Road consisted by 4 different compacted soil layers
- Original level of Road was probably 1 meter higher than current situation
- Two drainage canals stand about 1.40m away from foot slope of Road
- Eastern drainage canal measures about 7m wide and more than 1m deep.

Current was not speedy flowing in this canal during the ancient time

- Western drainage canal was about 8 meters wide and 1 meter deep. Current was not speedy flowing as well.
- Road might be rehabilitated during two different periods of times in this area. The rehabilitation was done at central part of Road.

6.3.4 Associated structures of the Royal Road

6.3.4.1 Chapel of Rest-houses, *Dharmashala*

17 chapel of rest-houses, *Dharmashala,* which mentioned in Preah Khan inscription, are totally found: 8 chapel situated in side current Cambodia and 9 building in Thailand (Fig. 6-14)

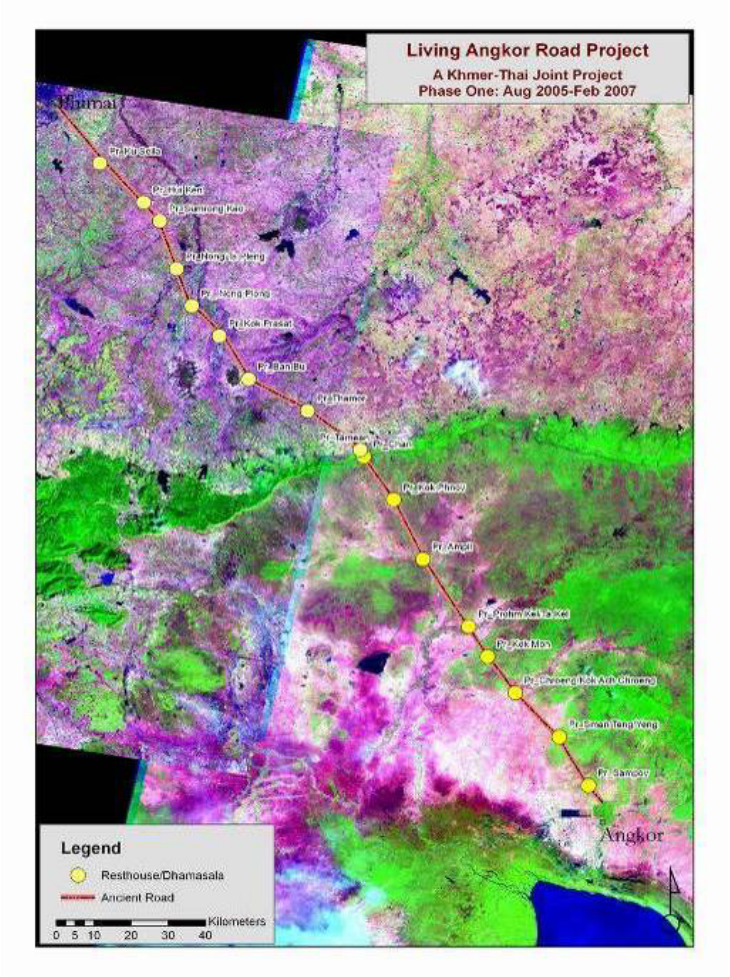

Fig. 6-14 Trace of Royal Road from Angkor to Phimai

Distance Calculation (walking speed) from *Yashodharapura* to Dangrek Range

Dhamarshala	Distance (Km)	Time (H)	Total (d/h/m)
Angkor-Sampov	7	1.45	
Sampov-Samanteng	18.71	4.40	
Samanteng-Kok Ach Chroeng	17.36	4	
Kok Ach Chroeng-Kok Mon	11.81	4	
Kok Mon-Prohm Kel	10.36	2.50	
Prohm Kel-Ampil	22.58	5.50	
Ampil-Kok Phnau	18.61	4.45	
Kok Phnau-Prasat Chan	14.61	3.50	
Average distance/time	15.13	4	
Total distance/time	123.2	31	1.7

Distance Calculation (walking speed) from Dangrek Range to *Vimāyapura*

Dhamarsala	Distance (Km)	Time (H)	Total (d/h/m)
Tamean-Thmor	17	4.25	
Thmor-Ban Bu	17.6	4.4	
Ban Bu-Kok Prasat	17.8	4.45	
Kok Prasat-Nong Plong	9.5	2.37	
Nong Plong-Samrong Kao	10.6	2.65	
Samrong Kao-Hui Ken	20.4	5.1	
Hui Ken-Kuk Sila	16.6	4.15	
Kuk Sila-Phimay	19.4	4.85	
Average distance/time	16.11	4.02	
Total distance/time	128.9	32.22	1.8.22
Angkor-Dangrek	123.2	31	1.7
Yashodarapura-Vimāyapura	245	61.25	2.13.25

6.3.4.2 Ancient Stone Bridges, *Spean Boran*

a- General Findings

Totally, there are 32 stone bridges have been identified and located along the axis in present Cambodia side as following (fig. 6-15):

- 20 stone bridges found in Siem Reap province
- 18 stone bridges found in Uddor Meanchey province
- The first one located near the capital city Angkor currently named *Spean Prasat Sampov* which measures 27m long x 9m wide.
- The last one located close to Dangrek, named *Spean Khmeng* which measures 12m long x 6m wide x 4 arches. Bridge was partly destroyed by mine in 1980's.
- The longest bridge named *Spean Top* situated in Chongl Kal district, Uddor Meanchey, measures 150m long x 14.5 m wide x 28 arches.
- The shortest bridge named Spean Hal at Kol village measuring 7.5 x 6.10 x 3 arches. (see detail work below). Here is table demonstrating of calculation of distance from each bridge, their size and location.

No.	Name	Distance (Km)	Size (M)	Location (district and Province)
1	Spean Tmo (Pr Sampov)	7.5	27 x 9 x arches?	Angkor Thom, Siem Reap
2	Spean Srah /Spean Stung Chkae Kon	8	18 x 7 x 7 arches	Pouk, Siem Reap
3	Spean Phnak Dai	8.5	24 x 6.5 x12 arches	Angkor Chum, Siem Reap
4	Spean Thmo (Kok Doung)	1.5	12 x 6.5 x 5 arches	Angkor Chum, Siem Reap
5	Spean Klakon	1.5	20 x 6 x 8 arches	Angkor Chum, Siem Reap
6	Spean Trapeang Spean	1	12 x 6.5 x 6 arches	Angkor Chum, Siem Reap
7	Spean Prey Spean	2.50	10 x 6 x arches?	Angkor Chum, Siem Reap
8	Spean Ta Liv/Ta Lev	3	18 x 6 x 7 arches	Angkor Chum, Siem Reap
9	Spean Thmo Toch	1.60	11 x 6.5 x 5 arches	Angkor Chum, Siem Reap
10	Spean Thmo	0.20	34 x 9 x 17 arches	Angkor Chum, Siem Reap

No.	Name	Distance (Km)	Size (M)	Location (district and Province)
11	Spean Thmo Trapeang Yeay Loem	1.30	14 x 6 x 4 arches	Angkor Chum, Siem Reap
12	Spean Memay	2.50	32 x 6.5 x 6 arches	Angkor Chum, Siem Reap
13	Spean Hal	1.35	7.5 x 6.10 x 3 arches	Angkor Chum, Siem Reap
14	Spean Memay	0.20	32 x 6.5 x 6 arches	Angkor Chum, Siem Reap
15	Spean Preah Chang E	0.30	34 x 8 x 13 arches	Angkor Chum, Siem Reap
16	Spean O Krabao	13.50	25 x 7 x arches?	Srei Snom, Siem Reap
17	Spean Tbong	4.50	25 x 6.5 x 9 arches	Srei Snom, Siem Reap
18	Spean Choeng	0.50	51 x 10 x17 arches	Srei Snom, Siem Reap
19	Spean Khmeng	2.60	40 x 9 x 11 arches	Srei Snom, Siem Reap
20	Spean Memay	0.60	40 x 8.5 x11arches	Srei Snom, Siem Reap
21	Spean Yeang	0.70	92 x 9.5 x15 arches	Chong Kal, Uddor Meanchey
22	Spean Top	0.20	150 x 14.5 x28arches	Chong Kal, Uddor Meanchey
23	Spean Tbong	0.18	43 x 9.5 x 11 arches	Chong Kal, Uddor Meanchey
24	Spean O Thlok	6	46 x 9 x 14 arches	Chong Kal, Uddor Meanchey
25	Spean Memay	0.60	20 x 7.5 x 9 arches	Chong Kal, Uddor Meanchey
26	Spean Kantrip	0.50	15 x 6 x 7 arches	Chong Kal, Uddor Meanchey
27	Spean Ta Nat	6.10	16 x 7 x 6 arches	Chong Kal, Uddor Meanchey
28	Spean Chramos Spean	2.60	25 x 7.5 x 8 arches	Chong Kal, Uddor Meanchey
29	Spean Memay	1.30	40 x 8 x arches?	Chong Kal, Uddor Meanchey
30	Spean Khmeng	11.30	22 x 7 x 4 arches?	Samrong, Uddor Meanchey
31	Spean Khmeng	5.50	18 x 6.5 x 5 arches	Tonle Sar, Banteay Ampil, Uddor Meanchey
32	Spean Khmeng	17.10	12 x 6 x 4 arches	Prey Veng, Banteay Ampil, Uddor Meanchey

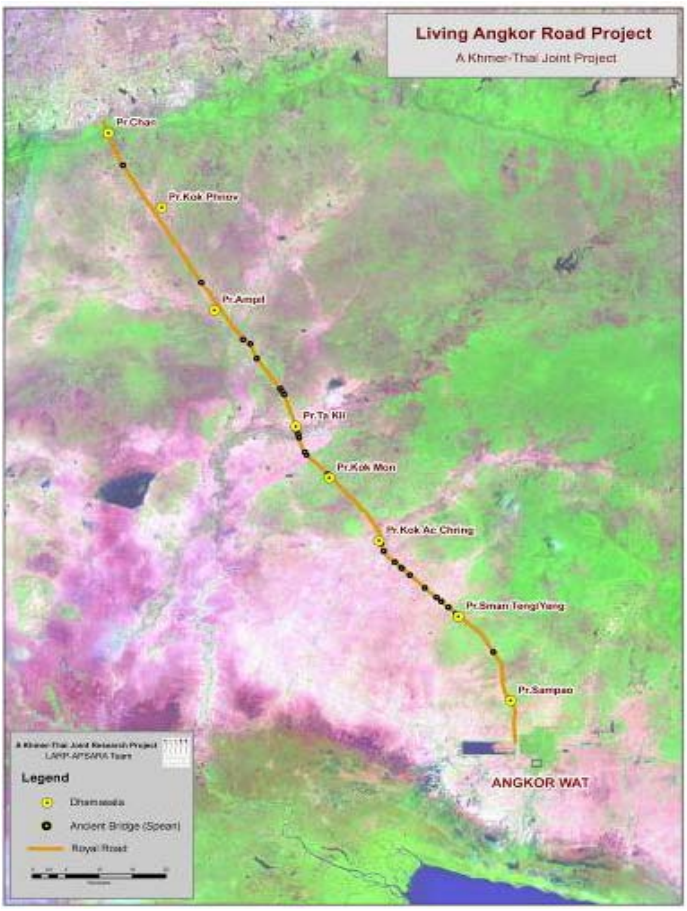

Fig. 6-15 *Spean Boran*, Stone bridges Location

b- A study on an ancient bridge, *Spean Hal* at Kol village[6]

b-1 Location

In Kol village, there are three ancient bridges which situated about 200 meters away from each others. All these bridges were built by laterite of their whole structures. Spean Hal[7] is the smallest one located on the South-east of the other two bridges, and on the North of a huge water reservoir, named *Veal Roneam*, ancient water structure (fig. 6-16).

[6] This report reworked on last LARP report by Srun Tech

[7] The local villagers called this ancient bridge as “Spean Hal or Hal Bridge”.

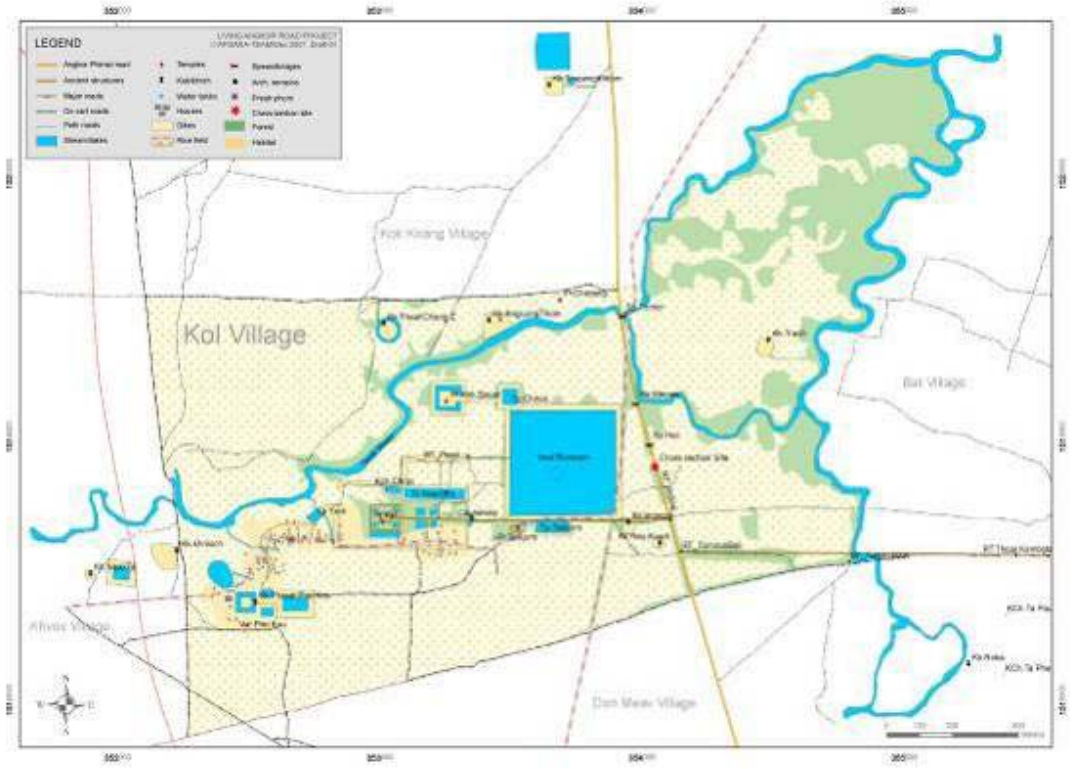

Fig. 6-16 Archaeological map of Kol Village

b-2 Current Condition of the bridge

Nowadays, no any traffic held at Hal bridge, but it is still functioning as a drainage system which water at up stream flows down to feed the community and the rice fields at the down stream. The bridge's condition is supposed in good condition about 55% . Its current status found as following:

- Being covered by the vegetation
- Corbelled arches[8] were blocked by sediment about 70 cm thick
- Some movable laterite blocks are in the both side of the bridge
- One big tree grows on the bridge caused some block of its balustrade moved at South-west corner
- West façade's structure is preserved in good condition

[8] The Siem Reap Villagers called bridge's drainages "corbelled arch" as "Runtadev" (in French technical terms called arche en encorbellement).

- Middle part of east façade was fallen down from 2 to 3 layers of stones

- South-east wing wall is still in better condition. But some laterite stones at embankment are moved from the original place, and some are fallen from their original places

- Other three wing walls are completely fallen down, except their basement (see fig. 6-17, 6-18)

- 4 retaining walls are fallen remained only some of their structures

Fig. 6-17 South-east view from a tree

Fig. 6-18 View form North-east

b-3 The bridge structure

b-3-1 Structural Material

The bridge was built from laterite stones. The average dimensions of each block for the construction are: 40 centimeters in width, 60 meters in length and 30 meters in thick. And others are from 190 to 240 centimeters in length.

b-3-2 Construction Technique

The size of the bridge is 6.10 meters by 7.35 meters and 2.50 meters high (from the lower basement). The bridge's body is standing on 2 pillars (1.30 meters wide by 1.57 meters high), 3 corbelled arches (1 meter wide). There are four wing walls and four retaining walls used as stabilizer for the bridge and its foundation (see fig. 6-19).

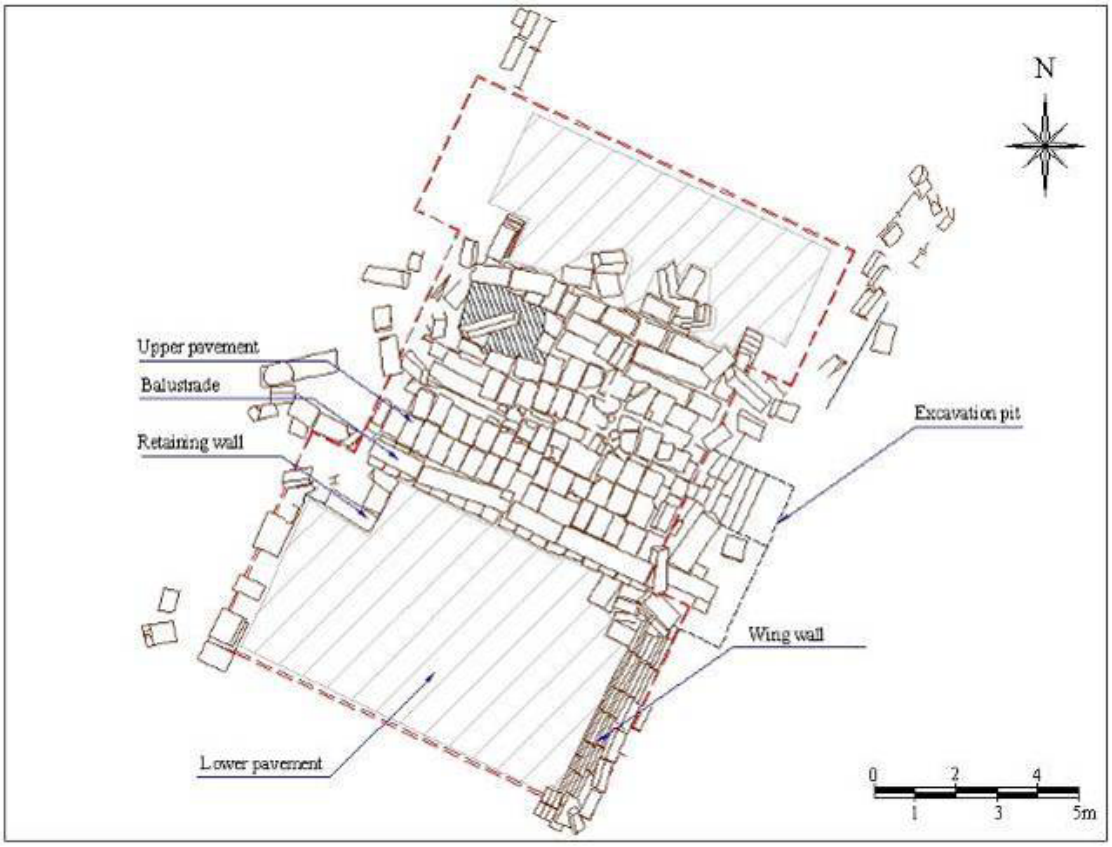

Fig. 6-19 Ground plan, Current status

b-4 Assembling Structure

The bridge's structure was constructed by 9 laterite block layers (from the top layer of the base pavement to the top layer of the bridge body pavement "upper pavement") and might be two more layers for the foundation. The total structure is assembled by 11 layers of laterite stones (see fig. 6-8).

b-4-1 Basement and Foundation

Basement and Foundation are not excavated during the last mission. But we did the coring by using the metal stick at two sides, upstream and downstream close to the facades. This test confirmed the existing laterite stones paved underneath. This laterite layer was paved on compacted sand with rock"[9]. This is the foundation of the bridge.

The upstream basement is recorded about 3.50 meters long and the downstream basement is about 5.00 meters long (measuring away from the pillars). This basement was paved through a slope from upstream with 10 centimeters higher than to downstream.

b-4-2 "Bridge's Head of Bridge Structure/Base of bridge Structure

In the ancient time, Khmer people were skillful in making the slope of the roads, dikes and temple's foundation. Referring to the excavation's result at the "bridge's head" showed that there was also a present of slope's structure which was formed by as staircases of 6 steps linked directly to the road's structure. It was a skillful technique for one supporting the bridge stability, and second from the road's pressure.

Moreover, the 6 steps of the staircase firmly linked with the road's structures by 5 different layers of compacted soil. Some of this layers were composed by fine sand with small stone, and other layers was composed by fine clay compacted with coarse laterite.

By studying on this "bridge's head", we found this is a strong structure which well made bridge to be strong and stabilize (see fig. 6-23, 6-24 and 6-25).

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[9] This is a common foundation structure of ancient stone bridges. We found the structure during the 3 different excavations on ancient bridges situated along the National Road No 6.

b-4-3 Pillars

Nowadays, we can see the bridge's pillars on their upper part about 80 centimeters high. The down part remained underneath of the current sediment about 70 centimeters thick. These pillars were built by 5 layers of laterite blocks[10] as following:

- 1st layer (down from the bridge's body): all the blocks are parallel assembled along the bridge. Their sizes are about 1.70 meters by 35 centimeters.

- 2nd layer: all the blocks are also assembled along with the bridge. They are about 1.20 meters by 35 centimeters.

These two layers were formed as an architrave.

- 3rd layer was assembled along bridge's width by three successive blocks. These three blocks are same size of 35 centimeters wide by 35 centimeters thick.

- 4th and 5th layers are currently underneath of sediment. All these layers might be remained under water (see fig 6-21, 6-22 and 6-23).

b-4-4 Corbelled Arch

Corbelled arches were constructed by two pillars on each side and on the upper part joined by two layers of laterite blocks of their architraves where the block moved toward about 1/3 of each. The dimension of opened arch is 100 centimeters which is large enough for flowing water (see fig 6-20, 6-21 and 6-22).

b-4-5 Wing wall

There are 4 wing walls on the both bridge's head is a slope with 9 tightened steps of laterite block. The wing wall is plying an importance role to protect step bridge from water flow and water erosion to bridge foundation (see fig 6-20 and 6-22).

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[10] This 5 layers situated on the surface of pillars.

b-4-6 Retaining wall

The 4 retaining walls were overlapped in square shape and paralleled with the both bridge's head. They were maybe the adding construction after the bridge was finished, in order to add more support. There is no any special connecting point, which is confirmed to fix to the bridge structure. Refer to this point, its function are playing role to protect water pressure and water eroded. Therefore, in the ancient time, it might be strong current or might be bridge's structure was weak? (see fig 6-20, 6-22 and 6-23).

Fig. 6-20 View of retaining wall and wing wall

Fig. 6-21 West facade elevation view

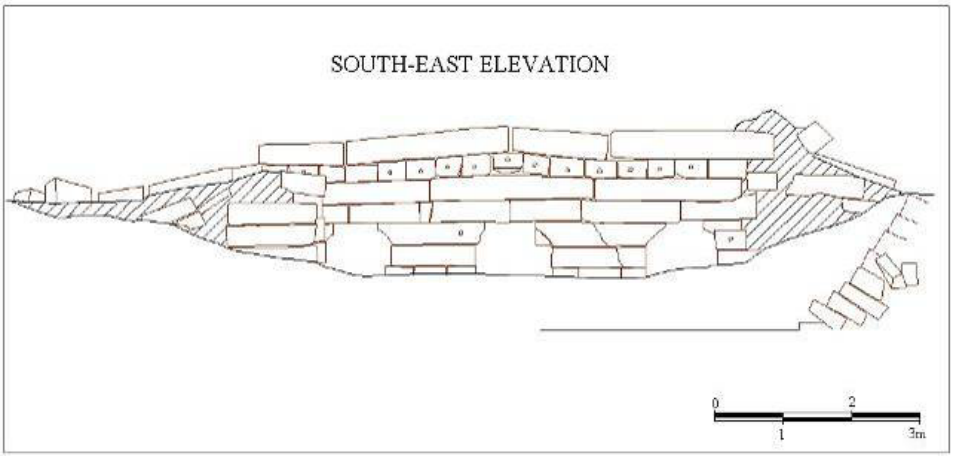

Fig. 6-22 Southeastern Facade

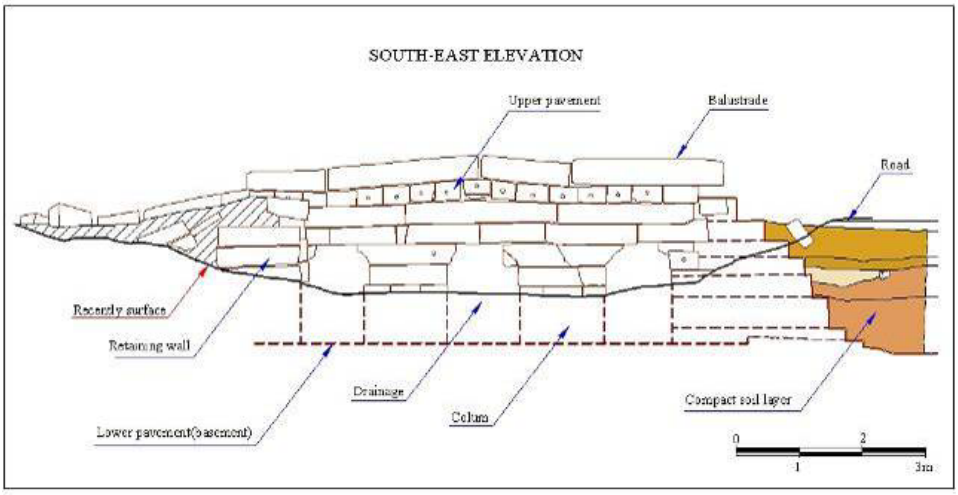

Fig. 6-23 West facade profile

Fig. 6-24 bridge's head structure

Fig. 6-25 Compacted soil layers at bridge's head

b-4-7 Bridge's body

The three layers of laterite were overlapped in crisscross for the bridge's body. It was laid on the step bridge, columns and drainages (see fig. 6-21, 6-22 and 6-23).

b-4-8 Balustrade

Generally, the bridge always has balustrade. This balustrade is short or high depends on the type of structures. This bridge has short balustrade, but no supporter only put long laterite blocks on the both edges of the bridge. The importance function of balustrade is pressing on small stone, in order to stucks them to move from its original place and its function to protect the traffic safety. Thus, all the blocks of balustrade are long (see fig. 6-21, 6-22 and 6-23).

b-5 Reflection to an original form of bridge and road

Referring to result of cross-section and bridge's survey (107 meters away from the two locations), we found the axis line of road and bridge were not standing on the same line. They are standing 5 degree away from each other. If we measure from the bridge's axis, the road's axis stays 5 degree on West. For reflecting the road and bridge use, we reconstructed the original form of bridge and road, based on the studies above, as showing in fig. 6-26, 6-27 and 6-28 below.

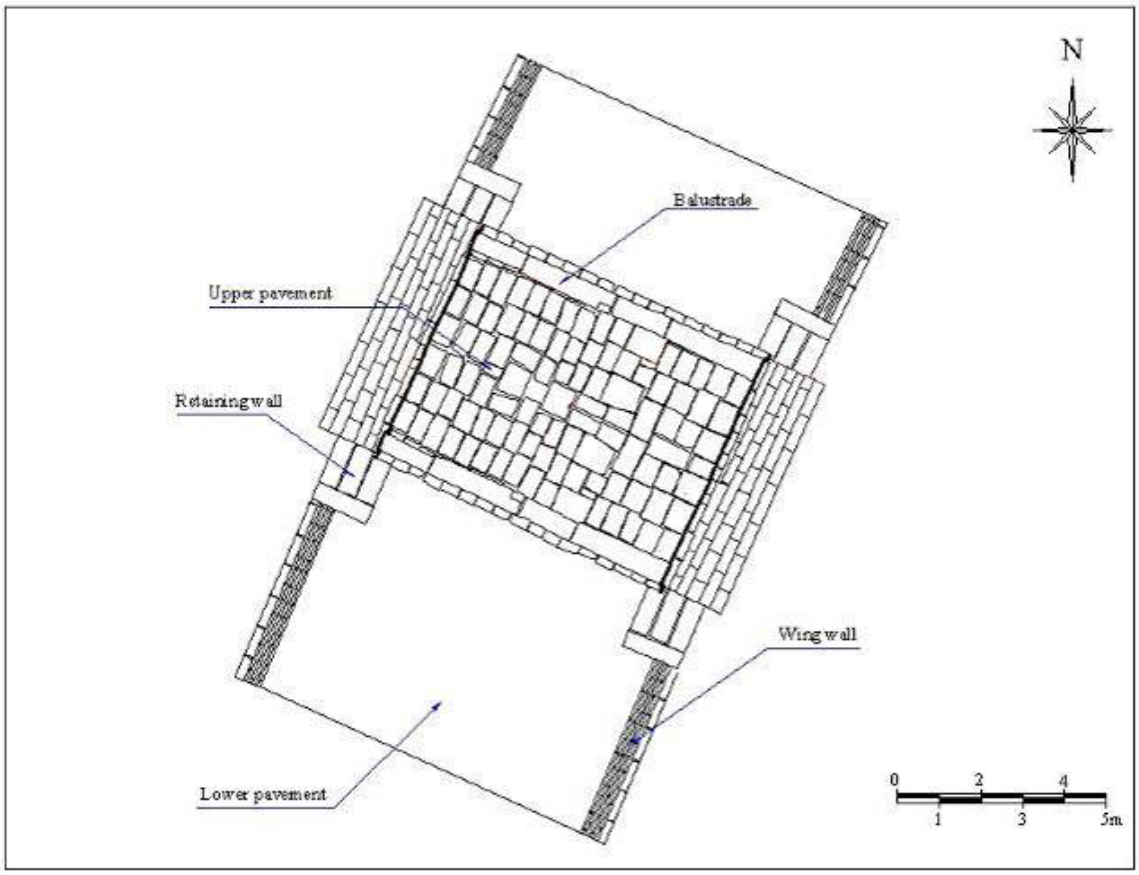

Fig. 6-26 Reconstruction to its original structure

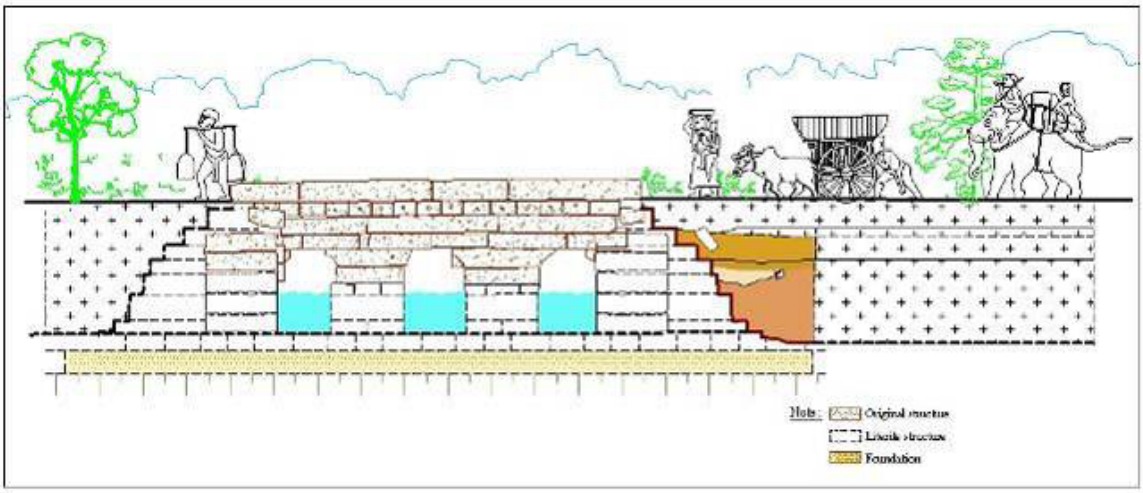

Fig. 6-27 Reflection to the bridge in Use

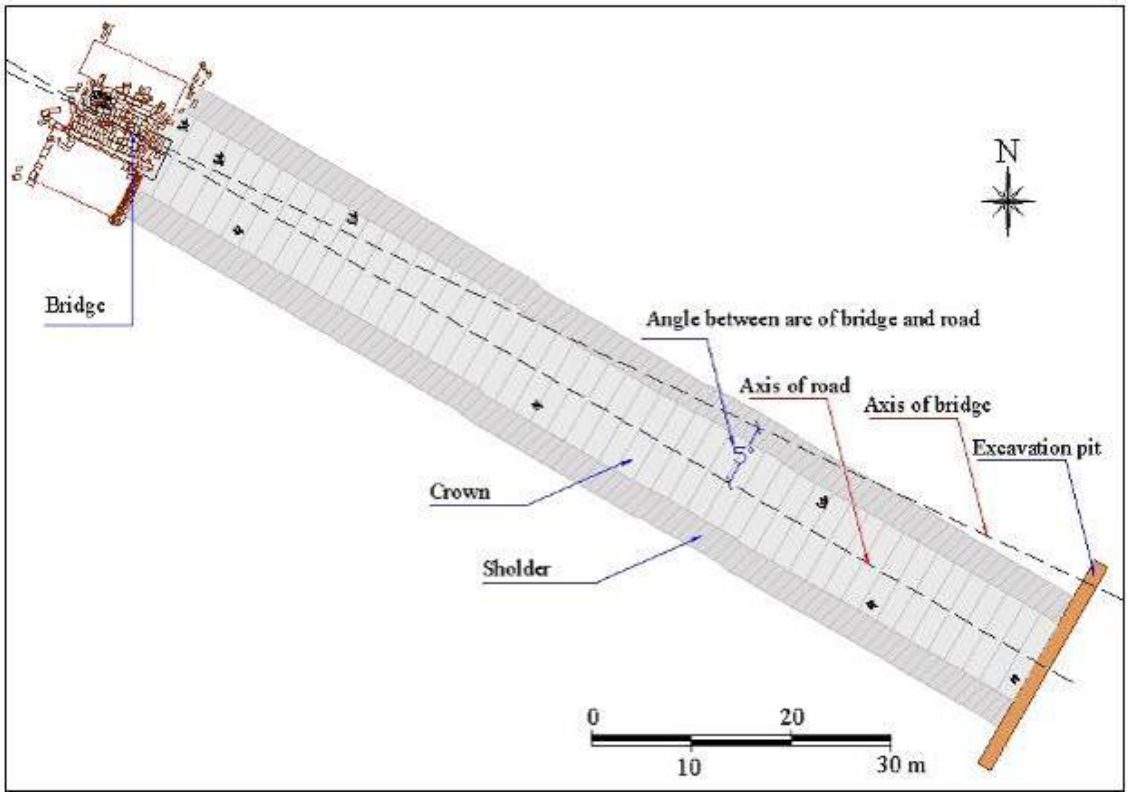

Fig. 6-28 Reflection on the axis of bridge and road

c- Excavation work at Bridge Site[11]

Two pits are opened: one at the Head of bridge on the south. We opened this for finding the structure linked between bridge and road. This is the first study on bridge structure in Cambodia. Second pit is done at extremity of south-western wing wall for finding its structure.

c-1 Bridge's Head Site

- Step1: Pit is opened 3m (E-W) x 2m (N-S)
- Step2: Pit is extended to East 50cm and to West 80cm
- Step3: Due to time limited, we reduced the pit's size into 1m x 1.5m at the Eastern corner and 80cm x 80cm at the Western corner. The Eastern pit had its deep 2m down until ground water infiltrated. We dug down the Western pit just at 90cm deep (see fig. 6-29 and 6-30).

[11] This section contributed jointly with Ea Darith

c-1-1 Soil Layer

- Layer 0: 0cm-40cm is upper layer of Royal Road. This layer was worn during last thousand year remained just such thick: Sandy loam, light gray, fine, slightly hard
- Layer I: 40cm-85cm, sandy loam, grayish brown, organic soil, hard
- Layer IIa: 85cm-105cm, loamy sand, grayish brown, coarse laterite, sticky, very hard
- Layer IIb: 105cm-130cm, sandy loam, grayish dark red, coarse alterite, very weak
- Layer IIIa: 130cm-170cm, loamy sand, dark red, coarse laterite, sticky and very hard
- Layer IIIb: 170cm-260cm, loamy sand, grayish dark red, sticky and very hard
- Layer IV: under 260cm, coarse laterite layer

c-1-2 Object Found

10 small ceramic pieces found at this site: 6 Khmer ceramic pieces and 4 Chinese ceramic pieces (more detail see full report below).

c-2 Wing Wall Site

- Step1: Pit is opened 3m (N-S) x 2m (E-W)
- Step2: Extension 1m to the North (see fig. 6-31 and 6-32).

c-2-1 Soil Layer

- Layer 0: 0cm-15cm, sandy loam, soft, sediment, fine
- Layer I: 15cm-35cm, sandy loam, grayish brown, fine, organic, sediment, soft
- Layer II: 35cm-55cm, loamy sand, grayish dark red, coarse laterite, slightly sticky
- Layer III: 55cm- 75cm, loamy sand, grayish red, very sticky and well stuffed
- Layer IV: under 75cm, loamy sand, dark brown, coarse laterite, very hard.


Fig. 6-29 and 6-30 Bridge's head site


Fig. 6-31 and 6-32 Wing wall site

c-2-2 Object Found

4 small Khmer ceramic pieces found at 30 cm deep. They were pieces of earthen pot. Base on decoration left on pieces, they probably were **pre-historic ceramic**.

d- Result from Analyzing

The bridge is small size. But laterite blocks are big size. This is important for construction technique, i.e. making bridge strong because of its whole structure is big for columns, arches and foundation. Moreover, the dimension of the basement is approximately 15 m x 10 m which making strong enough for the bridge structure.

So, this bridge structure was built for heavy load and supported the strong current in rainy season. Furthermore, by the study on Hal bridge, we understand geographical formation of Kol village where the slope runs down from North-east and the current flows down from the same direction. Thus, it reflects to thinking the same situation in the ancient time.

On the other hand, there are three bridges in this community where given water flow from the up North-east down to South-west, where the community settled. Hal bridge was one of the three who was served, besides its fundamental function for transportation, as water drainage system, an inlet where the water flows to feed Veal Roneam (an ancient water reservoir) for supplying to the local community, Kol village. The functional system of *Hal* bridge is currently using by local people.

Based on analyzing on stone samples and bridge structure done by Civil Engineering Department, CRMA, Thailand, loading capacity of *Spean Hal* could be reachable **42 tons** of weight. A heavy loaded such as elephant could freely pass through the bridge (see fig. 6-27).

6.3.5 Archaeological sites: Temples

These are very important feature of the study. Most of the buildings are badly ruined and seriously looted. These temples were built on plain mound which are covered on an area mostly bigger than sq. 900 meters (30m x 30m). These temples faced east, surrounded by moat and some plus with laterite wall (inside the moat). We always found a small or big water structure situated on the east of the building. Some temples opened to the both sides: East and West. And some opened only to the East. There are 87 temples found in the buffer zone which classified into three categories (see fig. 6-33):

- 68 brick temples which some of them can be identified as Pre-Angkorian styles Some of them had only one tower some had three towers and other with five towers.
- 13 sandstone temples
- 6 laterite temples

The last two types were certainly Angkorian styles which some can be identified a single tower with a library and wall enclosure, and other were a complex.

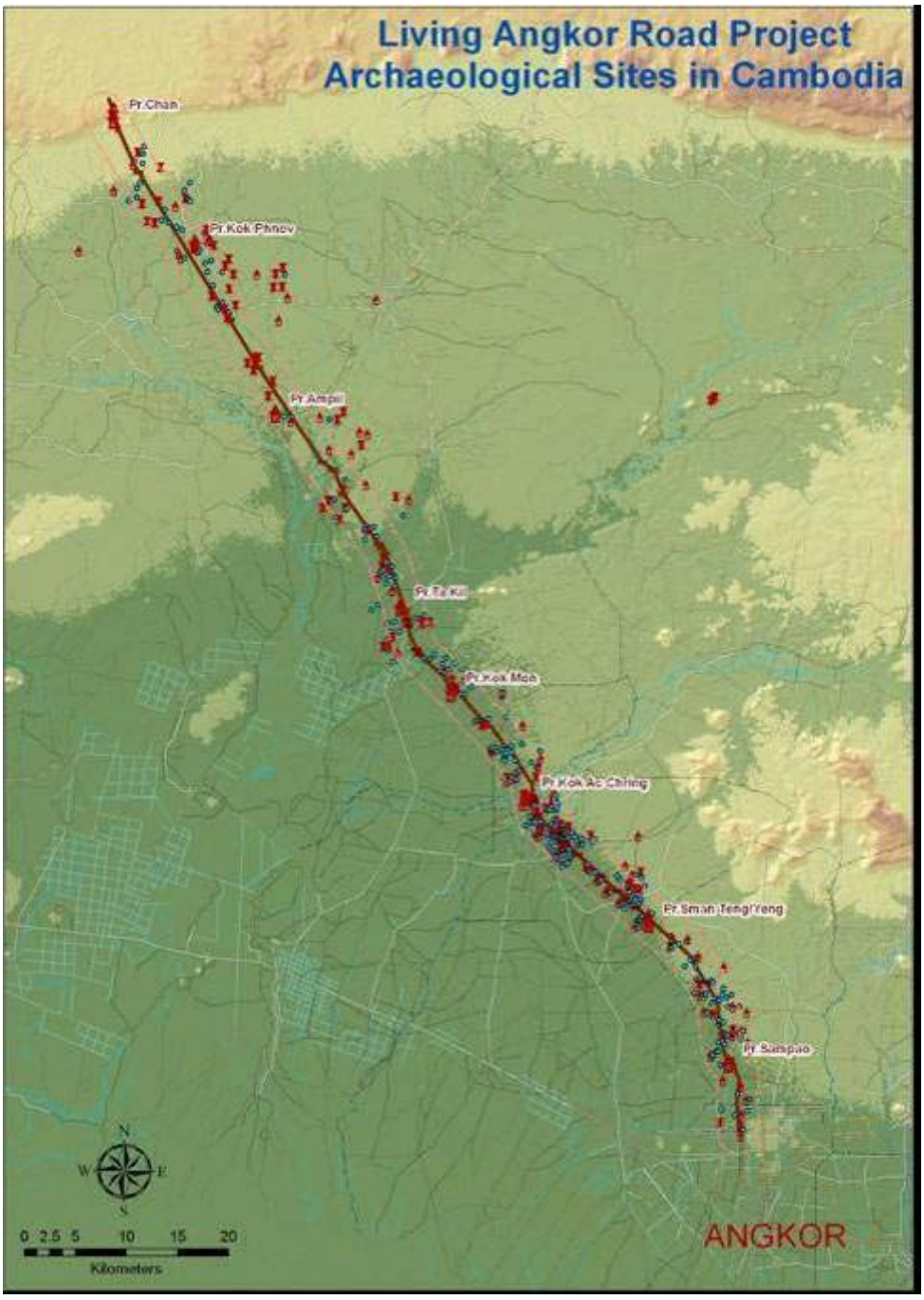

Fig. 6-33 Archaeological sites

6.3.6 *Arogyashala*, Chapel of Hospital

Ta Prohm's Inscription dated under reign of Jayavarman VII, listed 102 hospitals were built in his Empire (see fig. 6-34). These building called *Arogyashala* which were situated in capital city and in various provinces.

Fig. 6-34 Bas-relief at Bayon

Up to date, about 30 chapels are identified in current Thailand (see Muang Boran 2004) and 20 structures found in Cambodia which identified below:

- There are 5 chapels found in capital city Angkor
- 4 buildings found in Banteay Chhmar, sister city of Angkor Thom[12]
- 2 chapels found along Angkor-Sambor Prei Kuk Road
- 1 chapel found along Angkor-Bakan road
- 1 found in Beng Mealea
- 1 found in Bakan, called Preah Khan Kompong Svay
- 1 found in Koh Ker
- 1 situated on the north of Phnom Dek region, Preah Vihear province; etc.
- There are 8 hospitals found along Preah Kunlong, Angkor-Phimay where 4 chapels situated along the axis from Angkor to Dangrek. These chapels are: *Prasat Prei Prasat* situated on Northwest corner of Angkor Thom, just about one kilometer outside city wall; *Prasat Ta*

[12] This is a new finding. The report on these four structures will be published soon by the author.

Koem situated in Kol village; *Prasat Prei Nokor* located in Chonkal, Uddor Meanchey; and *Prasat Tor* (local name), called *Ta Mean Toch* situated on Dangrek.

If we do calculation the distance the four hospitals located along the road from Angkor to Dangrek, so we got the average distance from one to other is roughly 40 km. This means taking about half day walk, passing two relay stations, rest-houses.

6.3.7 Ancient Inhabitancy, *Kok*

We have identified 27 sites supposed as "ancient resident area" located along the axis. These sites called "Kok" (literally means "plain mound"). Most of these sites are still living by villagers. One of these communities has been studied in detail. That is Kol village[13] where situated close to the Royal Road. This is an example of a study on an ancient agglomeration structure (see detail report at LARP 2008, first semester: Sep 2007-Feb 2008). Archaeological features found at the community as below (see fig. 6-35):

- 5 ancient temples dated different periods: a chapel of hospital, *Arogyashala*; a chapel of rest-house, *Dharmashala*; a 11th century temple and a pre-angkorian brick temple.
- 3 stone bridges which one is called *Spean Hal* as written above.
- 9 different types of water structures
- 2 ancient local roads linked to Royal Road
- 5 *Kok Srok* sites where 3 of them are identified as prehistoric site dated Stone Age.

[13] we called here in our study as *Hospital Community* or *Arogyasala Community*

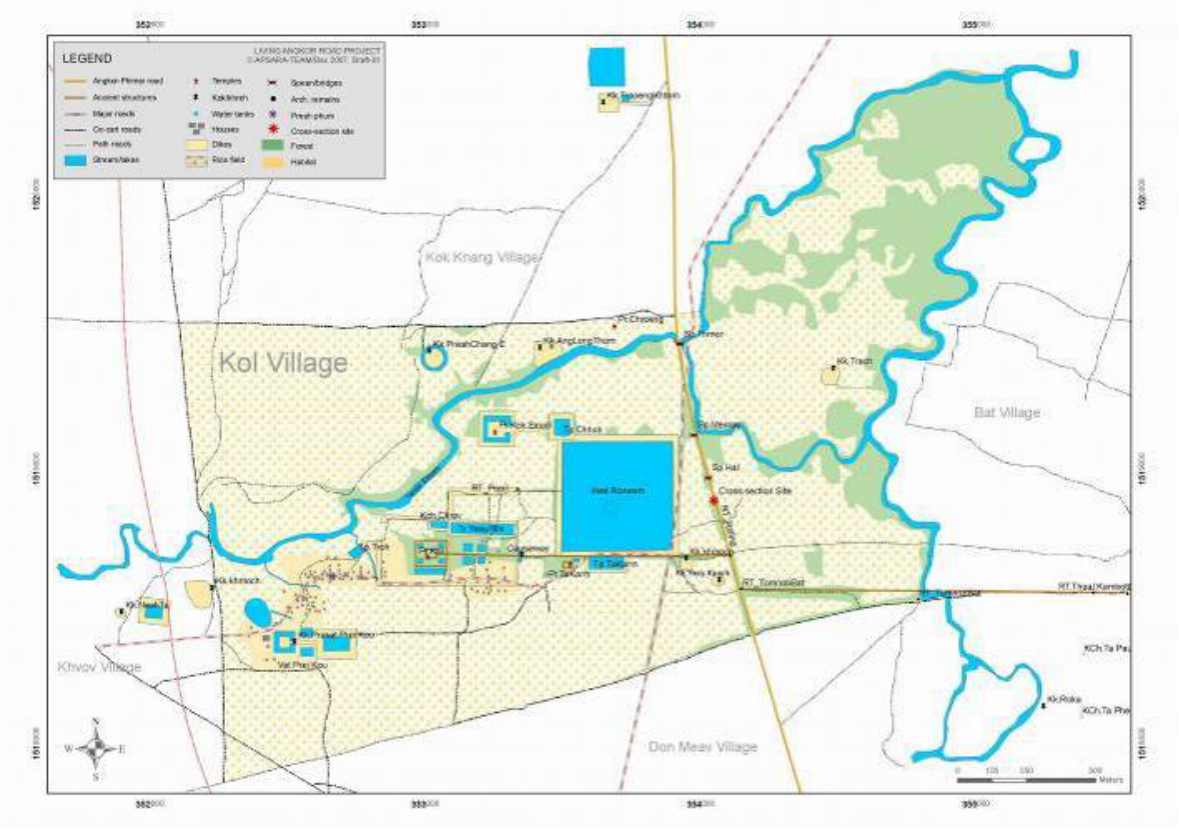

Fig. 6-35 Archaeological Map_Kol village

6.3.8 Water Structures[14]

The study on typology of water structures is almost done, but we need more study on other region, as a comparative study. For this project, there are 16 different types and names have been identified such as: *Thlok, Khou, Anlong, Srah, Kanhchan, Trapeang, Chok, Boeng, Santouk, Khnar, Khnach, Rohal, Rolom, Loboek, Tonle, Baray.* Each type designs a form, size, structure and origin different from other. Almost of them are the ancient name found in different inscription. For example: *Trapeang*, (Travan) written in inscription K.222; K.843; K. 207; *Rolom* written in Sdok Kak Thom inscription and K. 257,352, 229, 235, 353; *Chok* written in K. 357, 257, 235, 523; *Tonle* in K.904, 598, 383; etc.

We can divide into three different type of size: Small, Medium and Large; and into two type regarding their origin and form: Manmade with geometric form and Nature with no form but modified later on.

[14] This work developed by Khieu Chan

About the size:

- Small size: *Thlok, Khou, Anlong, Srah, Kanhchan,*
- Medium Size: *Trapeang, Santouk, Khnar, Khnach*
- Large Size: *Chok, Boeng, Rohal, Rolom, Loboek, Tonle, Baray*

About their Origins and Forms:

- Manmade: *Khou, Srah, Kanhchan, Trapeang, Santouk, Khnar, Khnach, Loboek, Tonle, Baray*
- Nature: *Thlok, Anlong, Chhok, Rohal, Rolom, Boeng*

During the ground survey along the axis from Angkor till Dangrek, there are 385 water structures have been identified as ancient structure based on remained of artifacts: ceramics, stone sculptures on their dikes; associated structures to communities or temples and road. Generally, we can determine these structures into three groups:

a- Most of theses structures are associated to communities situated in the buffer zone (4 km). At least one community had about three different sizes of water structures. They are mostly still using and highly threat to lose.

b- Some of them are associated to the temple complex. Normally, each temple had at least one water structure situated on the east (no included the temple moat).

c- And only 53 structures identified as associated to the Royal Road. These structures located the further one around few hundred meters and on the both side of Royal Road. They are mostly rectangular form built by four dikes, stretching east-west facing to the Royal Road. These structures are differently typology as following: 1 *Srah;* 42 *Trapeang;* 1 *Tonle;* 1 *Boeng;* 2 *Santouk;* 2 *Loboek;* 2 *Kou* and 3 *Rolom.*

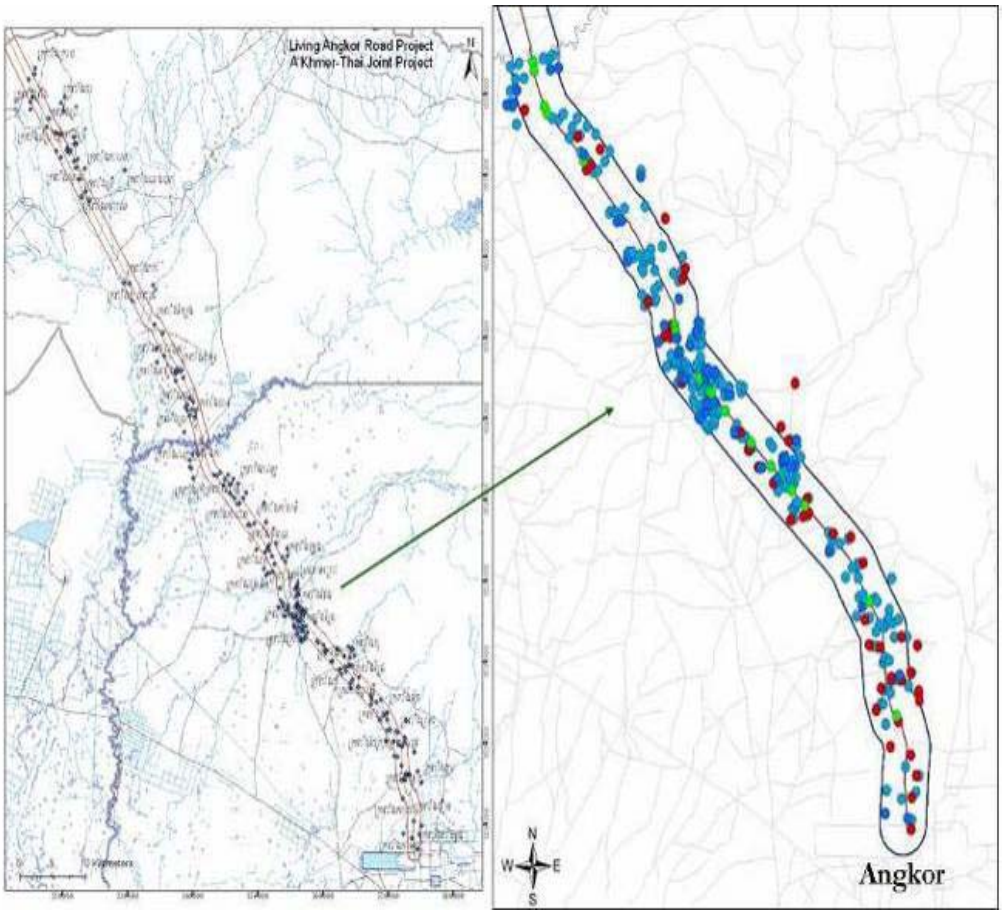

Fig. 6-36 Water Structures

We got a lot of information regarding "Thmo Kol", *gol*[15] (stone post) during the ground survey which told by villages. Despite the landmine and time limited, we could not be reached to all post, but we did mapping only 14 *Thmo Kol* which some located along the road and some scattered in the rice fields situated in the buffer zone. There are two forms of post: one was sculpted a lotus flower on top; and other one was curved on the top formed lotus petal or pyramid (see fig. 6-37, 6-38 and 6-39). Some posts were sculpted on its faces into Buddha images.

[15] *gol* means "stake, post", is written in many inscriptions such as: K.831; 521; 470; etc.

Fig. 6-37 Lotus flower

Fig. 6-38 Pyramid shape

Fig. 6-39 Buddha image

*** A reflection to the *gol* use**

As mentioned about the inscriptions cited here, *gol* was used for delimiting land, village and specially delimited the sacred and the profane. The last role found everywhere used at temple complex and in modern day at monasteries as well. Only one inscription remained on a door jamb of northern Kleang temple (11th century) in Angkor, drawn a plan of huge land offered to temples, etc (see fig. 6-40 and 6-41).

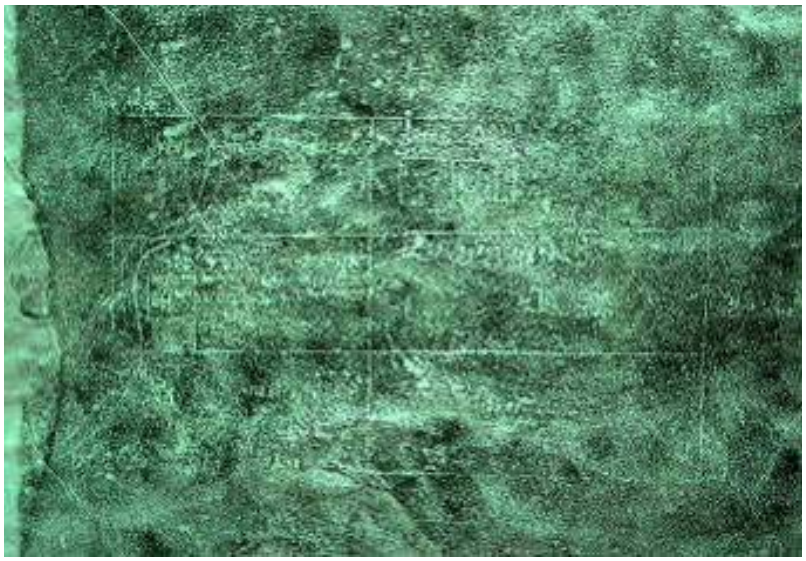

Fig. 6-40 Rubbing at Kleang (Plan of Land)

Fig. 6-41 Translation by G. Coedes

6.3.10 General Discussion on Royal Road *Yashodarapura-Vimayapura*

a- Collective knowledge on this axis is still living. Villagers called this road as *Preah*[16] *Kunlong*[17] (*vrah ganloṅ* which at first was found in an inscription K.175, dated 10th century), literally means Royal Road. In additions, local people still respect and worship to *Preah Kunlong*. No local people dare to disturb the ancient road. Interesting information found nearly everywhere, once we asked villagers, where this road comes from and leads to? They will be no hesitates reply back: *It's from Angkor and to Siam*. Some local people still remember its terminus and said that "it went to *Nokor Reach* in ancient time". Phimai is not familiar within the local people. But *Nokor Reach, Korat*, is still on their memories.

b- Villagers at the Dangrek region have an extraordinary knowledge concerning *Preah Kunlong*, its origin and destination. Many local legends relating to ancient road are still talking from generation to next. The most important one is a story regarding the Laterite steps called *Phlov Romkel Sap*, Banteay Chhmar and Angkor. It was the story of the King named *Yos Ker*, which was probably derived from the former name of *Yashovarman* (more study to be carried out in the future).

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[16] Glorious, illustrious, Sacred. A sacred being or object: god, king, statue, etc...

[17] Way, track, road

c- In theory, Royal Road was straight where can be detected for some distances from aerial view seen as a straight line. But for some area it was deviated accordingly its orbit. Here are just only three cases to give as example::

- It was deviated its direction when it was be reached to a temple called *Preah Khan* located about 20km on the northwestern of Angkor Thom. This means the Road might be existed after the temple built

- It was turned its direction to East about 20 degrees when it was reach Kol village situated about 35 km on the northwest of Angkor. Here is exactly the case. Based on the archaeological mapping on the village, we found human settlement here dated back to Stone Age, the present of Pre-Angkorian temple style, and some early Angkorian temple style. This is proved that Kol was settled for long time and became a huge agglomeration before building the current Royal Road.

- It was deviated its direction again when it arrived to a village named *Kok Spean* at Chongkal. This village is a prehistoric site, a mound moat site. Two stone bridges found at each side of the village: one at the southeast when road was be reached at the moat. Then, Royal Road was overlapped on the ring road of the village. And, Road linked to second stone bridge situated on northwest when it was passed through the moat of village again.

d- The integration of this multi-disciplinary research project has projected the history of Royal Road and its use. The evident issued from analyzing on ceramics found at excavation site in Kol village and found at different sites along the ancient road (see LARP 2008), from remote sending and GIS, from excavation work and historic context, can be used to propose some hypothesis as following:

- Royal Road and bridge were not built before 9^{th} – 10^{th} C
- Road might be entirely became an axis linked from Angkor to Phimai from 11^{th} century
- Stone bridges were built between 11^{th} - 15^{th} centuries

e- Based on the study on Cross-section, Royal Road was built by four compact soil layers and rehabilitated from time to time.

f- At Present *Preah Kunlong* is being in use for some parts, and highly threat from new rural development plan and land grabbing from new settlements, the outsiders.

6.4 Ceramic Study[18]

The entire article on this study has been specifically done a part from this report. It has attached along with this main report (see APPENDIX E).

6.5 Prehistoric Study[19]

Initially, this study was not included into the fold of the framework. But, during the course of the ground survey, we have accidentally found a lot of prehistoric remains such as stone tools, metal tools, ceramics and skeleton of human remains. These evident found at sites where some of them are presently occupied by local people living as their villages; and most of these sites are looted. We can identify these sites and classify them into four typologies:

- Plain mound
- Circular mound
- Circular mound moat
- Normal plain.

Along the Royal Road stretching in side Cambodia, 23 prehistoric sites are identified located in district of Pouk, Angkor Chum and Srei Snom in Siem Reap, and in the district of Chongkal in Uddor Meanchey. These sites are listed in the table below:

Location	Number of Site	Typology	Artifacts found
Siem Reap	18	- 14 Mound moat - 2 Circular mound - 1 Circulra mound moat	Stone tools, metal tools, litho phone, Ceramics and Skeletons
Uddor Meanchey	5	- 4 Mound - 1 Circular mound moat	Stone tools, metal tools, Ceramics and Skeletons

All the sites situated close to water way: stream, creek or natural water structure. Some of them are villages where people are still living and also remained ruined temples which some

[18] This entire section contributed by Ea Darith

[19] It is contributed by Heng Than

dated Pre-Angkorian period, and some Angkorian period. Some sites called *Kok Srok* situated near by the village.

6.6 Initiate Archaeological Database

We also developed the Excel format for Archaeological information collected from field survey. The structure is designed as following:

- Inventory Code by LARP
- Old Inventory Code done by Ministry of Culture and Fine Arts
- Archaeological site's name: Khmer and Romanization
- Date of Survey
- Site Location: Administrative location and its UTM
- Current Status: Threat, Looting, Vandalism, Nature (high, medium, low)
- Archaeological Typology: Temple, Arogyasala, Dharmasal, Road, Bridge, water structure, etc
- Archaeological Structure
- Art Styles; Date
- Dimension
- Remark/description

For detail information see Annex V_Archaeological database.

6.7 Application of Remote Sensing and GIS[20]

6.7.1 Objective:

- Identification the archaeological data information along the ancient road: temples, water structures, road traces, ancient industries, human settlements, and man made structures, etc.
- Surveying and analyzing the lost part of road traces, laterite step and ox-cart passage at Dangrek Mnt. Cliff near Tamean temple

[20] This section contributed by Kim Samnang.

- Mapping and Analyzing the complexities of the Ancient settlement, *Arogayasala communities*, at Kol Village (40km on the North-west of Angkor)

- Development of basic Geo-Informatics information resources for the further study

- Development of Internet Geo-Spatial Database Server

6.7.2 Methodology

6.7.2.1 Resources

- Old maps: different old maps drawn by French dated from late 19th century (Bastian, Aymonier, etc.), early 20th century (Lunet de Lajonquère) and following until current date.

- Topographic Map 1960, scale 1:50,000

- Topographic Map 1972, scale 1:250,000

- Topographic Map 2003 (JICA), scale 1:100,000

- Aerial photos dated 1945, 1957, 1997 and 2004, scale 1:40,000

- Landsat ETM 2002 with 15m resolution

- Spot 2003 with 15m resolution

- Ikonos 2005 with 1m resolution

- SRTM with 90m resolution`

- Hand Drawing Map local chief authority

Fig. 6-42 Lunet de Lajonquère, 1904

Fig. 6-43 Topographic Map 1972, scale 1:250,000

Fig. 6-44 Topographic Map 1960, scale 1:50,000

Fig. 6-45 Topographic Map 2003 (JICA), scale 1:100,000

Fig. 6-46 Aerial photo 1945

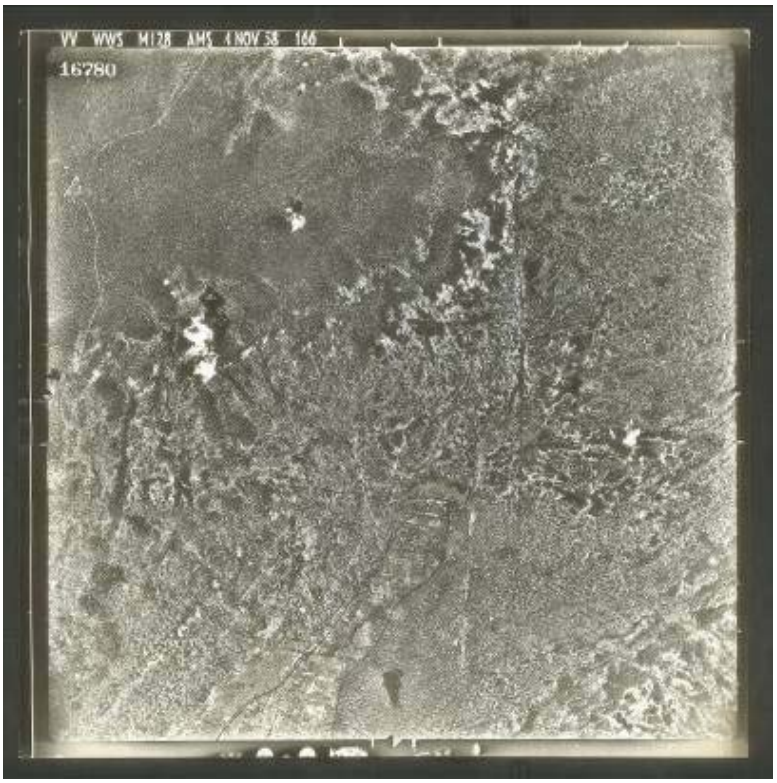

Fig. 6-47 Aerial photo 1957

Fig. 6-48 Aerial photo 1997 and 2004

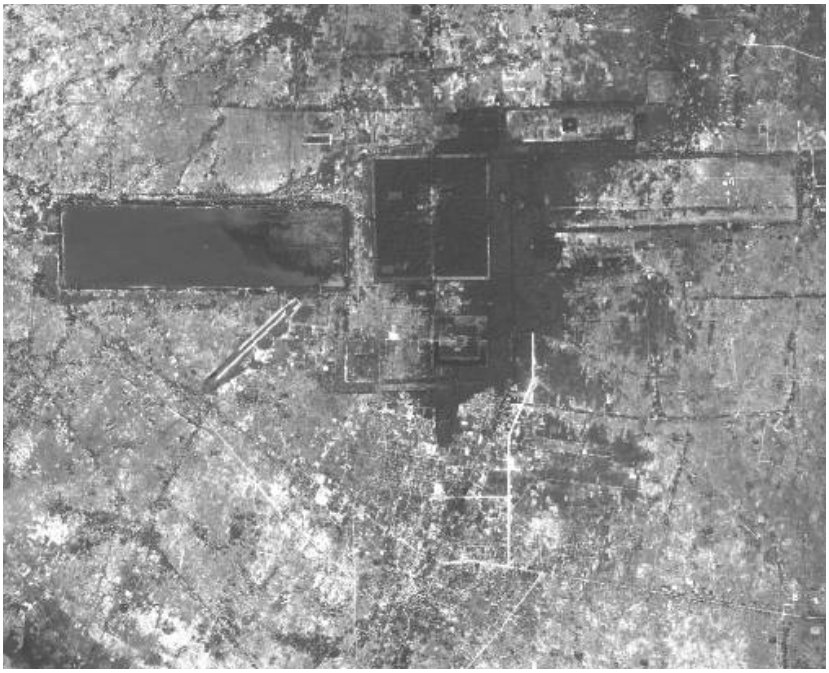

Fig. 6-49 Spot 2003 with 15m resolution