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1. INTRODUCTION

The guy anchor foundation (Leg A) of the Beta–Delphi 400kV Line Tower 74 pulled out on the 13th May 2021 which caused the line to trip however the tower did not collapse. The tower was stabilized on the 15th May 2021 by installing temporary woodpole stay anchor 3m in front of the failed anchor as shown on Figure 2. The tower is located on a maize farm in the Free State, see Table 1 for the TXIS details of the tower and Figure 1 for geographical position of the tower. Figure 3 shows the section of the deadman foundation that pulled out, it is also evident from the picture that the cause of the failure is the corrosion on the link plate. The concrete was also encased in a steel pipe which had also corroded.

It is the aim of this report to provide the Scope of Work (SOW) for the replacement of Tower 74 anchor foundations and investigate the causes of the accelerated corrosion because the line is fairly new.

Table 1: for Beta - Delphi 400kV Tower 74 Stay

BET/DEL	74	75	TERN	3	19/2.7	19/2.7	4500073136	TOWERTEL/OPTIC1	522.0m	36.397km	60C	2007
BET/DEL 74	N	529	B	30.40	F34A	11	-29.037676S	25.763777E	1253.3			

Figure 1: Location of Tower 74

Figure 2: Temporary Wooden Poles

Figure 3: Section of the guy anchor that pulled out

1.1 SCOPE

Replacement of all anchor foundations for the Beta - Delphi 400kV Tower 74

1.2 PURPOSE

The purpose of this document is to detail the scope of work for Replacement of all anchor foundations for the Beta - Delphi 400kV Tower 74

1.3 APPLICABILITY

This document shall apply throughout Eskom Holdings Limited Divisions.

1.4 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs

- 240-47172520 (TRMSCAAC6) - The Standard For the Construction Of Overhead Powerlines
- Trmscabg8_Corrosion
- Construction Regulations

  2014
- ISO 9001:2015 Quality Management System
- ISO 14001: 2015 Environmental Management System
- National Environmental Management Act, 1998 (NEMA) (Act No 107 of 1998)
- Occupational, Health and Safety Act 85 of 1993

1.5 HEALTH AND SAFETY

- Qualification/training requirements
- Prevention/mitigation measures.
- No climbing of towers is permitted and all work to be done at ground level.
- No outages will be required. No live-line authorization is needed since all work will be Executed on ground level.
- Safety regulations applicable to ground work under power lines will need to be followed.
- Personal Protective Equipment (PPE) as marked below

												
O/all	Pants	Top	Dust coat	Hard hat	Gum boots	Safety shoes	Safety Glasses	Dust mask	Respirator	Ear protection	Safety (harness)	Gloves
X				X	X	X	X				X	X

1.6 DEFINITIONS

Term	Definition
Construction work	The installation, erection, dismantling or maintenance of a fixed plant where such workincludes the risk of a person falling
	The construction, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system or any similar civil engineeringstructure
Contractor	An employer who performs construction work and includes principal contractors

2. PRELIM INVESTIGATION

2.1 CORROSION ASSESSMENT

The Beta- Delphi Line 400kV was commissioned in 2007, which is new to have the severe corrosion that will lead to the failure of a foundation anchor. According to the corrosion Table 2 which explains the different categories of corrosion, the link is categorized level 7 because the member had completely disintegrated , broke off and pulled out, the recommendation for this project is to replace all deadman foundations of Tower 74. From the site visit conducted by LES, there was various observations made that could contribute to the corrosion found on the pulled out stay. The steel encasement around the concrete from the deadman section that pulled out, shows severe corrosion as shown on Figure 4. The corrosion on the steel encasement sleeve/pipe is of no surprise since the steel was in direct contact with the soil.

The link plate on the other hand was encased in concrete but not the entire link was encased, the bottom of the link was also in direct contact with the soil. This facilitated the corrosion to the point that there was material loss leading to the failure of the foundation as shown on Figure 5.

Table 2: Corrosion categories

Corrosion Category:	Corrosion Condition	Restoration Category
1	No visible signs of galvanic depletion. Galvanising thickness 60 microns or more.	No Corrosion
2	No visible signs of galvanic depletion. Galvanising thickness 30 - 59 microns.	
3	Galvanising visibly depleted. Onset of steel discolouring	Light Corrosion
4	Galvanising almost depleted. Thin film of rust developing in surface.	
5	Deeper rust hardened crust / Pitting in smaller areas of 2cm	
6	Component rusted through more than 30% of cross sectional area	Severe Corrosion
7	Component rusted through more than 60% of cross sectional area and or completely disintegrated	

Figure 4: Corrosion on the encasement

Figure 5: Corrosion of link plate

2.2 CONCRETE DEFECTS

Many were picked up when it comes to the concrete from the section that pulled out. First being that the concrete looked like it was not mixed well or vibrated correctly. The sand from the concrete had separated from the stones which means that the concrete strength had been compromised and might had cracked as well. From the top of the section it was found that there was no concrete but what seemed like a brick and debris as shown on Figure 6. The incorrect material inside the encasement allowed for water to penetrate to the link and cause corrosion. From the images is also evident that there were air gaps between the bricks and debris allowing water to pond in the section. For the concrete encasement to be effective in protecting the link it has to be socketed into the foundation plinth, but in this instance the link was not encased all the way to bottom. Figure 7 shows the breaking point of the corroded stay, there was no concrete found at the bottom of the excavation during the failed anchor investigation.

Figure 6 : Debris and bricks inside the encasement

Figure 7: Breaking point of the corroded link

2.3 FARMING ACTIVITIES

The tower is on a maize farm and the contaminants can influence the rate of corrosion on the foundations. Soil sampling to be done in order to determine what type of contaminants are in the soil. The farming activities have also lead to the foundations (masts and anchors) being buried as shown on Figure 8 meaning that the link plate is in direct contact with the soil promoting corrosion. The guy anchor foundation should protrude above ground a minimum of 250mm as per specification. Figure 9 shows the white clayish material which is an indication of the water path for the water encountered in the excavation. The soil type for tower 74 is type 4 defined as submerged cohesionless and cohesive soils. This includes all soils below the permanent water table, including soils below a re-occurring perched water table, or permeable soils in low-lying areas subjected to confirmed seasonal flooding.

Figure 8: Buried guy anchor foundations

Figure 9: Water encountered in the excavation

3. FOUNDATION DESIGN & CONSTRUCTION

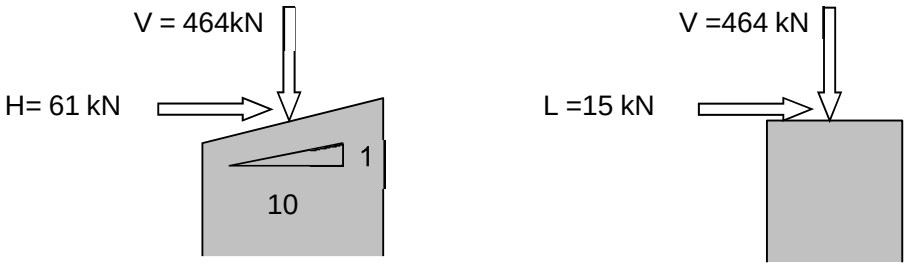
3.1 FOUNDATION LOADS

The tower type installed is the 529 B Cross rope, see Appendix A for the tower outline and foundation drawing. The foundation loads of the tower are provided below. The Contractor will use the loads to design the dead man foundation system considering also the soil condition which will be determined using TRMSCAAC Rev 6.

The 529B Crossrope Tower (3Tern Conductor)

Factored Foundation Reactions for Critical Loading Condition

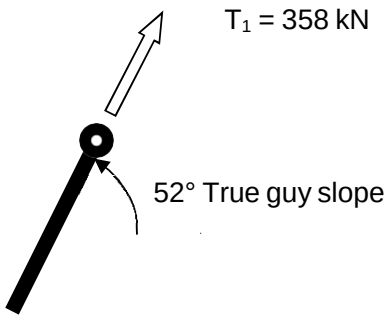
a) Mast foundation loads



V = Factored vertical component of mast load

H = Factored horizontal component of mast load

L = Factored horizontal shear load due to wind - can occur in any direction



3.2 CONSTRUCTION OF NEW FOUNDATIONS

The process for the installation of the new guy is explained below in the steps below.

Figure **10** illustrates all the foundations for Tower 74, the new foundations will be installed 4m away from the existing foundations along the same radius. The vertical angle of the tower to be kept constant.

1. The Contractor will be required to provide the design of the new foundation done as per TRMSCAAC 1 Rev 6 to LES for acceptance.
2. Before any construction can start, the tower has to be back stayed, the Contractor to advice on the preferred method of backstaying the tower. All the hardware, existing guy wire, attachment points to be inspected prior to construction.
3. The Contractor will need to make use of a qualified surveyor to peg the exact position and alignment of the new anchor as per Figure 10.
4. The anchor links of new foundations are to be encased in concrete to 250 mm above ground level with a smooth watershed top surface. The link to be encased in a 300mm diameter HDPE Pipe that will be used as permanent form work.
5. All the links must be painted with bitumastic paint 500mm above and 500mm below NGL, the concrete can also be painted with a corrosion protection coat.
6. The concrete to have a minimum 35MPa at 28 days.
7. The process of transfer of the old stay to the new one will only commence once the concrete tests pass, and the transfer will be done one leg at a time.
8. The new anchor attachment to the existing guy shall utilise known methods of attachment which will not be prone to slippage, such as be performed guy grips.
9. Temporary connection plates will be attached to the link plate. Slings will be attached from the connection plate to the guy wire. The sling will be gradually tensioned to introduce slack on the bottom end of the guy wire. This will allow the guy wire to transfer to the new foundation.
10. The guy wire will then be attached to the new link plate and tensioned to remove the slag.
11. A waiting period of 1 minute shall be required before the load is transferred from the old anchor onto the new anchor. This will be required to investigate any movements of the new anchor and associated hardware.
12. After the successful transfer of the anchors, the old anchors should be excavated to remove the entire deadman foundation for investigation purposes

13. All excavation should be backfilled as per TRMSCAAC 6.

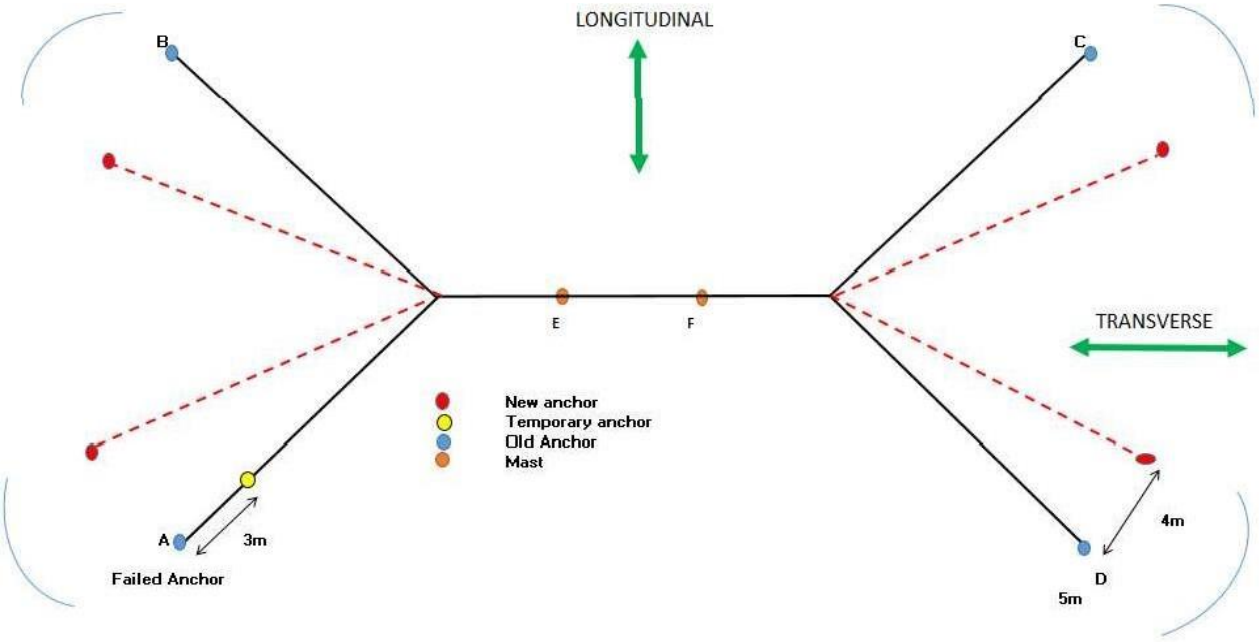


Figure 10: Location of the new foundations for Tower 74

4. PROJECT RISKS

The following risks can be encountered on site and must be taken into account when compiling the Safe Work Procedure:

(i) Unstable Tower

(ii) Unstable ground during excavation

(iii) Risk of failure of equipment

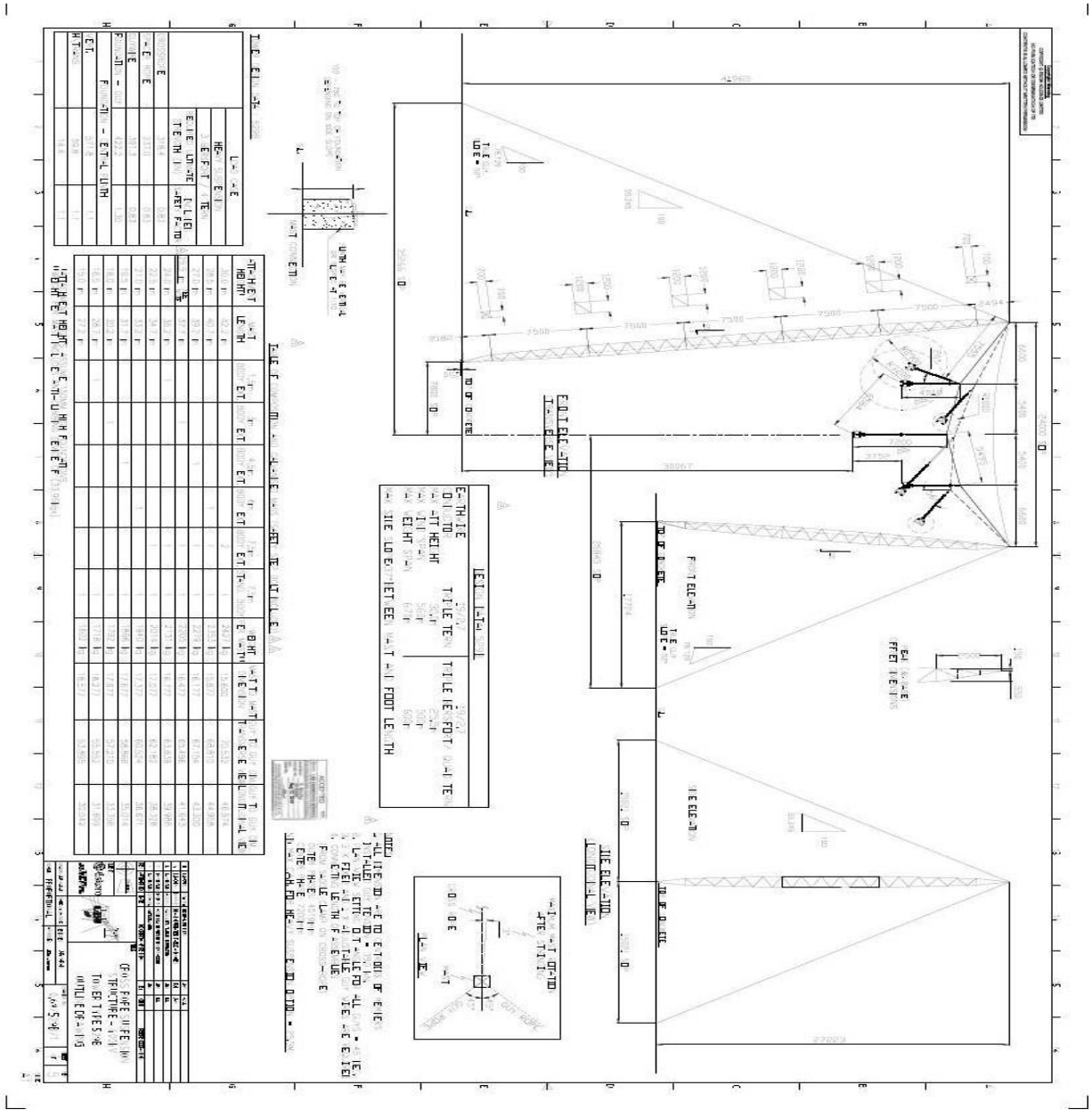
(iv) Excavations next to the old anchors that could be corroded

(v) Backfilling next to the old anchors that could be corroded

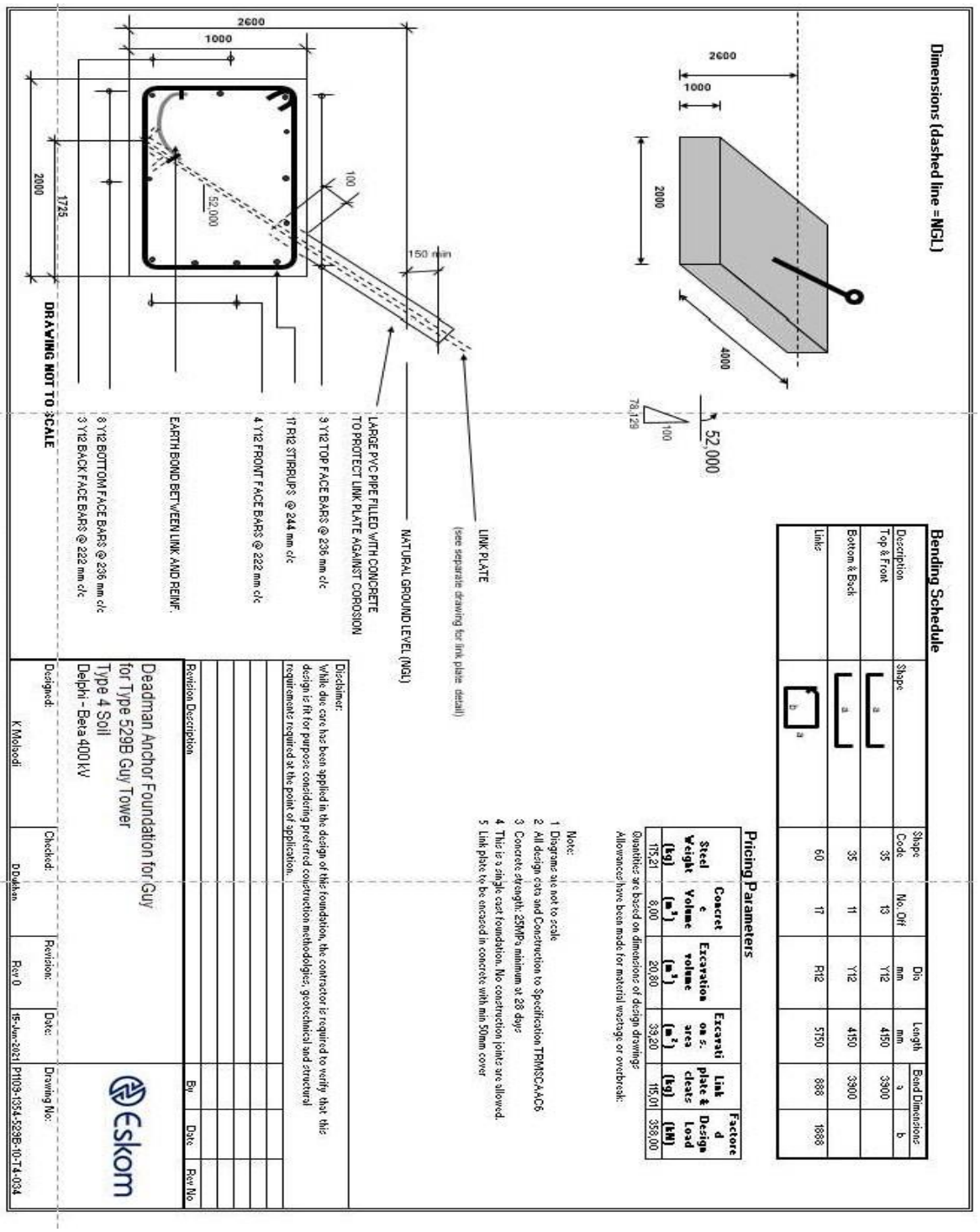
(vi) Transfer of loads from the old to new anchors

5. APPENDIX A

5.1 TOWER OUTLINE – 529B



5.2 FOUNDATION DRAWING



5.3 Bill of Material

Bill of Material			
1.	**Minor works**		
1.1	Pegging of new tower position Guyed –Vee Tower	no	1
1.2	Soil Nomination for foundations as per TRMSCAAC 5.3 (2 per tower)	no	3
2.	**Installation of foundations (Refer to attached drawing)**		
2.1	Excavation	m^3	20,80
2.2	Concrete volume	m^3	8
2.3	Formwork surface area	m^3	39.20
2.4	Steel weight (Rebar)	Kg	175.21