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Case Study of Trenchless Technology Around The Globe

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Abstract: ***Trenchless technology is the science of installing, repairing and renewing underground constructions, pipes, and cables that minimize the use of open-cut excavation methods. The use of traditional construction techniques, preferably open-cut construction are being used less because of innovation in trenchless methods. These methods reduce the impact on the environment i.e harmful gas and disruption i.e traffic delays, pedestrian problems, noise problems, and surface issues. This research will describe the advantages of trenchless methods over conventional trenching methods.***
Keywords: Trenchless technology, Open-cut excavation.

I. INTRODUCTION

Before trenchless methods, conventional open-cut methods were widely used for underground construction and replacement works. These trenching methods create many problems during construction like road blocking, noise, time delays, difficulties for neighbors, and many more general disruptions. There is a need to address all these problems economically and effectively. The development of trenchless methods is boosting the construction industry due to an increase in underground construction.

Trenchless methods are used to install, upgrade, repair, or replace underground infrastructure with minimum surface disruption. In conventional methods, the equipment and tools are used to release CO2 emissions and other harmful pollutants into the atmosphere which cause many health problems.

Another harmful by-product of open-trench constructions is noise i.e generated by the equipment. Trenchless technology is the science of installing, repairing, and renewing the underground constructions, pipes, and cables which minimizes the use of open-cut excavation methods. These methods reduce the impact on the environment i.e harmful gas and disruption i.e traffic delays, pedestrian problems, noise problems, and surface issues.

II. METHODS OF TRENCHLESS TECHNOLOGIES

A. New Installations

1) *Micro Tunneling:* The micro tunneling boring machine is a remote-controlled laser-guided system that uses a jacking system to thrust and provide continuous pressure to the face of the excavation. It is extensively used for sewage work where surface disruptions have to be avoided. Noise and traffic disruption are totally minimized.
2) *Pipe Jacking:* It is a trenchless method of installing pipes, conduits, and conduits that are using force to push the pipe into the ground while controlled excavation occurs on the surface. The jacking process begins by digging small holes for entry and exit at the beginning and end of the pipeline installation (usually in the pit areas). The pits are large enough to accommodate tunnel equipment and construction workers. When the holes are drilled, a hydraulic jacking rig and micro tunneling machine are put in place. The hydraulic jacking rig then uses the force of the "push" on the wall of the entrance and floor. Once the machine has reached a pre-determined location in the ground, part of the pipe is lowered into the entrance hole behind the jacking league and micro tunneling machine. An adapter ring is usually used to connect part of a pipe and a tunnel machine.
3) *Horizontal Directional Drilling (H.D.D):* Horizontal Directional Drilling is a way to get resources from one place to another without destroying the existing space or barriers between the two points. Direct drilling involves controlling tunnel systems in both narrow and wide lines. In most cases, it is a 2-stage process. The first step involves drilling a small diameter test hole (approximately 3 inches wide) near the required centreline of the proposed line. In Step 2, the test hole is enlarged to the desired diameter to meet the program line and pull the utility line through the extended hole.

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B. Rehabilitation

Rehabilitation of underground pipelines is a new area where the competitive cost of trenchless technology is well recognized. Many used pipes, especially sewage, are problematic due to the corrosion of modern waste. They also suffer from overload and loss of material, material-related variability, wall thickness provided to repair structural or physical defects, the level of refurbishment, and the limited closure of the existing service. The FFP / DRP process uses thermoplastic folded or deformed pipe to reduce the cross-sectional area, and then pulled into place, expanded, and circular using heat or pressure, so that adapts to the interior shape and size of the existing pipe. CIPP, FFP, and DRP are the methods of trenchless pipeline rehabilitation techniques.

1) *Cured-in Pipe Lining (CIPP):* It is a liquid thermosetting resin-saturated material that is installed into the existing pipeline by hydrostatic inversion.
2) *Spray Lining:* The material used in this method, has to be used carefully and approved by regulatory authorities due to its ability to extract solvents and residues. Spray linings are ready to deal with leaks but not where there are structural defects.
3) *Slip Lining*: Slip lining involves inserting a pipe inside the pipe and grouting the resulting annulus between the new pipe and the old pipe. This causes a decrease in volume and the process has now been changed to using polyethylene to reduce liner thickness and reduce annulus size.

C. Replacement

Replacement of damaged or overloaded pipes has been identified as an urgent need, especially now as much is known about the condition of past installations. In densely populated areas, an existing faulty pipeline can be an “asset” that can be expanded by pipeline replacement. Significant progress has been made in terms of scale, to address the type of existing line construction, difficult area conditions, and improved durability of newly installed lines.

Common switching systems are compiled under the heading Pipe bursting, although there are many variations with terms such as pipe cracking, pipe splitting, and pipe eating.

1) *Pipe Bursting:* When the pipes are replaced, the damaged pipe explodes, usually as a result of a fracture, using air or hydraulic membrane, and the pieces are forced into the surrounding ground or removed with a new pipeline pulled after the mole. Pipe blasting is often used in soft soil conditions and is usually not suitable for rocks or boulders. It is widely used in the gas industry to replace old steel pipes that lend out brittle breakage.
2) *Pipe Splitting:* It is used to separate existing open pipes to allow a new pipe to replace the old one.
3) *Pipe Eating:* It uses a special design of a small microtunnel machine that cuts the old pipe into pieces and removes them rather than removing them from the ground. The new pipe is jacked into place as during microtunneling.
4) *Pipe Reaming:* Using a specially designed variant of the reaming process used in HDD to remove old pipe into pieces and remove them instead of removing them - the new pipe is pulled into place behind the reaming head.
5) *Pipe Extract:* The old pipe is removed towards the receiving manhole or dug where it breaks and a new pipe is removed and used to eject the old pipe.

III. ADVANTAGES OF TRENCHLESS TECHNOLOGY

1) Minimum impact on the environment.
2) Saves resources.
3) Avoid traffic jams.
4) No damage to the road surface.
5) Easy to lay service lines across railway lines where open trenching is impossible.
6) Minimum noise pollution.
7) Underground space is available for future developments.
8) Maximum safety of the laborers is achieved.
9) Deterioration of underground networks can be prevented.
10) Provision of future development is enhanced in trenchless techniques.

IV. COST COMPARISON BETWEEN TRENCHLESS AND OPEN-CUT METHODS

The open cut method includes trenching along the alignment, slope sides, and backfilling and compacting the trench soil. These create high social costs due to traffic disruptions, pavement damage, dust, and construction noises. Environment impact concerns, such as removal of trees, emissions of greenhouse gas, and damage to trees also affect the cost of the projects.

Trenchless methods Auger boring is efficient in the installation of underground utilities, such as water lines and sewer lines. In this method, there is minimal disruption to the ground surface. It can be used in various types of soil conditions.
Horizontal directional drilling is another trenchless method that has a low impact on the environment as well as neighboring areas. It does not damage the existing surface and no need to excavate the whole trench.

V. CASE STUDIES RELATED TO TRENCHLESS TECHNIQUES IN DIFFERENT COUNTRIES

A. Comparison of Emitted Emissions between Trenchless pipe replacement and Open cut construction

City: - Los Lunas, New Mexico
Work: - Pipe replacement
Depth: - 2.1 m
Length: - 106 m

1) By Using Open-Cut Construction Method

Equipment involved during construction:

Equipment	Total working time
Excavator	25 hrs
Water pump	2 hrs
Soil compactor	6 hrs
Paver	90 min
Asphalt compactor	1 hrs

Emission generated by the equipment:

Types of equipment	HC	CO	NO	PM	CO2	SO
Excavator	2.41	16.2	23.36	2.86	1.3	5.25
Water pump	0.36	2.85	2.2	0.27	0.14	0.53
Loader	0.37	1.42	5.6	0.42	0.28	1.12
Soil compactor	0.58	3.87	5.64	0.65	0.31	1.27
Paver	0.19	0.71	2.82	0.2	0.14	0.56
Asphalt compactor	0.14	0.55	2.1	0.18	0.10	0.42

2) By Using Trenchless Methods

Equipment	Total working time
Hydro guide winch	15 mins
Air compressor	35 mins
Backhoe	90 mins
Paver	15 mins
Soil compactor	45 mins
Asphalt compactor	15 mins

Emissions generated by them:

Equipment	HC	CO	NO	PM	CO2	SO
Hydro guide winch	0.02	0.07	0.06	0.01	0	0.01
Air compressor	0.07	0.28	0.23	0.06	0.06	0.26
Backhoe	0.66	4.82	4	0.41	0.41	1.08
Paver	0.07	0.48	0.71	0.08	0.08	0.16
Soil compactor	0.03	0.12	0.47	0.03	0.02	0.09
Asphalt compactor	0.04	0.14	0.52	0.04	0.03	0.10

By comparing all the factors between open cut and trenchless method, trenchless construction method can reduce up to 80% of emissions.

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B. Evaluation of the Construction and investment process of a High-Pressure Gas pipeline with use of the trenchless method and open excavation method.

1) By Open Excavation Method

a) Excavation and filling operation required
b) Removal or cutting of trees

2) By Trenchless Method

a) No disruption on banks or vegetation
b) Away from the shoreline
c) No disturbance in the flow of water

3) Cost Evaluation at the Different Stages

In Trenchless Method-

a) Installation of pipes
b) Restoring sites

In the Open excavation method-

a) Installation of pipes
b) Restoring sites
c) Use of earthworks
d) Drainage

4) Economic Cost

It includes the cost of expenditure on materials and works not directly connected with the construction.

a) Cost of damage to private property
b) Cost of damage and wear of road surface.
c) Increased expenditure on road maintenance.
d) Cost of environmental supervision.

The economic cost of the trenchless method will be more than the open excavation method.

5) Social Cost

The cost incurred by the local community during the construction period.
It includes,

a) Traffic organization's problems
b) Safety issue
c) Human factors

6) Environmental Cost

For analysis purposes, this factor is divided into five criteria: -
Air, soil, water, physical factors, and natural factors.

C. Trenchless Rehabilitation Of 60-Inch Residuals Transfer Main At East Side Water Treatment Plant

City: - Dallas, Texas
Work: - Replacing main in the main existing alignment.
Type of pipe: - Reinforced concrete pipe
Length: - 3.54 km
Diameter: - 60 inch
Capacity: - 540 million gallon per day

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1) Problems in the Existing Pipeline

a) Longitudinal cracks in the pipe.
b) Leakage at various points.
c) Foundation failure may occur.
d) Pooling inside the pipe.

2) Alternation of this Work

a) Alternative 01: Open and cut method at the same location.
b) Alternative 02: Open and cut at a different place
c) Alternative 03: Cured in place pipe method

It involves the insertion of a fully saturated resin fabric tube into an existing pipeline by use of water inversion or winching. Material can be polyester, or fiberglass reinforced.

Water of air pressure used for inversion process and hot water, stream, up light curing.

Alternative 04: Slip lining

Small diameter pipe inserted in the existing pipe.

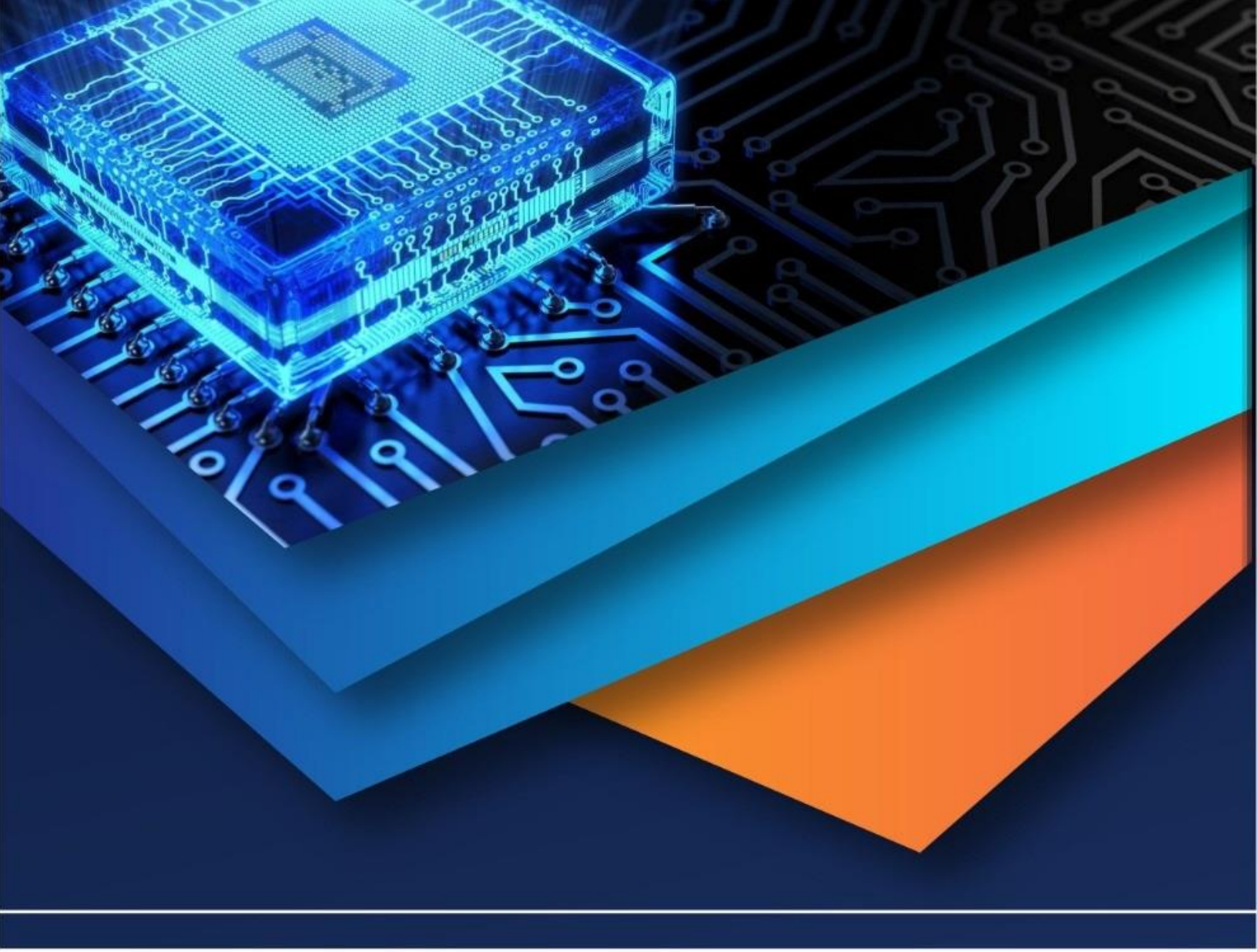
As we see author gives 4 alternatives option for rehabilitation work and of which options give the choice to adopt the most beneficial option out of this alternative.

VI. CONCLUSION

In cities and urban areas, water and sewage infrastructure and other resources available through underground pipes or pipes are laid, repaired, or instead of the usual methods of sealing the trenches. The open drainage systems create road closures, traffic delays, noise, and common interruptions. This makes repairs and rehabilitation of underground resources difficult, especially in traffic jams and buildings. Lack of repairs and renewals for water disturbance pipes and sewage systems leads to leaks and spills of dirty water, which leads to pollution of the water supply system as well groundwater. These problems affect health and the environment. The needs of different technologies lead to from Trenchless Technology, which includes a family of methods used to install and rehabilitate underground applications with minimal ground disturbances and devastation as compared to open-cut cutting methods. Trenchless technologies and methods provide effective, another logical alternative to inclusion, repairs, and maintenance of underground equipment services. Proper use of trenchless Technology to resolve both Engineering and Environmental problems can be considered natural sound technology. In solving urban sanitation problems, Trenchless Technologies has production potential environmental significance and other similar benefits job opportunities reduce disruption in order to passengers, reducing fuel consumption also improved traffic flow.

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