



# PRESERVATION OF TOMBS OF SULTAN IBRAHIM & AMIR SULTAN MUHAMMAD, WHS MAKLI

**1<sup>ST</sup> CONSULTATIVE COMMITTEE MEETING**

***Folio IX – Geo-Technical &  
Structural Consultants' Assessments***





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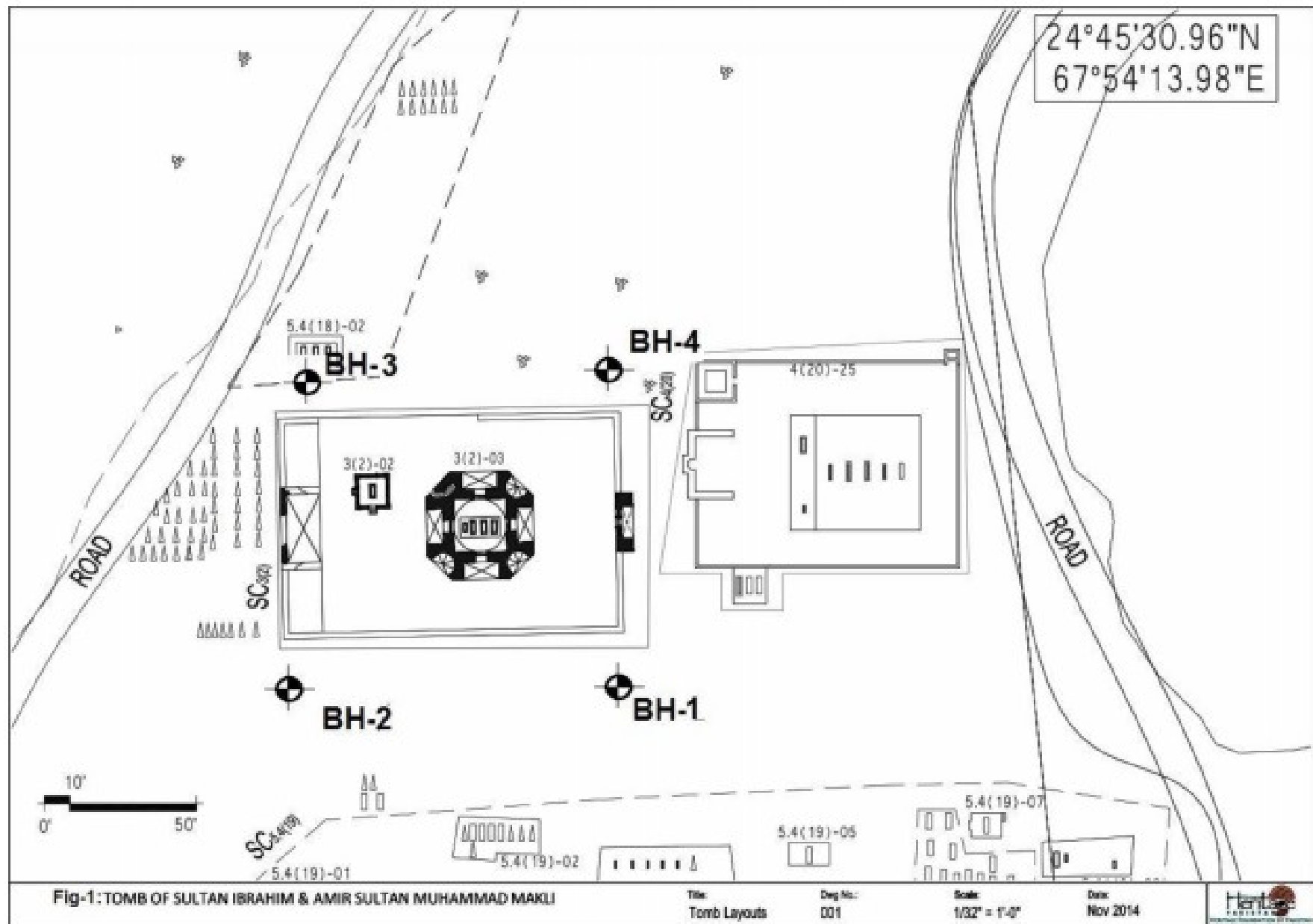
***Folio IX – Geo-Technical Findings***  
***by Consolidated Engineering Services***



## SCOPE OF GEO-TECHNICAL STUDIES

- **The program of investigation included drilling of Four boreholes up to 50ft depth, at selected locations, collection of representative subsoil samples and conducting laboratory tests with following scope:**
- **Preparation of Soil Investigation Report**
- **Recommendations**

# SITE PLAN SHOWING LOCATION OF BOREHOLES



# GEO-TECHNICAL INVESTIGATION FINDINGS

- **Stratigraphy/Sub soil profile of Tomb was found to be in following layers:**
- **Layer-I: Highly fractured, highly weathered LIMESTONE retrieved in gravelly form, which encountered from existing ground level and extended up to 5ft depth.**
- **Layer-II: Highly fractured, highly weathered very poor LIMESTONE which extended up to 30ft depth in BH-1, BH-2, BH-4 and up to 35ft depth in BH-3.**
- **Layer-III: SHALE which extended up to maximum investigated depth of 50ft.**

# ORIGINAL MATERIAL TEST RESULTS

HARDNESS ON MOH'S SCALE					
S. NO.	SAMPLE	MARKING	LOCATION	Hardness on Moh's Scale	Physical Description
1	Sample No.1	Historic Burnt Brick Specimen	Makli -Thatta	2.5	
2	Sample No.2	Original Historic Mortar - Brick (17th Century)	Makli -Thatta	3.5	
3	Sample No.3	Original Historic Mortar -Kashi Tile Layer 2 (17th Century)	Makli -Thatta	> 1	
4	Sample No.4	Original Stucco Plaster (17th Century)	Makli -Thatta	3.5	
5	Sample No.5	Stone Lime	Jangshahi	1.5	Lime
6	Sample No.6	Chiroli ( in Stone form before Burning )	Thatta	2	Gypsum

COMPRESSIVE STRENGTH & ABSORPTION TEST OF BRICK								
SAMPLE	MARKING	LOCATION	BULK DENSITY		COMPRESSIVE STRENGTH		ABSORPTION	
			gm/ cm <sup>3</sup>	Pound/ Inch <sup>3</sup>	Kg/cm <sup>2</sup>	PSI	24 HOUR	5 HOUR BOILING
Sample No.1	Historic Burnt Brick Specimen	Makli - Thatta	1.423	0.0514	56.2	808.2	20%	23%

# ORIGINAL MATERIAL TEST RESULTS

CHEMICAL TEST											
S. NO.	SAMPLE	MARKING	LOCATION	Magnesium Oxide MgO	Silica SiO <sub>2</sub>	Alumina Al <sub>2</sub> O <sub>3</sub>	Iron Oxide Fe <sub>2</sub> O <sub>3</sub>	Calcium Carbonate CaCO <sub>3</sub>	Loss On Ignition	Calcium Sulphate Dihydrate CaSO <sub>4</sub> . 2H <sub>2</sub> O (Gypsum)	Calcium Oxide CaO
				%	%	%	%	%	%	%	%
1	Sample No.1	Historic Burnt Brick Specimen	Makli -Thatta	3.99	55.11	19.68	7.32	3.54	1.82		
2	Sample No.2	Original Historic Mortar - Brick (17th Century)	Makli -Thatta	0.40	6.96	4.53	1.35	0.57	20.08*	81.80	2.23
3	Sample No.3	Original Historic Mortar -Kashi Tile Layer 2 (17th Century)	Makli -Thatta	0.39	7.10	4.73	2.34	3.43	19.96*	80.21	
4	Sample No.4	Original Stucco Plaster (17th Century)	Makli -Thatta	Nil	1.03	1.16	0.33	3.84	22.16*	93.79	
5	Sample No.5	Stone Lime	Jangshahi	< 0.02	0.20	1.03	0.12	11.93	24.45		66.79
6	Sample No.6	Chiroli ( in Stone form before Burning	Thatta	Nil	2.49	2.17	4.55	5.34	23.83*	83.50	



# PRESERVATION OF TOMBS OF SULTAN IBRAHIM & AMIR SULTAN MUHAMMAD, WH MAKLI

***Folio IX – Structural Consultants Findings***

***By Amin Tariq Associates***





## CONCLUSIONS BASED ON GEO-TECHNICAL FINDINGS

- It is envisaged that the foundations of the Tomb are at shallow depth of the order of 3-4 ft below natural sub grade which essentially consists of LIMESTONE
- It is envisaged that the Tomb structure is supported on Strip Foundation on the periphery of the Tomb structure.
- The area surrounding the Tomb is covered with a platform of stone blocks extending around the Tomb to about 30ft on East, 50ft on West and 20ft on North and South. The platform is about 2ft above the surrounding grade level
- Based on physical features, it appears that the Tomb has not suffered any distress related to the performance of foundation system.
- The platform of Stone Blocks around the Tomb has provided a cover to the surrounding sub grade and saved it from weathering. However, it is likely that the lime mortar binding the stone blocks, has weathered over the period which provides access to the rainwater to percolate into the sub grade. Such a phenomena is detrimental which may cause weathering of sub grade (Limestone) and weaken the foundation system supporting the Tomb.

## OBSERVATIONS

**These structures were subject to severe floods and earthquakes during their life time so far and the signs of distress are quite visible from the surroundings. During floods these small hills were used as shelters hence much of the damages might be due to robbery or theft.**

**The apparent condition of Tomb of Sultan Ibrahim does not immediately alarm about global instability cause there is no significant tilt, major diagonal or vertical cracks at present.**

**These cracks if existed might have been repaired but never reappeared till now. Local spalling and detachments are quite expected.**



Structural Issues in Historic Masonry

## GENERAL OBSERVATIONS

**The walls have visible reddish tiles as later additions on all the outer faces the most and inner faces also.**

**The historic tiles laid in lime mortar has muddy or brownish color and one can easily be distinguished.**

**All problems like coving, crumbling are present but rise of damp or apparent efflorescence could not be observed. May be some sub-efflorescence existed which need be verified.**

**Lots of signs of robbed out masonry tiles with cavitations can be seen. Few of the entries to the dome from outside are kept closed by thorny bushes.**

**Lime stone of historic traditional yellowish color is also part of construction. Internal gravestones are also of same origin with beautiful work by artisans.**

## OBSERVATIONS ON DOME

**The dome itself has outer main shell and inner as false shell. Outer dome shell has few dents distorting the round geometry and look critical.**

**The inner dome has very damaged condition with lots of spalling , pitting or detachments may be sort of crumblings or just the damage by birds keen to making holes or nests.**

**This part is serious and need to be supported by some sound arrangement or immediate conservational strengthening.**



# STRUCTURAL SAFETY ZONING OF TOMBS AT MAKLI

## [ZONING CATEGORIES]

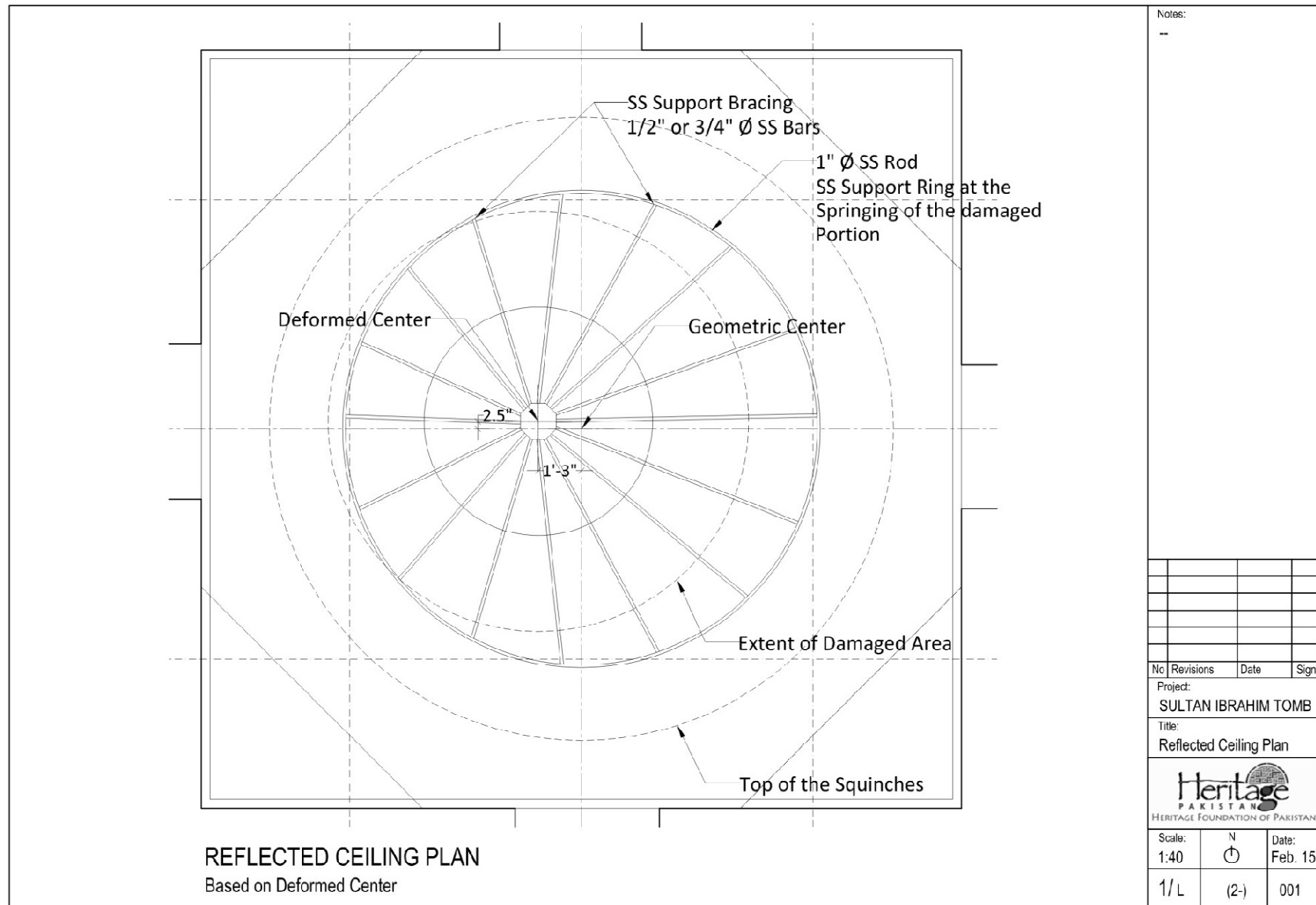
- **Makli Necropolis can be divided into four Zones with respect to Structural Safety.**
- **Zone-A:** It is non-historic part comprising local shrine as later addition .Hence to be removed whenever possible but keeping safety on top priority with zero damage to adjoining historic parts.
- **Zone-B:** This is relatively safe zone for historic conservation works if to be carried out. Minimum danger of global failure but local failure may occur hence one can move inside with precautions and care.
- **Zone-C:** Dangerous Zone but movement for conservation works is possible with safety & care.
- **Zone-D:** This is the zone which is technically collapsed because tilt is much more than permissible limits and separated parts at top levels may fall down and most dangerous to the people and property inside and around. This is no-go area and any sort of activity is not permitted inside or around.



## CONCLUSIONS & RECOMMENDATIONS

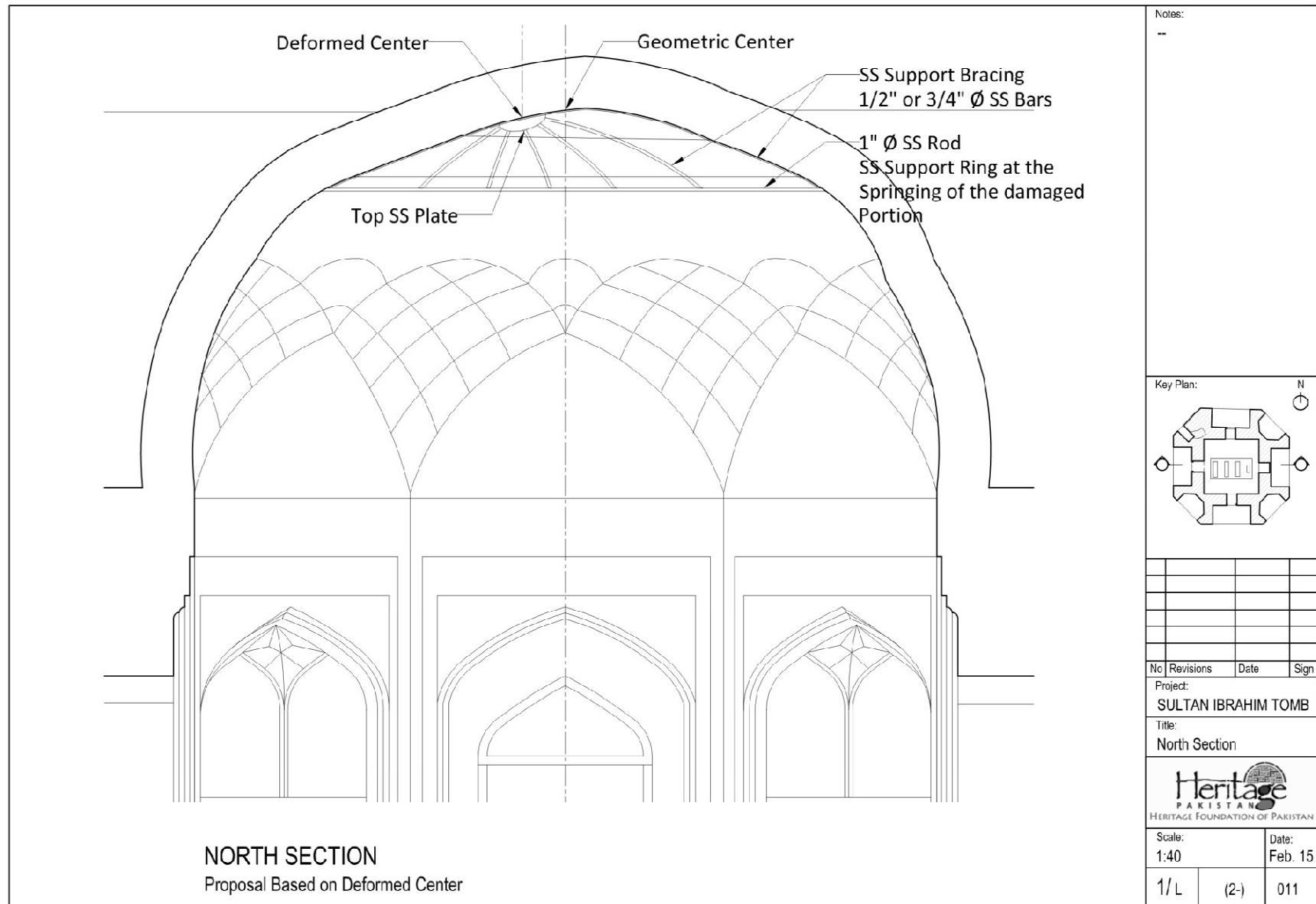
- **The Tomb of Sultan Ibrahim and Amir Sultan Muhammad comes under Zone C except dome which comes under zone D.**
- **The dome looks critical and need to be supported immediately; therefore the temporary scaffolding system is recommended.**
- **Moreover, bamboo cover may protect the grave with wooden planks as base.**
- **Tomb has not suffered any distress related to the performance of foundation system as per geo-technical report**
- **As per geo-technical report, around the Tomb, platform of stone blocks covers the surrounding sub-grade and saved it from weathering. But the lime mortar binding the stone blocks has weathered over the period which provides access to the rain water to percolate into the sub grade. So, the lime mortar binding should be renewed as it could be harmful to the structure causing weathering of sub grade and weakening of foundation system supporting the Tomb.**

# RECOMMENDATION FOR INNER DOME STABILIZATION

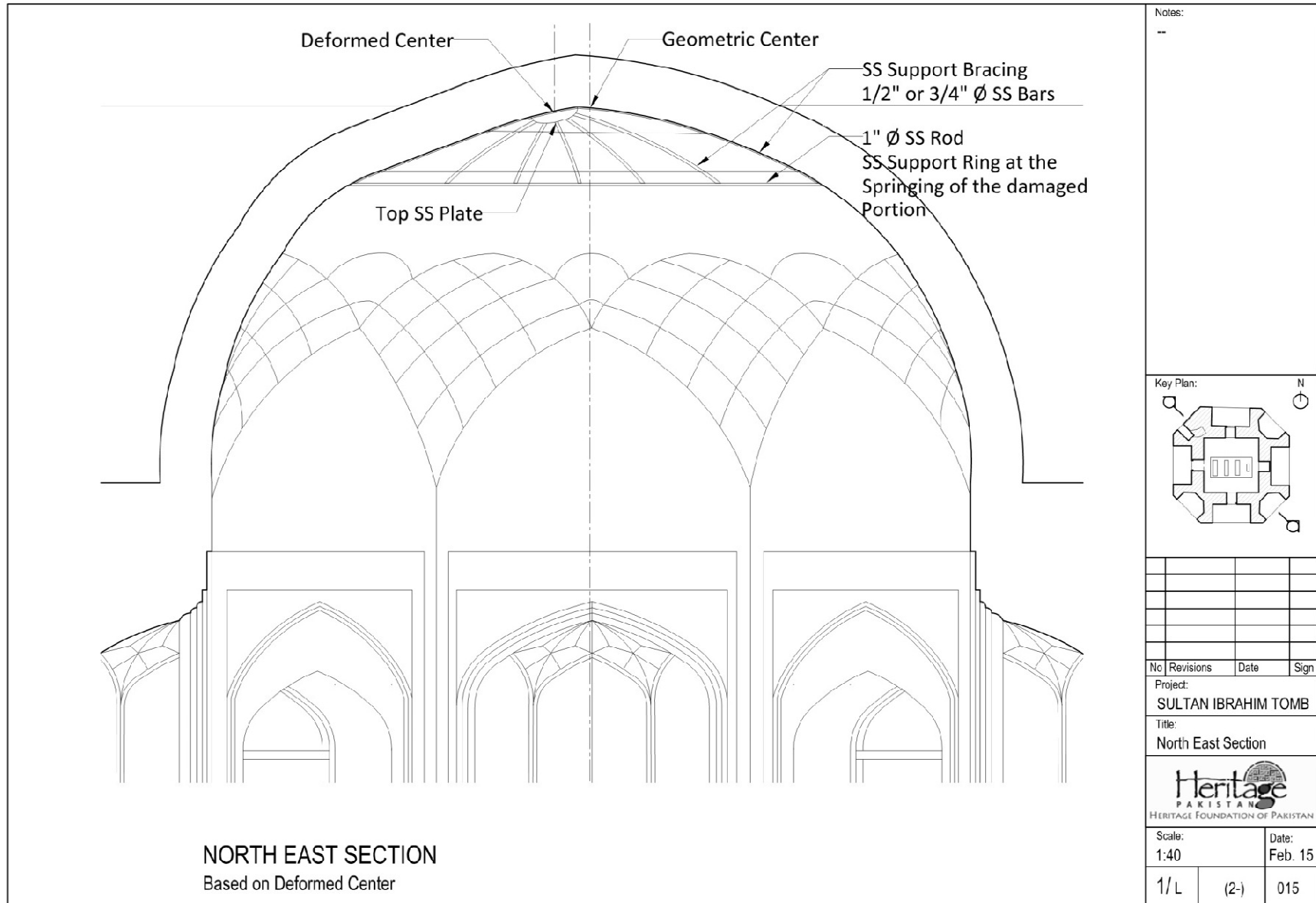




# RECOMMENDATION FOR INNER DOME STABILIZATION



# RECOMMENDATION FOR INNER DOME STABILIZATION



# RECOMMENDATION FOR SCAFFOLDING

