

AI-00131 FTA Bicycle Braking Failure

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Perform a comprehensive FTA of a bicycle braking failure

Fault Tree Analysis (FTA) is a systematic and structured method used to identify all possible causes and contributing factors of an undesired event, and to organize them into a logical and hierarchical tree structure. In this case, we will perform a comprehensive FTA of a bicycle braking failure.

1. Undesired Event: Bicycle Braking Failure
2. Primary Cause: Loss of Braking Ability
3. Contributing Factors:
 - a. Brake Component Failure
 - i. Brake Pads Worn Out
 - ii. Brake Disc/Rotor Worn Out or Warped
 - iii. Brake Cable Snapped
 - iv. Brake Lever Malfunctioned
 - b. Brake System Overload
 - i. Excessive Weight on Bicycle
 - ii. Overheating of Brake Components
 - iii. Excessive Speed
 - c. Environmental Factors
 - i. Wet or Slippery Surface
 - ii. Debris or Obstacles on Road
 - iii. Uneven or Rough Terrain
 - d. Human Factors
 - i. Poor Maintenance and Inspection

- ii. Incorrect Braking Technique
 - iii. Distractions or Impairments (e.g., fatigue, alcohol, drugs)
- 4. Logical Structure of the Fault Tree:
 - a. Loss of Braking Ability
 - i. Brake Component Failure
 - 1. Brake Pads Worn Out
 - 2. Brake Disc/Rotor Worn Out or Warped
 - 3. Brake Cable Snapped
 - 4. Brake Lever Malfunctioned
 - ii. Brake System Overload
 - 1. Excessive Weight on Bicycle
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 - iii. Environmental Factors
 - 1. Wet or Slippery Surface
 - 2. Debris or Obstacles on Road
 - 3. Uneven or Rough Terrain
 - iv. Human Factors
 - 1. Poor Maintenance and Inspection
 - 2. Incorrect Braking Technique
 - 3. Distractions or Impairments (e.g., fatigue, alcohol, drugs)
- 5. Analysis of the Fault Tree:
 - a. Brake Component Failure:
 - i. Brake Pads Worn Out: This can occur due to normal wear and tear or lack of proper maintenance. Regular inspection and replacement of worn-out brake pads can prevent this.
 - ii. Brake Disc/Rotor Worn Out or Warped: This can occur due to overheating, excessive wear, or impact. Regular inspection and replacement of worn-out or warped brake discs/rotors can prevent this.
 - iii. Brake Cable Snapped: This can occur due to wear, rust, or improper installation. Regular inspection and replacement of worn-out or damaged brake cables can prevent this.
 - iv. Brake Lever Malfunctioned: This can occur due to wear, damage, or improper adjustment. Regular inspection and maintenance of brake levers can prevent this.
 - b. Brake System Overload:

- i. Excessive Weight on Bicycle: This can occur due to carrying heavy loads or passengers. Exceeding the weight capacity of the bicycle or the brake system can cause brake failure.
- ii. Overheating of Brake Components: This can occur due to prolonged or intense braking, especially on downhill slopes. Using proper braking techniques and allowing brakes to cool down can prevent this.
- iii. Excessive Speed: This can occur due to downhill slopes or high-speed riding. Riding at safe speeds and using proper braking techniques can prevent brake failure.
- c. Environmental Factors:
 - i. Wet or Slippery Surface: This can reduce the friction between the brake components and the surface, reducing braking effectiveness. Using appropriate braking techniques and avoiding

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riding on wet or slippery surfaces can prevent brake failure.

- ii. Debris or Obstacles on Road: This can interfere with the braking mechanism and reduce effectiveness. Keeping a safe distance from obstacles and using appropriate braking techniques can prevent brake failure.
- iii. Uneven or Rough Terrain: This can reduce the friction between the brake components and the surface, reducing braking effectiveness. Using appropriate braking techniques and avoiding rough terrain can prevent brake failure.
- d. Human Factors:
 - i. Poor Maintenance and Inspection: Regular maintenance and inspection can identify potential brake problems and prevent brake failure.
 - ii. Incorrect Braking Technique: Applying brakes abruptly or unevenly can cause brake failure. Using appropriate braking techniques can prevent brake failure.
 - iii. Distractions or Impairments (e.g., fatigue, alcohol, drugs): Impaired judgment or reduced reaction time can result in improper braking technique or failure to identify potential brake problems. Riding while alert and focused can prevent brake failure.

1. Mitigation Strategies:

- a. Regular maintenance and inspection of brake components can prevent component failure.

- b. Regularly replace worn-out or damaged brake components.
- c. Observe weight limits and avoid overloading the bicycle and the brake system.
- d. Use appropriate braking techniques, such as gradual and even application of brakes.
- e. Avoid riding on wet or slippery surfaces, rough terrain, and obstacles.
- f. Ride at safe speeds, especially on downhill slopes.
- g. Avoid riding while under the influence of alcohol, drugs, or fatigue.

In conclusion, a comprehensive FTA of a bicycle braking failure identified several primary and contributing factors that can cause brake failure. Regular maintenance and inspection of brake components, appropriate braking techniques, and avoiding environmental and human factors can prevent brake failure and ensure safe riding.

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It is essential to note that a combination of factors can lead to brake failure, and therefore, it is crucial to consider all possible factors when conducting an FTA. Mitigation strategies should also address all potential causes and include education and awareness campaigns for riders to promote safe and responsible cycling practices.

It is also important to note that while mitigation strategies can reduce the risk of brake failure, there is always the possibility of unforeseeable events that can cause brake failure. Riders must always be alert and prepared to react appropriately in such situations.

Overall, conducting an FTA of a bicycle braking failure is an important step in promoting safe cycling practices and ensuring the well-being of riders. Regular maintenance, appropriate braking techniques, and awareness of potential hazards can help prevent brake failure and promote safe and enjoyable cycling experiences.