



# Optimization of Tyre Dimensions for Indian Road Conditions Based on Pothole Impact Absorption Analysis

Chetan B. Powar

Student, Kolhapur  
Institute of Technology's  
College of Engineering  
(Empowered  
Autonomous) Kolhapur,  
India

[chetanbpowar@gmail.com](mailto:chetanbpowar@gmail.com)

Pravin S. Gosavi

Professor, Kolhapur  
Institute of Technology's  
College of Engineering  
(Empowered  
Autonomous), Kolhapur,  
India

[goasvi.pravin@kitcoek.in](mailto:goasvi.pravin@kitcoek.in)

Shivraj S. More

Student, Kolhapur  
Institute of Technology's  
College of Engineering  
(Empowered  
Autonomous) Kolhapur,  
India

[shivrajmore305@gmail.com](mailto:shivrajmore305@gmail.com)

Omkar S. Patil

Student, Kolhapur  
Institute of Technology's  
College of Engineering  
(Empowered  
Autonomous) Kolhapur,  
India

[omkarp9777@gmail.com](mailto:omkarp9777@gmail.com)

## Abstract

Road surface irregularities and potholes significantly influence vehicle ride quality, tyre durability, and impact loads experienced by the suspension system. Indian road conditions frequently contain potholes of varying geometry, making tyre selection an important factor in improving vehicle performance and passenger comfort. This study investigates the influence of tyre dimensions on pothole impact absorption using manually collected pothole geometry data and analytical modelling techniques. A total of fifteen potholes were surveyed and parameters including pothole length, depth, entry discontinuity, and exit discontinuity were recorded. Statistical analysis of the collected data showed an average pothole length of **19.47 cm** and an average depth of **11.8 cm**, with severe potholes reaching depths of **20 cm**. Tyre configurations **165/80 R14**, **185/65 R15**, and **215/60 R16** were analysed by evaluating sidewall deformation, absorbed energy, impact force, and transmitted load under varying road conditions. Vehicle categories including hatchbacks, sedans, and SUVs were considered, and speed variation analysis was carried out from **20–80 km/h**. Results indicated that tyres with larger sidewall heights exhibited greater deformation capability and higher impact energy absorption, thereby reducing transmitted loads. The study concludes that moderate to high sidewall tyre configurations provide improved suitability for Indian road conditions due to

their enhanced pothole impact attenuation characteristics.

**Keywords:** Pothole analysis, tyre dimensions, impact absorption, sidewall deformation, Indian roads, vehicle dynamics, transmitted load.

## Introduction

Road surface conditions play an important role in determining vehicle performance, passenger comfort, tyre life, and suspension durability. Indian roads frequently contain potholes and surface irregularities of varying dimensions due to traffic loading, environmental conditions, and pavement deterioration. These road defects generate impact loads during vehicle motion, affecting tyres, wheels, and suspension systems while reducing ride quality and increasing maintenance requirements.

Tyres act as the first contact element between the vehicle and the road surface and therefore play a significant role in absorbing road-induced impacts. Parameters such as tyre width, aspect ratio, sidewall height, and wheel diameter directly influence deformation capability and impact attenuation characteristics. Tyres with larger sidewall heights generally provide improved shock absorption, whereas lower profile tyres may transmit larger impact loads under rough road conditions.

The present research focuses on evaluating the suitability of different tyre dimensions for Indian road conditions using manually collected pothole geometry



data and analytical calculations. A total of **15 potholes** were surveyed and parameters including pothole length, depth, entry discontinuity, and exit discontinuity were recorded. Tyre configurations **165/80 R14**, **185/65 R15**, and **215/60 R16** were analysed to evaluate deformation behaviour, energy absorption, impact force, and transmitted load characteristics. The study aims to identify tyre configurations that provide improved pothole impact attenuation and better suitability for Indian roads.

## Literature Review

Tyre–road interaction has been a major area of study in vehicle dynamics because tyres are the first components to respond to road irregularities and directly influence ride quality, handling, structural loading, and passenger comfort. Tyres behave as deformable elastic elements and play an important role in attenuating road-induced vibrations before the load is transmitted to the suspension and vehicle body. Modern vehicle dynamics research considers tyre stiffness, damping, sidewall deformation, contact patch behaviour, and road profile interaction as important parameters in analysing vehicle response. Recent reviews emphasize that tyre modelling remains one of the most critical aspects of realistic vehicle simulation due to the complexity of tyre deformation and tyre–road contact behaviour.

Several researchers have investigated tyre deformation and its influence on vehicle performance. Studies on tyre deformation indicate that variations in tyre geometry, inflation conditions, and load significantly influence vehicle response and energy dissipation characteristics. Tyre deformation modifies load transfer and vehicle behaviour while also affecting performance characteristics such as drag, ride height, and vertical dynamics. Research has shown that vertical tyre stiffness and deformation characteristics strongly affect the ability of tyres to absorb road disturbances. Larger tyre dimensions and greater sidewall flexibility generally increase deformation capability and improve energy absorption characteristics.

Road surface irregularities such as potholes are recognised as one of the major causes of vibration excitation in vehicles. Potholes induce transient impact loads that generate forced vibrations in both sprung and unsprung masses. Previous studies on pothole effects reported that pothole geometry, vehicle velocity, wheel dimensions, and suspension characteristics directly

influence acceleration levels and transmitted forces. Larger pothole depths and higher vehicle speeds produce greater impact loads and increase the probability of structural damage to tyres, wheels, and suspension components. Investigations on pothole-induced vibration further indicate that vehicle speed and pothole dimensions are dominant parameters governing impact severity.

Most available research focuses on suspension modelling and quarter-car analysis to study vehicle response under irregular road conditions. However, fewer studies specifically compare the influence of tyre dimensions and sidewall geometry using measured pothole data. Existing approaches frequently rely on vehicle dynamic models, finite element methods, or empirical tyre models to evaluate impact behaviour. Modern tyre models combine analytical and empirical approaches to improve prediction accuracy and capture tyre deformation effects more realistically. Researchers have increasingly adopted hybrid modelling techniques to represent tyre behaviour under both on-road and off-road conditions.

Recent developments in road condition assessment have also improved pothole detection and geometry analysis. Computer vision and three-dimensional road reconstruction methods have been proposed for automated pothole identification and classification. Advanced detection methods achieved high accuracy in identifying pothole geometry and severity using imaging systems and machine learning techniques. These developments demonstrate the growing importance of quantitative pothole analysis for vehicle dynamics and road safety studies.

Based on the reviewed literature, it is evident that tyre geometry and pothole characteristics strongly influence vehicle impact response. However, limited work has been carried out on correlating real pothole measurements with tyre dimensions under Indian road conditions. Therefore, the present study focuses on manually collected pothole geometry data and evaluates tyre configurations **165/80 R14**, **185/65 R15**, and **215/60 R16** using analytical impact calculations to determine their suitability for Indian roads.



## Methodology

The methodology adopted for the present study consisted of field data collection, pothole geometry analysis, analytical modelling, tyre parameter evaluation, and impact load calculations. The objective was to determine the influence of tyre dimensions on pothole impact absorption characteristics under Indian road conditions. The complete methodology flow adopted in the study is shown as: **Field Survey → Data Collection → Statistical Analysis → Tyre Selection → Analytical Modelling → Impact Analysis → Result Evaluation.**

### 3.1 Pothole Data Collection

A field survey was conducted to collect pothole geometry data from road sections representing typical Indian road conditions. A total of **15 potholes** were manually measured and recorded. Measurements were taken using standard measuring instruments and observations were noted for each pothole individually. Four geometric parameters were considered during the survey:

- **Length (l):** Maximum pothole length in the direction of wheel travel.
- **Depth (d):** Maximum vertical depth of the pothole measured from the road surface level.
- **Entry discontinuity (h<sub>1</sub>):** Sudden vertical drop present at pothole entry.
- **Exit discontinuity (h<sub>2</sub>):** Sudden rise present at pothole exit.

The measured pothole geometry was represented using the pothole profile developed during the survey process. Inclusion of entry and exit discontinuities enabled the evaluation of sudden impact effects produced during wheel traversal.

### 3.2 Statistical Analysis of Pothole Geometry

The collected pothole measurements were statistically analysed to determine representative Indian road conditions. Arithmetic mean values were calculated for pothole length and depth using:

$$\bar{x} = \frac{\sum x}{n}$$

where:  $n = 15$  represents the total number of potholes surveyed.

The measured pothole lengths ranged from **10 cm to 30 cm**, while pothole depths varied between **3 cm and 20 cm**.

Average pothole length obtained:  $\bar{l} = \frac{292}{15} = 19.47$  cm

Average pothole depth obtained:  $\bar{d} = \frac{177}{15} = 11.8$  cm

The statistical analysis indicated that the surveyed roads

predominantly contained **medium and severe potholes**, with several potholes exhibiting large entry and exit discontinuities.

Representative potholes selected for analysis were:

Category	Length (cm)	Depth (cm)
Mild	15	8
Medium	20	12
Severe	19	20

Table no.1

The severe pothole category corresponded to the highest measured depth and maximum discontinuity values.

### 3.3 Selection of Tyre Configurations

Three tyre configurations representing common Indian passenger vehicles were selected for analysis:

Vehicle Category	Tyre Size
Hatchback	165/80 R14
Sedan	185/65 R15
SUV	215/60 R16

Table no.2

These tyre sizes were selected because they represent commonly used wheel configurations in Indian road vehicles and provide variation in sidewall height and wheel dimensions.

The sidewall height was determined using:  $H = \frac{W \times AR}{100}$

where:

$W$  = tyre width (mm)

$AR$  = aspect ratio (%)

Calculated sidewall heights obtained were:

- **165/80 R14:** 132 mm
- **185/65 R15:** 120.25 mm
- **215/60 R16:** 129 mm

### 3.4 Tyre Deformation and Energy Absorption Analysis

Tyre deformation capability was evaluated to estimate impact attenuation behaviour. Tyres were treated as elastic energy absorbing elements and deformation was calculated as:  $\delta = 0.15H$

where:

$\delta$  = tyre deformation

$H$  = sidewall height

Energy absorption was determined using:  $E = \frac{1}{2}k\delta^2$

where:

$k$  = tyre stiffness

Tyre stiffness values used during analysis were:

Vehicle Type	Stiffness
Hatchback	180 kN/m



Vehicle Type	Stiffness
Sedan	200 kN/m
SUV	220 kN/m

Table no.3

The analysis enabled comparison of energy absorption capability among different tyre sizes.

### 3.5 Impact Force Evaluation

Impact loads generated during pothole traversal were estimated analytically using:

$$F = \frac{mv^2}{2d}$$

where:

$m$ = wheel corner mass

$v$ = vehicle speed

$d$ = pothole depth

Vehicle speed analysis was performed between **20 km/h and 80 km/h** to evaluate variation in transmitted loads.

The severe pothole condition:  $d = 20$  cm was used as the critical loading case.

Impact severity was further evaluated using:  $I = \frac{d+h_1+h_2}{l}$

The highest pothole severity index obtained was:

$$I = 1.68$$

indicating severe road irregularity.

### 3.6 Result Evaluation

The final stage involved comparison of tyre configurations based on:

- Sidewall deformation
- Energy absorbed
- Impact force
- Transmitted load
- Pothole severity index

The obtained results were plotted graphically to compare tyre performance under varying pothole and speed conditions. The methodology enabled evaluation of tyre suitability for Indian roads without development of physical vehicle models and provided analytical assessment based on actual pothole measurements collected during field investigation.

## Mathematical Model

The mathematical model developed in the present study was used to evaluate the influence of tyre dimensions on pothole impact absorption characteristics under Indian road conditions. The model was based on analytical calculations using actual pothole geometry collected during field investigations. Parameters such as

pothole depth, length, sidewall height, tyre deformation, absorbed energy, impact force, and transmitted load were considered for the analysis.

The complete analytical sequence adopted in the study is represented as:

**Pothole Geometry** → **Tyre Dimensions** → **Deformation Analysis** → **Energy Absorption** → **Impact Force** → **Transmitted Load**

### 4.1 Pothole Geometry Model

The pothole geometry collected during field survey was represented using four parameters:

- $l$ = pothole length in wheel travel direction
- $d$ = pothole depth
- $h_1$ = entry discontinuity
- $h_2$ = exit discontinuity

The average pothole dimensions obtained from field measurements were:

Average length:  $\bar{l} = 19.47$  cm

Average depth:  $\bar{d} = 11.8$  cm

The severe pothole condition used for critical impact calculations was:

$$l = 19 \text{ cm}$$

$$d = 20 \text{ cm}$$

$$h_1 = 6 \text{ cm}$$

$$h_2 = 6 \text{ cm}$$

### 4.2 Sidewall Height Model

The ability of a tyre to absorb road impacts depends strongly on sidewall height. Sidewall height was calculated from tyre dimensions using:  $H = \frac{W \times AR}{100}$

where:  $H$ = sidewall height (mm)

$W$ = tyre width (mm)

$AR$ = aspect ratio (%)

Calculated values obtained were:

$$\text{For } \mathbf{165/80 R14}: H = \frac{165 \times 80}{100} \quad H = 132 \text{ mm}$$

$$\text{For } \mathbf{185/65 R15}: H = \frac{185 \times 65}{100} \quad H = 120.25 \text{ mm}$$

$$\text{For } \mathbf{215/60 R16}: H = \frac{215 \times 60}{100} \quad H = 129 \text{ mm}$$

Higher sidewall height indicates larger deformation capability and improved impact absorption.

### 4.3 Tyre Deformation Model

Tyres were modelled as elastic energy absorbing elements. Deformation was related to sidewall height by:

$$\delta = 0.15H$$

where:

$\delta$ = tyre deformation

$H$ = sidewall height

Calculated deformations:



For **165/80 R14**:  $\delta = 0.15(132)$   
19.8 mm

For **185/65 R15**:  $\delta = 18.04$  mm

For **215/60 R16**:  $\delta = 19.35$  mm

The deformation values represent the tyre displacement available for impact attenuation.

#### 4.4 Energy Absorption Model

The tyre was treated as an elastic spring and absorbed energy was determined using:  $E = \frac{1}{2}k\delta^2$

where:

$E$ = absorbed energy (J)

$k$ = tyre stiffness (N/m)

$\delta$ = tyre deformation (m)

Tyre stiffness values used:

Vehicle Category	Stiffness
Hatchback	180 kN/m
Sedan	200 kN/m
SUV	220 kN/m

Table no.4

For **165/80 R14**:  $E = \frac{1}{2}(200000)(0.0198)^2$

$$E = 39.2J$$

For **185/65 R15**:  $E = 32.54J$

For **215/60 R16**:  $E = 41.18J$

The results indicate that tyres with larger sidewall deformation absorb more impact energy.

#### 4.5 Impact Force Model

Impact load generated during pothole traversal was calculated using:  $F = \frac{mv^2}{2d}$

where:

$F$ = impact force (N)

$m$ = wheel corner mass (kg)

$v$ = vehicle speed (m/s)

$d$ = pothole depth (m)

For severe pothole condition:  $m = 300kg$

$v = 11.11m/s$

$d = 0.2m$

$$\text{Thus: } F = \frac{300(11.11)^2}{0.4}$$

$$F = 9259N$$

The model shows that impact force increases significantly with increasing vehicle speed.

#### 4.6 Transmitted Load Model

The force absorbed by the tyre was calculated as:  $F_a = k\delta$

For **165/80 R14**:  $F_a = 200000(0.0198)$

$$F_a = 3960N$$

Transmitted load:  $F_t = F - F_a$

$$F_t = 9259 - 3960$$

$$F_t = 5299N$$

The transmitted load represents the force transferred to the suspension and vehicle structure after tyre absorption.

#### 4.7 Pothole Severity Index

Pothole severity was evaluated using:  $I = \frac{d+h_1+h_2}{l}$

For the most severe pothole:  $I = \frac{20+6+6}{19}$

$$I =$$

1.68

Higher severity index values indicate more aggressive pothole profiles and greater impact loading conditions. The developed mathematical model enabled comparison of tyre performance using actual pothole measurements and analytical calculations without requiring physical vehicle models or experimental setups.

### Calculations

#### 1. Tyre Size Interpretation

Tyre: **165/80 R14**

Where:

- Width  $W = 165$  mm
- Aspect ratio:  $AR = 80$
- Rim diameter:  $R = 14$  in

Convert rim diameter:  $D_r = 14 \times 25.4$   $D_r = 355.6$  mm

#### 2. Sidewall Height Calculation

Formula:  $H = \frac{W \times AR}{100}$

Substitute:  $H = \frac{165 \times 80}{100}$   $H = 132$  mm

Therefore:  $H = 0.132$  m

This means the tyre has a **132 mm sidewall** available for deformation.

#### 3. Estimated Tyre Deformation

Assumption:

Usable deformation:  $\delta = 0.15H$

Substitute:  $\delta = 0.15(132)$   $\delta = 19.8$  mm

Convert:  $\delta = 0.0198$  m

#### 4. Tyre Stiffness



For passenger vehicle tyre:  
Assume:  $k = 200000 \text{ N/m}$

### 5. Energy Absorption

Formula:  $E = \frac{1}{2}k\delta^2$

Substitute:  $E = \frac{1}{2}(200000)(0.0198)^2$

First square deformation:  $(0.0198)^2 = 0.000392$

Then:  $E = 100000(0.000392) \quad E = 39.2\text{J}$

Energy absorbed:  $E = 39.2\text{J}$

### 6. Severe Pothole Impact Force

Given:

Vehicle mass:  $M = 1200\text{kg}$

Wheel corner load:  $m = \frac{1200}{4} \quad m = 300\text{kg}$

Speed:  $40 \text{ km/h}$

Convert:  $v = \frac{40 \times 1000}{3600} \quad v = 11.11\text{m/s}$

Worst pothole:  $d = 20\text{cm} \quad d = 0.2\text{m}$

Impact equation:  $F = \frac{mv^2}{2d}$

Substitute:  $F = \frac{300(11.11)^2}{2(0.2)}$

Velocity square:  $11.11^2 = 123.43$

Thus:  $F = \frac{300(123.43)}{0.4} \quad F = \frac{37029}{0.4} \quad F = 9257\text{N}$

Approximately:  $F \approx 9259\text{N}$

### 7. Transmitted Force Through Tyre

Absorbed load estimate:  $F_a = k\delta$

Substitute:  $F_a = 200000(0.0198) \quad F_a = 3960\text{N}$

Remaining transmitted load:  $F_t = F - F_a \quad F_t = 9259 - 3960 \quad F_t = 5299\text{N}$

Table no. 5

### 2. Tyre Size Interpretation

Tyre: **185/65 R15**

Where:

Width:  $W = 185\text{mm}$

Aspect ratio:  $AR = 65$

Rim diameter:  $R = 15\text{in}$

Convert rim diameter:  $D_r = 15 \times 25.4 \quad D_r = 381\text{mm}$

### 2. Sidewall Height Calculation

Formula:  $H = \frac{W \times AR}{100}$

Substitute:  $H = \frac{185 \times 65}{100} \quad H = 120.25\text{mm}$

Convert:  $H = 0.12025\text{m}$

Thus:  $H = 120.25\text{mm}$

### 3. Estimated Tyre Deformation

Usable deformation:  $\delta = 0.15H$

Substitute:  $\delta = 0.15(120.25) \quad \delta =$

$18.04\text{mm}$

Convert:  $\delta = 0.01804\text{m}$

### 4. Tyre Stiffness

Sedan tyre:  $k = 200000\text{N/m}$

### 5. Energy Absorption Calculation

Formula:  $E = \frac{1}{2}k\delta^2$

Substitute:  $E = \frac{1}{2}(200000)(0.01804)^2$

Square deformation:  $(0.01804)^2 = 0.000325$

Thus:  $E = 100000(0.000325) \quad E = 32.54\text{J}$

Energy absorbed:  $E = 32.54\text{J}$

### 6. Severe Pothole Impact Force

Vehicle mass:  $M = 1400\text{kg}$

Wheel corner mass:  $m = \frac{1400}{4} \quad m = 350\text{kg}$

Speed:  $40 \text{ km/h}$

Convert:  $v = 11.11\text{m/s}$

Worst pothole:  $d = 20\text{cm} \quad d = 0.2\text{m}$

Impact equation:  $F = \frac{mv^2}{2d}$

Substitute:  $F = \frac{350(11.11)^2}{0.4}$

Velocity square:  $11.11^2 = 123.43$

Therefore:  $F = \frac{43200.5}{0.4} \quad F = 10800\text{N}$

Approximately:  $F \approx 10800\text{N}$

### 7. Force Absorbed by Tyre

Formula:  $F_a = k\delta$

Substitute:  $F_a = 200000(0.01804) \quad F_a = 3608\text{N}$

Parameter	Value
Width	165 mm
Aspect ratio	80
Rim size	14 in
Sidewall height	132 mm
Deformation	19.8 mm
Stiffness	200 kN/m
Energy absorbed	39.2 J
Impact force	9259 N
Absorbed force	3960 N
Transmitted force	5299 N



## 8. Transmitted Force

Formula:

$$F_t = F - F_a$$

Substitute:  $F_t = 10800 - 3608$

$$F_t = 7192N$$

Parameter	Value
Width	185 mm
Aspect ratio	65
Rim size	15 in
Sidewall height	120.25 mm
Deformation	18.04 mm
Stiffness	200 kN/m
Vehicle mass	1400 kg
Energy absorbed	32.54 J
Impact force	10800 N
Absorbed force	3608 N
Transmitted force	7192 N

## Discussion

The present study investigated the effect of tyre dimensions on pothole impact absorption characteristics under Indian road conditions using manually collected pothole geometry data and analytical calculations. The results obtained from pothole analysis, tyre deformation calculations, energy absorption evaluation, and impact load estimation showed that tyre geometry significantly affects vehicle response while traversing road irregularities.

The pothole survey conducted during the study indicated considerable variation in pothole dimensions. Analysis of the collected data showed an average pothole length of **19.47 cm** and an average depth of **11.8 cm**, while the maximum recorded depth reached **20 cm**. The measured potholes also contained entry and exit discontinuities, indicating sudden road profile changes capable of producing high impact loads. The calculated pothole severity index reached **1.68** for the worst pothole condition, confirming the presence of severe road irregularities within the surveyed road sections.

Comparison of tyre geometries showed that sidewall height plays an important role in impact attenuation. The **165/80 R14** tyre exhibited the largest sidewall height of **132 mm**, followed by **215/60 R16** with **129 mm**, while **185/65 R15** provided a sidewall height of **120.25 mm**. Higher sidewall heights resulted in greater deformation capability and increased impact energy absorption during pothole traversal.

The calculated tyre deformation values showed that the **165/80 R14** tyre achieved **19.8 mm** deformation, while **185/65 R15** and **215/60 R16** produced **18.04 mm** and **19.35 mm** respectively. Greater deformation allowed the tyre to absorb a larger portion of the impact energy before transmission to the suspension system. This behaviour demonstrates the importance of sidewall flexibility in improving ride quality and reducing structural loading.

Energy absorption analysis further supported the influence of tyre geometry. The calculated absorbed energies were **39.2 J** for **165/80 R14**, **32.54 J** for **185/65 R15**, and **41.18 J** for **215/60 R16**. The **R16** configuration produced the highest energy absorption because of its higher stiffness and larger dimensions, while the **R15** tyre showed comparatively lower absorption capability. The difference in absorbed energy demonstrates that tyre size and construction parameters directly influence impact attenuation performance.

Impact load analysis showed that vehicle speed strongly affects pothole-induced loading conditions. For the severe pothole case having a depth of **20 cm**, the calculated impact force reached **9259 N** at a vehicle speed of **40 km/h** for the hatchback configuration. The speed sweep analysis indicated rapid increase in transmitted load with increasing speed because impact force varies proportionally with the square of velocity. Therefore, even moderate speed increases can significantly increase tyre and suspension loading under severe pothole conditions.

Transmitted load analysis also indicated differences among tyre configurations. The calculated transmitted load for **165/80 R14** was **5299 N**, while **185/65 R15** and **215/60 R16** produced **7192 N** and **8083 N** respectively. Although the SUV tyre absorbed higher energy, the larger vehicle mass increased the overall impact load transmitted to the system. Consequently, tyre selection must consider both vehicle category and tyre geometry rather than wheel size alone.



The obtained results indicate that tyres having moderate to high sidewall heights provide improved suitability for Indian roads because of better deformation capability and higher impact absorption characteristics. Tyres with lower sidewall heights generally transmit greater impact loads and may increase the probability of wheel, tyre, and suspension damage under severe pothole conditions.

The deformation analysis showed:

Tyre	Deformation
165/80 R14	19.8 mm
185/65 R15	18.04 mm
215/60 R16	19.35 mm

Table no. 7

The results indicated that tyres having larger sidewalls possess greater deformation capability and therefore absorb a larger portion of the pothole impact energy before transmitting load to the suspension system.

Energy absorption calculations further supported these findings. The calculated absorbed energies were:

Tyre	Energy Absorbed
165/80 R14	39.2 J
185/65 R15	32.54 J
215/60 R16	41.18 J

Table no. 8

Among the evaluated configurations, the **R16 tyre** showed the highest energy absorption due to its larger dimensions and increased stiffness, while the **R14 tyre** provided excellent deformation capability because of its larger sidewall height. The **R15 configuration** showed intermediate behaviour between the two cases.

Impact force analysis was performed using the severe pothole condition:  $d = 20$  cm

At a vehicle speed of **40 km/h**, the impact forces obtained were:

Tyre	Impact Force
165/80 R14	9259 N
185/65 R15	10800 N
215/60 R16	12340 N

Table no. 9

The results showed that impact loading increased with vehicle class and wheel load. The SUV configuration experienced the largest impact force because of the increased vehicle mass.

The transmitted load analysis produced the following results:

Tyre	Transmitted Load
165/80 R14	5299 N
185/65 R15	7192 N
215/60 R16	8083 N

Table no. 10

The **R14 configuration produced the lowest transmitted load**, indicating superior pothole impact attenuation capability. Although the SUV tyre absorbed more energy, the larger vehicle mass increased the load transferred to the system.

Speed sweep analysis conducted between **20 km/h and 80 km/h** showed that transmitted load increased rapidly with speed because impact force varies proportionally with the square of velocity. Therefore, vehicle speed was identified as one of the most significant parameters affecting pothole impact severity.

## Conclusion

The overall findings of the research indicate that tyre dimensions strongly influence vehicle behaviour under pothole loading conditions. Tyres having moderate to high sidewall heights exhibited improved deformation capability, greater energy absorption, and lower transmitted loads. Such tyres are therefore more suitable for Indian road environments where medium and severe potholes are frequently encountered.

Based on the obtained results, the following conclusions can be drawn:

1. Indian roads contain a considerable number of medium and severe potholes with significant geometric variation.



2. Sidewall height is one of the most important tyre parameters influencing impact attenuation.
3. Larger sidewalls increase deformation capability and improve energy absorption.
4. Vehicle speed strongly affects pothole impact severity.
5. Higher vehicle mass increases impact force and transmitted load.
6. Tyres **165/80 R14** and **215/60 R16** demonstrated superior impact absorption behaviour compared to **185/65 R15**.
7. Tyres having moderate to high sidewall ratios provide better suitability for Indian road conditions.

The methodology developed in this research provides a practical analytical approach for tyre evaluation using actual pothole measurements and can be extended further using numerical simulations, finite element modelling, and experimental validation for future studies.

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