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# Reduction of Dynamic Lateral Earth Pressure on Retaining Wall Using Waste Tyre

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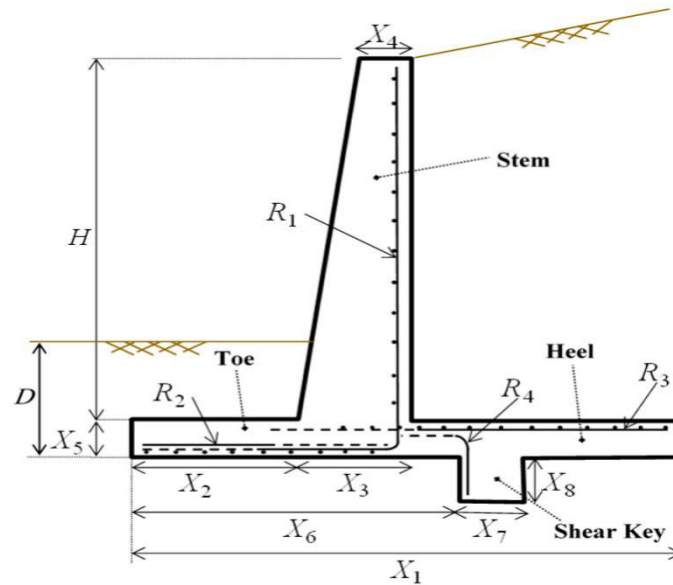
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**ABSTRACT:** Performance of retaining under various loading conditions depends on the types of backfills, however many lightweight fills material like EPS geofoam, geoboard, fly ash, waste tyre (in many forms) etc. are being extensively used as backfill material. The primary advantages of using these lightweight materials are the reduction in total lateral thrust on the wall and lateral displacement of retaining wall. Nowadays, the disposal of waste tyres has become a tremendous problem due to increasing number of vehicles. In the present time, waste tyres are increasingly being used in many geotechnical applications like embankment fill, retaining wall, machine foundation and bridge abutment etc. From the previous studies, it is noted that the shredded tyre inclusion with soil is used as backfill material for the earth retaining structures. Total lateral thrust on wall is the key element for the sectional design of retaining wall. It has been noted from the available literature that use of waste tyre in backfill reduces the total lateral thrust when used as sole backfill as tyre chips or a mixture of sand tyre or used as compressible inclusion between the wall and the backfill. In the present study, a numerical simulation using OPTUM G2 (finite element based numerical tool) has been carried out to study the influence of waste tyre as a backfill material on total lateral earth pressure for an 8m high wall. From the present study, it has been noted that inclusion of waste tyre as a backfill material substantially reduces total lateral earth pressure on the wall in a range of 60-64% in compared to wall backfilled with the soil.

**KEYWORDS:** Retaining wall; earth pressure reduction; waste tyre; numerical modeling; seismic earth pressure.

## I. INTRODUCTION

Rigid retaining wall structures are commonly civil engineering infrastructures which are constructed to retain the soil in steep and deep basement or in slopes. Withstand pressures from the retained materials, surcharge pressures due to movement of vehicular traffic or loads from foundations of the adjacent buildings on their backfill, seismic loading etc. Earth pressure behind the retaining structures governs the structural design and hence economy of the construction. So, the mitigation of lateral thrust from the backfill is the purpose of present study.



## II. WASTE TYRE

- The use of waste tyre in civil engineering applications is based upon their unique characteristics like lightweight, good insulation properties, very high ability to resist water, good long term durability and high compressibility.
- Design of various geo-engineering structures like retaining walls, embankments, and foundations requires index and engineering properties of the waste tyre and their inclusion with soil
- The Minnesota Department of Transportation determined that the use of waste tires is both cost effective and technical feasible after utilizing rubber chips at twenty-three different sites.
- Since several researchers (Edil and Bosscher 1994, Foose et al.1996, Ghazavi 2004, Hataf and Rahimi 2005, Kawata et al.2007, Lee et al.1996,2007, Masad et al.1996, Mashiri et al.2015, Rao and Dutta 2006, Sheikh et al.2013, Tatlisoz et al.1998, Youai and Bergado 2003, Zornberg et al. 2004)investigated the monotonic behaviour of sand-scrap tyres.

## III. CHALLENGES

- Waste tyre are categorised as solid or hazardous waste.
- In India top 7 large tyre companies are responsible for 85% tyre productions. The sale of automobile tyres was 8.8 million units in1982 which had increased to 17.7 million in the year of 1991,representing the growth rate of more than 100% in ten years.
- Developed and industrialized countries are facing a monumental problem in the disposal of used tyre.
- The volume of waste tyre generated is 1.5 billion per year owingto the increase in the number of vehicles worldwide (ETRMA2011).
- A huge volume of scrap tires has been stockpiled in many countries (Genan Business & Development A/S 2012) causing adverse impact on the environment.

- The disposal of these used tyres has become a global problem.
- Disposing of these waste tyres became a global problem for every countries because the stockpiling of these tyres threats to health hazard as well as environmental hazard (C Clark et al. 1991, Liu H et al. 1998, C Hermann et al. 2001) due to the following three reasons: (1) they occupy large volumes (2) waste tyre storage can be a dangerous fire risk (3) waste tyre dumps provide the breeding ground for vermin, including rats and mosquitoes.

### STOCKPILING OF WASTE TYRE



#### IV. WHY WASTE TYRE

Waste tyre is used in highway construction because of their following properties:-

1. Light weight
2. Free Drainage
3. Low Earth Pressure
4. Good Thermal Insulator
5. Good Durability



- 6. Low Compressibility
- 7. Vibration Damping
- 8. Low Cost

4.1 ENGINEERING PROPERTY OF TYRE CHIPS

S.NO.	PROPERTY	VALUE
1.	Specific Gravity	1.08
2.	Minimum Unit Weight	5.39
3.	Compacted Unit Weight	6.45
4.	Friction Angle	15-38 <sup>0</sup>

4.2 CHEMICAL COMPOSITION OF WASTE TYRES.

SR.NO.	COMPOSITION	%BY WEIGHT
1.	Zinc	1.52
2.	Calcium	0.378
3.	Iron	0.321
4.	Chlorine	0.149
5.	Fluroride	0.0010
6.	Lead	0.0065

## V. METHODOLOGY

### 5.1 LATERAL EARTH PRESSURE:

Lateral earth pressure is the force exerted by the soil mass upon an earth-retaining structure, such as a retaining wall. Proper design and construction of these structures require a thorough knowledge of the lateral forces that act between the retaining structures and the soil masses being retained. These lateral forces are caused by lateral earth pressure.

Three categories of lateral earth pressure:

- At rest earth pressure
- Active earth pressure
- Passive earth pressure

### 5.2 STABILITY CHECK BY USING RANKINE'S THEORY:

#### 5.2.1 STABILITY FOR OVERTURNING:

The horizontal component of active force will cause overturning on retaining wall about point O by moment called "overturning moment"

$$FSOT = MR / MOT \geq 2$$

## VI. EXPERIMENTAL RESULTS

Comparison of the distribution of lateral earth pressure on the retaining wall with soil or waste tyre. It can be observed that the total lateral pressure on wall increases from top to bottom in both the cases in the soil as well as in tyre. Once the magnitude of  $K_h$  (0.2g, 0.4g, 0.6g) increases, lateral earth pressure along the height of wall increases in both cases of wall i.e. backfilled with sand or waste tyre. However, it is noteworthy that lateral earth pressure on wall reduced at any height of wall when waste tyre is used to backfill the wall compared to the soil. Total lateral thrust on the wall is computed by calculating the area under each curve and reduction in total lateral thrust is calculated. From the above calculation, it is found that a substantial reduction of lateral pressure is found in the range of 60 to 64%, when waste tyre is used instead of soil as a backfill material behind the wall.

## VII. CONCLUSION

The present study evaluates the effectiveness of rigid retaining wall backfilled with soil and waste tyre under  $K_h = 0.2g, 0.4g,$  and  $0.6g$  in terms of total lateral thrust on an 8m high retaining wall. In all cases of wall backfilled with waste tyre are found to be more safer than the wall backfilled with soil. From the comparison of the distribution of lateral earth pressure on wall backfilled with soil and waste tyre, it is noted that for a given value of  $K_h$ , lateral earth pressure on wall reduces substantially when waste tyre is used instead of soil behind the wall. Furthermore, it is worth to mention that the reduction in total lateral thrust is observed in the range of 60-64% for an 8 m high retaining wall with a different value of peak horizontal ground acceleration.

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