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A STUDY ON INSTALLATION OF HDPE MICRO DUCT FOR INTEGRATION OF TELCOM UTILITY CORRIDOR IN LINE WITH THE CIRCULAR ECONOMY

Raji johnson Chacko. Btech, MBA, PMP

Research student (Off -campus) IIC University of Technology, Cambodia

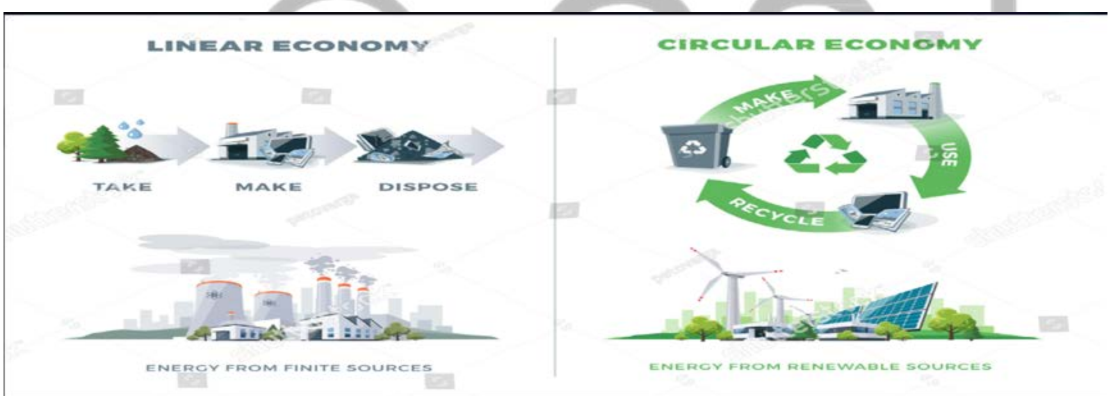
Abstract

The Circular Economy Policy **(1)** is the comprehensive framework for a country's governance approach to achieving the ideal use of natural resources, thereby adopting the consumption and production methods that ensure the quality of life of Future Generations. In January 2021, the U.A.E. cabinet approved the circular economic policy. The above policy comprises of the key objectives of:

- Promoting environmental health
- Supporting the private sector in adopting clean production methods
- Reducing natural environmental stress to achieve the country's vision to be a global pioneer of green development.

This framework of the policy is policy is for identifying the priorities in terms of a circular economy. Priorities include the sustainable approach to infrastructure, transportation, manufacturing, food production, and consumption. The circular economy promises to reduce waste, derive more value from products, Reduce damaging emissions.

Many European countries have already adopted the circular economic criteria and values, enabling them to change from the linear model of the economy towards the circular model, towards the circular model.



The expected outcome of the policy is

- Generate considerable economic proceeds for the country
- Mitigate environmental pressures
- Ensure the supply of raw materials
- Increase competitiveness
- Motivate innovation
- Strengthen economic growth
- Create job opportunities.

This important point of this research study proposal is to explore the possibility of having a common Right of the way underground utility corridors for Telecom, ITS, Fiber Optic Cables replacing the present way of allotment of an exclusive separate corridor Telecom, ITS, Fiber Optic Cables Electricity. This study has been done keeping a typical reference of the cross-section of utility corridors published in the Abu Dhabi infrastructure utility manual ROW-601 **(2)**

Recently Installation of HDPE micro ducts is being installed by various infrastructure utilities like telecommunication corridors, Electricity corridors, etc. When it comes to the circular economy, if any utility installs multiple HDPE micro ducts in their corridor, the other utilities can share the spare micro duct which are newly installed utilities for their network development. This methodology enhances the adoption of circular economy policy ineffective way by reducing the installation of non-degradable materials in utility corridors, which enhances the generation of frees spaces in utility corridors.

1. INTRODUCTION

Recently Installation of HDPE micro ducts **(3)** is being installed by various infrastructure utilities in their own corridors like telecommunication corridors, Electricity corridors, etc. This High-Density Polyethylene (HDPE) ducts are generally used for the construction of underground duct systems.
The configuration of the future path HDPE ducts consists of two or more various ducts called Micro ducts. This is an advanced solution for those customers who require a large number of fiber optic connections. Accordingly, the various bundles of fiber cables can be blown in the micro duct to plan for future possibilities and city developments.

Figure 1. Typical High-Density Poly Ethelene Micro ducts

The fiber optic and bundled telecom cables can be installed in the network by utilizing the HDPE Micro duct. These ducts are installed by direct buried in an excavated trench size of 0.6M(Width) x1.0M(Depth) small trench of 0.6M(Width) x1.0M(Depth).
In the modern world, the high M density Polyethylene Micro ducts s are used in FTTH networks **(4)** worldwide.

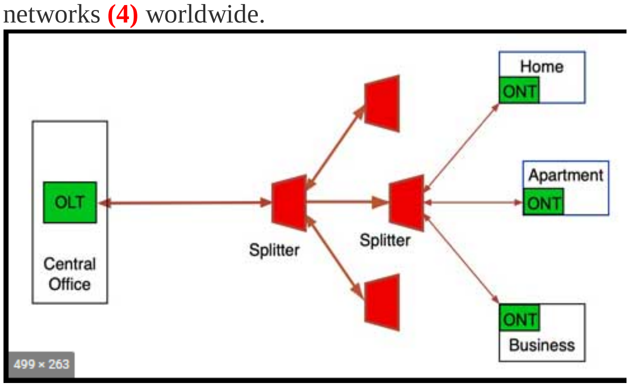


Figure2. Typical FTTH network

The FTTH (Fiber to the Home) represents an optical fiber architecture. In this technology, multiway fiber cables can be installed for access network direct to customer's buildings or offices or premises. The purpose of using optical cable in the access network is to provide broadband services to the customers. Using the fiber optic cables **(5)** makes high data rates possible due to the availability of huge bandwidth, which leads these in stallion a cost-effective solution.

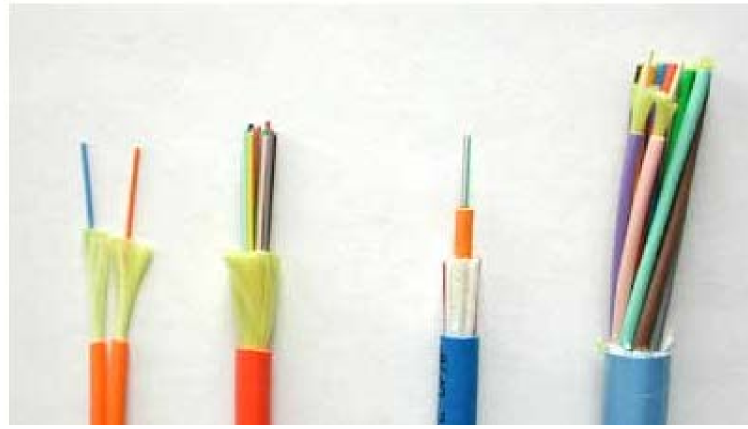


Figure .3 Various optical Fiber cables

The Fiber optic cables are of different types, which depend on the number of fibers. There are different ways of installation of fiber cables.
The factors affecting the selection of the fiber cables are to be considered. The first is the environment encountered in the installation, i.e., direct burial, underwater, strung aerially, whether the cable is exposed to chemicals, etc.
Mostly in the city developments and or in the telecom networks /providers, the Outside plant cable designs are optimized for underground installation in U.A.E.

1.1 <u>**Underground Cables**</u>

Underground cables installed in ducts, usually in 4 inches (10 cm) conduit with multiple inner ducts for pulling cables. In this method, cables are designed for high pulling tension, and lubricants are used to reduce friction on longer pulls. The cable winches are automated for controlling the pulling force

1.2. Installation Methods of Fiber Optic Cables (6) A) Direct Buried Cable

Direct buried cables are usually installed underground without any conduits. Here the cable must be designed to withstand the dirt, so it is generally an armored cable to prevent harm from rodent destroy or the pressures rocks in which it is buried. The direct burial method of installations is limited to areas where the ground is mostly mixed with soil and rocks. Hence up to the required depth trenching or plowing can easily accomplish. The micro duct should be installed deep enough in the ground to prevent it from being damaged by other utilities, tree roots, and freezing groundwater. It has to ensure that the trench bottom is leveled with soft sand, enabling micro-cut to be laid flat without bends. Care should be taken during installation to avoid sharp bends in the duct to make fiber installation easier..

It is better to reinstate with fine sand over the duct, up to 30cms above the installed duct. This protects against damages to the duct during compaction. During the installation of the access box or split boxes, proper alignment of the micro duct and access boxes or split boxes are to be maintained

1.3. B) Micro trenches or Slot

Trenches Micro trenches are usually used for the burial of ducts in hard surfaces, such as roads and footpaths. The Micro duct is installed at the bottom of the narrow trench. This trench shall typically be 12 mm (0.5 inches) wide. The practices followed during micro trenching to ensure the bottom of the trench is level is flat, enable the micro duct to lie flat. The trench must be clear of debris in a dry environment. The sharp bends must be avoided in the duct to make easier fiber installation simpler. It is always better to use fine red sand before and after installing the micro duct to prevent damage by stones being buried in dirt,

1.4. C) **Mole plow installations**

With the help of a tractor or excavator, a mole plow cuts a slot similar to a farmer's plow. The above unit is loaded with the micro duct along its back edge. The micro duct is drawn into the hole made in the ground by the tip of the plow. The two types of plows are vibrating and non-vibrating. Where ever there are roots or small stones in-ground, the vibrating plow is being used. This method cuts through the roots and pushes stones out of the way. Follow these best practices when mole plowing. Carry out Mole plow only where there are no hard surfaces, and there are unlikely to be other services. The machine should be chosen considering the profile of the ground; for soft soil, use a machine with wide If the ground has tree roots or small stones, use a vibrating plow.

While installing micro duct, do not lay the micro duct out on the ground to be pulled after the machine because it will be damaged and stretched

1.5. D) Install Micro duct in large duct

The micro duct is to be drawn and installed in larger ducts. The following methods are to be adopted while using this method. There should be sufficient space in the duct. The Micro duct is to be drawn /Pulled in extra length; as in the case of directional drilling, the length of the micro duct to be installed inside the large duct may increase. Allow for expansion of the micro duct if air temperatures or storage temperatures are high. Before restraining, the micro duct is to be kept for a minimum of 24 hours after installation to reach the same temperature as the duct and jointing chamber. Use a swivel to prevent the micro duct from twisting as it is pulled into the duct. While the winch machine to pull in the micro duct does not exceed the maximum pulling force. Pulling socks to be used for distribution of the pulling force over the first part of the micro duct

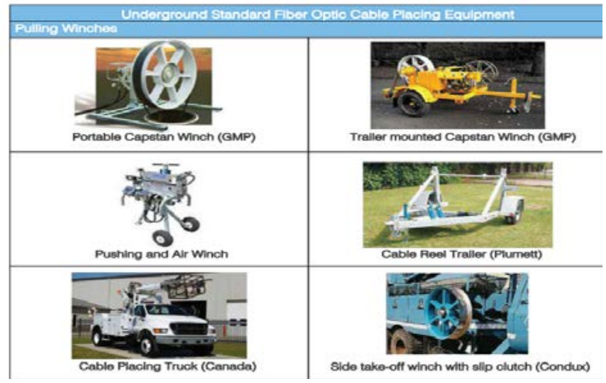


Figure 4. Different equipment's for Duct& Optical FO cable installations

1.7. Duct Integrity Testing (DIT) for Micro Ducts (7)

After installation and backfilling of the trenches, ducts shall be tested for fiber cable integrity.

Four types of tests are conducted:

1. Air Tightness Test
2. Foam Sponge Test
3. Mandrill Test
4. Pressure Test

1.8 . Air Test for cleaning the duct for dust

The following are the procedures for carrying out the test

• Fit a D.I.T. catcher on the far side and equip personnel with two-way radios.

• Allow the air to flow through the duct for at least one minute, to remove all loose particles and/or moisture.

1.9.Foam Sponge Test – Cleaning the duct for micro particles :

The following are the procedures for carrying out the test

• Fit a D.I.T. catcher on the far side and equip personnel with two-way radios.

• Allow the air to flow through the duct for at least one minute, to remove all loose particles and/or moisture.

1.10. Mandrill Test – check for bends in duct and , kinks or blockages in ducts :

The sponge test must be done preceded the mandrill test due to dust can damage a duct.

• Always use long mandrill made from Nylon or Teflon of 4cm size

• The outer diameter of the mandril must be no more than 85% of the micro duct in•
D.I.T. catcher must be used at the receiving end, a
• Care to be taken that a mandril can cause injury and/or damage to the human body
• Inspect the condition of the mandrill that emerged for, visible grooves which is an indication of duct particles

1.11. Pressure Test – check for coupler leaks or micro duct punctures:
• Place high-pressure end-cap at the far side of the duct end
• Increase gradually the pressure to be built up to 10 bars.
• Inspect the couplings used for this test by using soap, water, and a sponge for any leak
• The pressurized air must be fed and leave the duct open till pressure in the duct stabilizes at 10 bars.
• The air valve on the testing equipment must be closed to monitor the pressure gauge for 5min.
• Any leak greater than that must be found and fixed; however, losing 1 bar in 5min is acceptable –.
If the duct fails D.I.T. tests, action should be taken to use an alternative duct or repair the designated duct.

2) Design Methodologies

2.1 Planning a Utility corridor (8)

Planning Utility Corridors Practice Statement:
All the Designers and the Planning consultants should evaluate all the factors taken in to consideration while determining the placement of underground utilities.
Ideally speaking, the existing utility corridors must be used /occupied to the maximum /fullest extent before create a new installation.
The best and realistic design is "creation **of a common utility corridor for the current, and future placement of all utilities".**
While Pre-planning for allocation of a utility placement within current or proposed utility corridors it is very necessary to check and evaluate the size, and location of the area to be utilized.
The best practice is to bring the identical or similar utilities and its corridor in parallel /adjacent with one another.
This type of design will be helpful to adopt the identical utility to install near to each other which will be helpful to swap the corridor in case of any requirement. This will avoid the crossing across the other corridor while installations

In case of entirely a new installation in proposed corridors, the information should be developed and must be assessed considering the context of a common corridor configuration so that identical utilities can accommodates or share the corridor
While planning the utility corridor all specific consideration should give to the problems such as safety, future operations, setbacks, prevention of boundaries, specially clearances for future expansion
Planning practices should include developing joint trenching of Utility corridors should be considered as options for maximizing the effectiveness of the available area.
Also, proper consideration has to be given to standardize the line locations that promotes the safest, most efficient, and most effective installations.

2.2. Typical Utility Corridor allotment

Guide lines for corridor development
The increase in the population warrants the usage of utilities more due to continuous growth which result in the expansion of different utility networks.
This expansion resulting in to restriction of the spaces and demand of the nearest land which usually come in to conflicts
Usually, town planning is a wider subject which re to be in line with the Town planning sector designs, urban planning designs, urban corridor designs

2.3 Process for Developing a ROW Utilities Cross Section

The ROW (right of Way) is a set of different elements that have their own functionality and are integrated in the form of a road corridor.
The development of the cross section of Right of way utilities are usually dependent on the following:
A) Functionality of the road;
This is defined by the road hierarchy and the accessibility and mobility options.
B) Type of utilities and services
This is based on the demand of such services and utilities.
C). Order and arrangement of different types of utilities;
These are dependent on the specifications and standards of the service providers.
D) Geometric design standards;
These geometry standards are which are related to the road locations and other road elements e.g., medians and sidewalks.
D) Functionality of Roads
The functionality plays an important role in determining the hierarchy of the road. This defines the Corridor width, location of services, the utilities which are the main factors affecting the overall design of the road
Based on the above factors the roads are divided into many types

1. **Controlled access road**;

These roads provide higher level of mobility and lesser level of accessibility. The roads, which fall in this category, are Main roads.

2. **Non controlled access road;**
   These roads provide higher level of accessibility and lower level of mobility and roads, which fall in this category, are local streets and collectors.
3. **Other standard roads** are 30 feet road ,60feet road ,100feet road ,10feet road ,200feet road etc.

Generally, all these roads are being allotted with various utility corridor with adequate width for easy installation of the utilities

General design aspects of Right of Way (Examples)

The right of way ROW Width is based on the functionality of the road. The ROW can be estimated by considering the following road elements:

1. **Median width;**

The median width is dependent on the type of infrastructure that is to be placed within the median. In general, the center median is always installed with the lighting poles Usually, the light poles are placed in the median. The median width varies and depends on the overall width of the Right of Way.

2. **Carriageway width;**

The carriage way always depends on the number of lanes that are to be placed within the carriageway. Generally, each lane is 3.65 meters wide and a minimum of 2 lanes are provide in a non-controlled access road. The lanes of the road shall be increased depends on the hierarchy of the road, traffic volume

3. **Utility corridor width;**

The utility corridor is dependent on the types of utilities and services that are to the placed within the utility corridor. Each utility and service provider has its own corridor width requirements

4. **Width of service road;**

The width of service road is dependent on the number of service lanes.

5. **Parking and Sidewalk;**

These are optional elements which will vary based on the functionality and hierarchy of the road. However, the width of parallel parking is commonly taken as 2.5 meters.

Typical Road cross section taken from Right Of Way utilities (distribution manual ROW-601-Abudhabi –(2))-Page 39

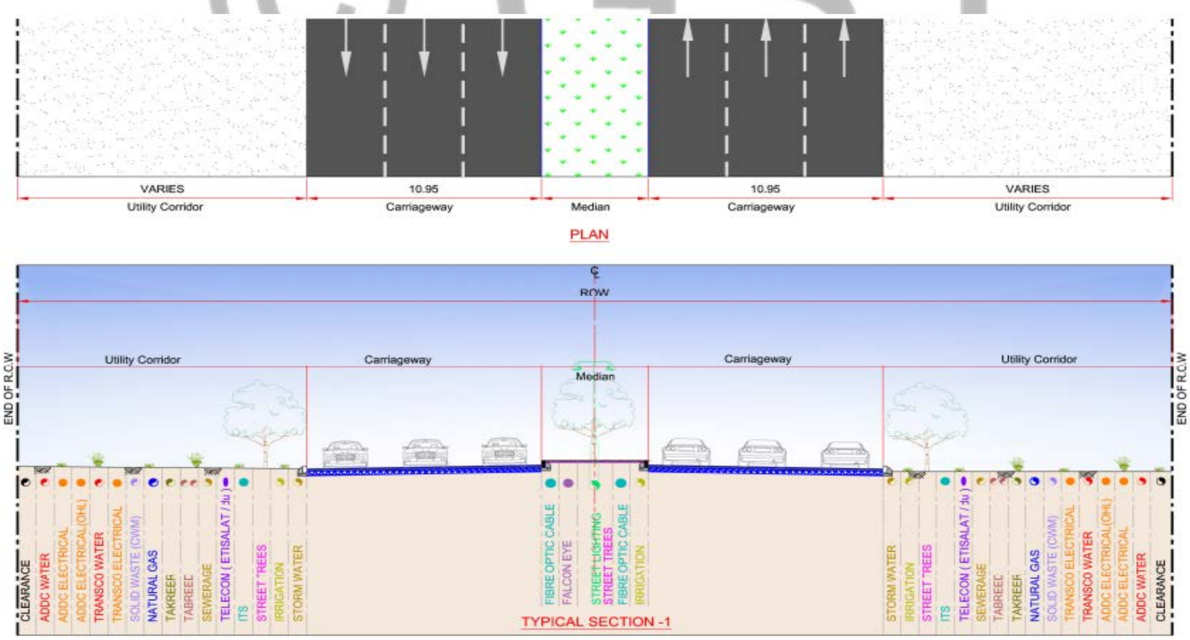


Figure.5. Typical Road Cross Section (7)

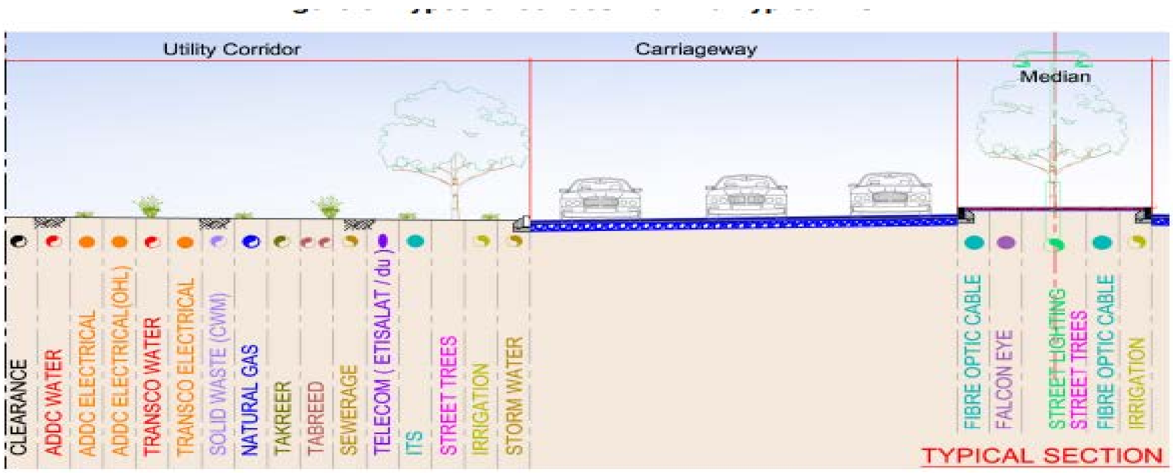


Figure.6. Typical Road Cross Section (indicated more Readable content (7)

3.RESULT AND ANALYSIS

Analysis on the cross above Road Cross Section (Figure 5)

The distribution of the utility corridor cross section of Figure 5 from L.H.S to R.H.S, in sequence are as follows

RHS TO LHS		
CORRIDOOR		UTILITY
UTILITY CORRIDOOR	1	CLEARANCE
	2	ADNOC WATER
	3	ADNOC ELECTRICAL
	4	ADNOC ELECTRICAL(OHL)
	5	TRANSCO WATER
	6	TRANSCO ELECRTICAL
	7	SOLID WASTE
	8	NATURAL GAS
	9	TAKREER
	10	TABREED
	11	SEWARAGE
	12	TELECOM(Etisalatl/DU)
	13	ITS
	14	STREET TREES
	15	IRRIGATIOIN
	16	STORM WATER
CARRIGA E WAY		CARRIAGE WAY
MEDIAN	17	FIBER OPTIC CABLE
	18	FALCON EYE
	19	STREET LIGHTING
	20	STREET TREES
	21	FIBER OPTIC CABLE

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	22	IRRIGATIOIN
CARRIGAE WAY		CARRIAGE WAY
UTILITY CORRIDOOR	23	STORM WATER
	24	IRRIGATIOIN
	25	STREET TREES
	26	ITS
	27	TELECOM(Etisalatl/DU)
	28	SEWARAGE
	29	TABREED
	30	TAKREER
	31	NATURAL GAS
	32	SOLID WASTE
	33	TRANSCO ELECTRICAL
	34	TRANSCO WATER
	35	ADNOC ELECTRICAL(OHL)
	36	ADNOC ELECTRICAL
	37	ADNOC WATER
	38	CLEARANCE

Figure .7 Corridor distribution of Fig 5

During analysis of Figure 5 it has been observed the following in the distribution of corridors

3.1 (LHS)(Left hand side)of Figure 5 (UTILITY CORRIDOOR)

- The utility corridor of TRANCO ELECTRICAL is placed after TRANCO WATER (the 6th corridor)
- The corridor of TELCOM & ITS are placed after SEWARAGE corridor (12th&13th corridor)

3.2 MEDIAN

- The FIBER OPTIC cable corridor is placed in median (17th corridor)
- The FIBER OPTIC cable corridor is placed in median (21th corrido)

3.3 RHS) (RIGHT hand side) of Figure 5 (UTILITY CORRIDOOR

During analysis it has been observed the following (RHS) (Right hand side

- The utility corridor of TRANCO ELECTRICAL is placed before TRANCO WATER (the 33RDcorridor)
- The corridor of ITS &TELCOM are placed before SEWARAGE corridor (26THth&27THth corridor)

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3.4 PROPOSED PTIMISED DESIGN MODELLING OF RIGHT OF WAY CONSIDERING CIRCULAR ECONOMY

By redesigning the corridor allotment by distribution of utilities which are working in the same & similar technology & engineering the following changes could be implemented

- Shifting of the ITS & Telecom corridor next to Electrical corridor
- Shifting of Transco electrical corridor adjacent to ADNOC Electrical corridor)
- Both the Fiber optic corridor in the median can be shifted adjacent to each other or could be shifted to utility corridor adjacent to Etisalat &Du corrido

The corridor model after redesigning shall be as below

REDESIGNED MODEL RHS TO LHS		
CORRIDOOR		UTILITY
UTILITY CORRIDOOR	1	CLEARANCE
	2	ADNOC WATER
	3	TRANSCO WATER
	4	TELECOM(Etisalatl/DU)
	5	ITS
	6	ADNOC ELECTRICAL
	7	TRANSCO ELECRTICAL
	8	ADNOC ELECTRICAL(OHL)
	9	SOLID WASTE
	10	NATURAL GAS
	11	TAKREER
	12	TABREED
	13	SEWARAGE
	14	STREET TREES
	15	IRRIGATIOIN
	16	STORM WATER
CARRIGAE WAY		CARRIAGE WAY
MEDIAN	17	FIBER OPTIC CABLE
	18	FIBER OPTIC CABLE
	19	STREET LIGHTING
	20	STREET TREES
	21	FIBER OPTIC CABLE
	22	IRRIGATIOIN
CARRIGA E WAY		CARRIAGE WAY
UTILITY CORRIDOOR	23	STORM WATER
	24	IRRIGATIOIN
	25	STREET TREES
	26	ITS
	27	TABREED
	28	TAKREER
	29	NATURAL GAS
	30	SOLID WASTE
	31	ADNOC ELECTRICAL(OHL)
	32	TRANSCO ELECTRICAL
	33	ADNOC ELECTRICAL
	34	ITS
	35	TELECOM(Etisalatl/DU)
	36	TRANSCO WATER
	37	ADNOC WATER
	38	CLEARANCE

Figure .8 Redesigned corridor by arranging identical utility adjacent to each other

3.5 Adavatnages of arranging the identical coridoor adjacent to each other

The best and realistic design should be **creation of a common utility corridor for the identical utilities adjacent to each other will generate more space for future expansion**

3.6 Circular Economy

What is a circular economy? The circular economy is "an economic model of production and consumption, on which the sharing, , reusing, leasing , refurbishing repairing, and recycling existing materials and products as long as possible" .This aims at the that aims at managing the global challenges which are the climate change, loss of biodiversity ,reduction of pollution and wastage

This study and research is mainly focusing on the HDPE micro duct installation for the common use for the telecom networks. This study is in line with the present Circular Economic Point of view and considering the circular economic criteria of eliminate waste

Once the HDPE micro ducts are installed in any

Corridor either in Etisalat corridor or very near to electricity corridor the multiple micro duct, each one of the above duct can be shared for Etisalat, DU , Fiber optic cables and any FO cables required for transmission for Scada network for electricity .
This enhances the cancellation of the present corridor which are allocated for Etisalat /Du and the Fiber optic cables. All the above utility can share the Micro duct of above model, if ducts are being installed in a corridor adjacent to electricity corridor.

Thereby the utility corridor space can be spared for future use and will definitely minimize installation of the non-degradable plastics material such as PVC pipes, HDPE pipe in the multiple corridors. Adapting such changes shall definitely enhance utility companies to adapt with the UAE circular economic policies which shall contribute reduction of non-degradable underground material installed

4.CONCLUSIOIN

This study and research had been mainly focused on the usage of High-Density Poly Ethelene Duct in the utility corridor there by the multiple micro ducts can be shared by the Telecom utilities. As the Fiber optic cable doesn't interact with the electric and magnetic field, this can be installed adjacent to the electric corridor. In this way, the space and corridor at present utilized for the telecom network can be spared for future use by optimal design of the Right of Way infrastructure. for the telecom network can be spared for future use by optimal deign of the Right of Way infrastructure

ACKNOWLEDGMENT

The author wishes to express the sincerest gratitude to the Electrical utility department, where the knowledge had attained during his work in the field of infrastructure, design, and concepts, and submit this paper for the new scientist and research candidates to open a window for further researches in the circular economic model in line with U.A.E. circular economic policies.

Developed Right of way design for Telecom network in lien with the Circular Economy Model

CORRIDOR	No.	UTILITY	
UTILITY CORRIDOR	1	CLEARANCE	
UTILITY CORRIDOR	2	ADNOC WATER	
UTILITY CORRIDOR	3	TRANSCO WATER	
UTILITY CORRIDOR	4	CAN BE SPARED	CORRIDOOR CAN BE SPARED
UTILITY CORRIDOR	5	CAN BE SPARED	
UTILITY CORRIDOR	6	ADNOC ELECTRICAL HDPE MICRO DUCT	
UTILITY CORRIDOR	7	TRANSCO ELECRTICAL	
UTILITY CORRIDOR	8	ADNOC ELECTRICAL(OHL)	
UTILITY CORRIDOR	9	SOLID WASTE	
UTILITY CORRIDOR	10	NATURAL GAS	
UTILITY CORRIDOR	11	TAKREER	
UTILITY CORRIDOR	12	TABREED	
UTILITY CORRIDOR	13	SEWARAGE	
UTILITY CORRIDOR	14	STREET TREES	
UTILITY CORRIDOR	15	IRRIGATIOIN	
UTILITY CORRIDOR	16	STORM WATER	
CARRIGAE WAY		CARRIAGE WAY	
MEDIAN	17	FIBER OPTIC CABLE	
MEDIAN	18	FIBER OPTIC CABLE	
MEDIAN	19	STREET LIGHTING	
MEDIAN	20	STREET TREES	
MEDIAN	21	FIBER OPTIC CABLE	
MEDIAN	22	IRRIGATIOIN	
CARRIGAE WAY		CARRIAGE WAY	
UTILITY CORRIDOR	23	STORM WATER	
UTILITY CORRIDOR	24	IRRIGATIOIN	
UTILITY CORRIDOR	25	STREET TREES	
UTILITY CORRIDOR	26	ITS	
UTILITY CORRIDOR	27	TABREED	
UTILITY CORRIDOR	28	TAKREER	
UTILITY CORRIDOR	29	NATURAL GAS	
UTILITY CORRIDOR	30	SOLID WASTE	
UTILITY CORRIDOR	31	ADNOC ELECTRICAL(OHL)	
UTILITY CORRIDOR	32	TRANSCO ELECTRICAL	
UTILITY CORRIDOR	33	ADNOC ELECTRICAL HDPE MICRO DUCT	
UTILITY CORRIDOR	34	CAN BE SPARED	CORRIDOOR CAN BE SPARED
UTILITY CORRIDOR	35	CAN BE SPARED	
UTILITY CORRIDOR	36	TRANSCO WATER	
UTILITY CORRIDOR	37	ADNOC WATER	
UTILITY CORRIDOR	38	CLEARANCE	

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