Journal of Physics Special Topics
An undergraduate physics journal

A3 2 Clint Eastwood, Dead or Alive

L. Rudkin, J. Ballisat, C. Nijjar, H. Lai, J. Spurden

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

October 22, 2026

Abstract

In this paper, we evaluate the physical plausibility of the boilerplate armour scene in the film *A Fistful of Dollars*. A simplified shear-failure model is used to estimate whether wrought-iron boilerplate could resist a bullet fired from a Winchester 1892 rifle. The model predicts that the work required to pierce the armour is 216 J, compared with an estimated kinetic energy of 939 J. The bullet has sufficient energy for penetration, but the simplified model neglects projectile deformation.

Introduction

In the western film *A Fistful of Dollars*, Joe (Clint Eastwood's "Man with No Name") survives a close-range shootout with Ramón Rojo using a wrought iron boiler sheet as improvised armour [1]. When Rojo fires a Winchester 1892 rifle [2] chambered in .44 Winchester [3], the plate intercepts the bullet. This paper assesses whether late-nineteenth-century boilerplate could protect Joe by comparing bullet kinetic energy with the armour's shear resistance.

Method

To assess Joe's survival, we develop a simplified penetration model by applying work and shear failure to a bullet passing through a plate. The kinetic energy of the bullet (E_k) is calculated using Equation (1) [4]:

$$E_k = \frac{1}{2}mv^2, \tag{1}$$

where m and v are the mass and velocity of the bullet. Next, we have Equation (2) [4]:

$$W = \int F \cdot dx, \tag{2}$$

where W is the work done by force F to shear a hole that is x deep. The force is related to shear stress by [5],

$$\tau = \frac{F}{A}, \tag{3}$$

where τ is the material's ultimate shear stress, the maximum shear stress before failure, and A is the remaining shear plane area as a function of penetration depth. Thus $A = \pi d(T - x)$, where d, T and x are the bullet diameter, plate thickness and the hole depth respectively. Replacing A and rearranging Equation (3) for force and substituting into Equation (2), we get

$$W = \int_0^T \tau\pi d(T - x) \cdot dx. \tag{4}$$

Finally, integrating Equation (4) gives

$$W = \frac{1}{2}\tau\pi dT^2. \tag{5}$$

The model assumes a rigid, blunt bullet that shears a cylindrical hole through the plate, ignoring projectile and armour deformation. This is a simplification, since lead is substantially softer

than wrought iron [6]. The projectile's kinetic energy density is given by Equation (6)

$$U = \frac{E_k}{V}, \tag{6}$$

where V is the volume of the bullet. This can be compared with the modulus of resilience to assess the plausibility of plastic deformation.

Results

Assuming negligible air resistance over the distance of less than 10 m [2], a 13 g bullet travelling at 380 $\mathrm{m\,s^{-1}}$ [6] has a kinetic energy of 939 J. Assuming a similar construction to the Califat haystack boiler [7], we modelled it as 6.35 mm thick wrought iron. Using a shear-to-tensile strength ratio of 0.83 [8] and an average ultimate tensile strength of 367 MPa [9], we estimated an ultimate shear stress of 305 MPa. For an 11.2 mm diameter bullet, the work required to pierce the armour was 216 J.

For the 13 g lead projectile [6], a density of 11.3 $\mathrm{g\,cm^{-3}}$ [10] gives a volume of 1.15 $\mathrm{cm^3}$. Using Equation (6), the energy density was calculated as 814 $\mathrm{MJ\,m^{-3}}$. Using the Young's modulus of lead, $E = 16$ GPa, and yield stress, $\sigma_y = 5$ MPa [10], its modulus of resilience, $U_r = \frac{\sigma_y^2}{2E}$, was calculated as 781 $\mathrm{J\,m^{-3}}$. The energy density is approximately 1.04×10^6 times this value, suggesting that plastic deformation may occur.

Equation (5) was rearranged to plot the relationship between bullet kinetic energy and the critical armour thickness in Figure 1. Using Rojo's bullet energy, the required armour thickness was calculated as 13.2 mm for the rigid-bullet model.

Discussion

The model predicts that the projectile energy exceeds the predicted penetration work. This suggests that penetration is energetically possible under the model's assumptions. However the model does not account for energy dissipated through projectile deformation, plate bending or other impact effects, so the actual outcome cannot be established from this comparison alone.

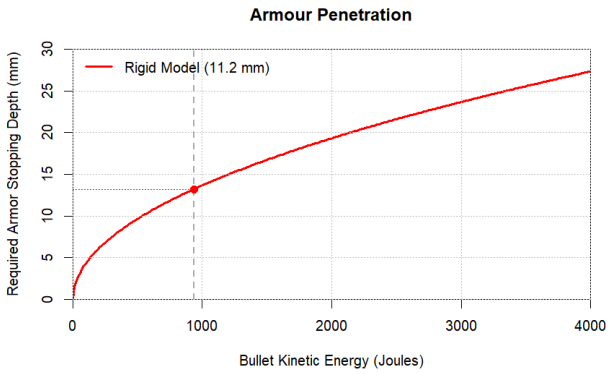


Figure 1: Predicted relationship between bullet kinetic energy and critical armour thickness (Rojo's bullet marked for reference)

The main limitation is the assumption that the bullet remains rigid during impact. Since lead is substantially softer than wrought iron, plastic deformation may affect the penetration process. The calculated projectile energy density far exceeds lead's estimated modulus of resilience, indicating that deformation is a possibility. However, this comparison does not establish the extent of deformation or how it would affect penetration resistance.

An important source of uncertainty is the assumed ultimate tensile strength of the wrought iron, which varies across the literature [9]. The model also assumes that all the bullet's kinetic energy contributes solely to the work required to shear the armour. In reality, its likely that some energy will be dissipated through heating, plate movement, and as discussed, deformation.

Conclusion

The model predicts that the projectile has sufficient energy to penetrate the assumed boilerplate. Therefore, the shear-failure model alone cannot explain Joe's survival. Although projectile deformation and other impact effects may influence the outcome, their effects cannot be established using this simplified model. The physical plausibility of the scene therefore remains uncertain.

References

[1] Encyclopedia Britannica. (n.d.). Boiler — engineering. [online] Available at: https://www.britannica.com/technology/boiler: [Accessed: 28/09/2026].

[2] A Fistful of Dollars . (1964). Italy : Available at Amazon Prime video: [Accessed: 26/09/2026].

[3] Winchesterguns.com. (2018). 150 Years of winchester — The gun that won the western. [online] Available at: https://www.winchesterguns.com/news/articles/gun-won-western.html: [Accessed: 27/09/26].

[4] Paul Allen Tipler and Mosca, G. (2008). Student study guide volume I for Tipler and Mosca's Physics for scientists and engineers, 6th edition. New York: W.H. Freeman ; Basingstoke.

[5] MA, H., JI, S., MEI, Y. and Dzianis Marmysh (2024). Mechanics of materials. EDP Sciences.[Accessed online at : University of Leicester David Wilson Library 28/09/26].

[6] National Rifle Association (2026). An official journal of the NRA — the .44-40 WCF: History and performance. [online] An Official Journal Of The NRA. Available at: https://www.americanrifleman.org/content/the-44-40-wcf-history-performance/: [Accessed: 27/09/26].

[7] Warburton, S. (2017). Califat haystack boiler significance analysis report. [online] Available at: https://www.lihs.org.uk/wp-content/uploads/Haystack-boiler-report.pdf: [Accessed: 27/09/26].

[8] Roymech.org. (2020). *Shear strength of metals - Roy Mech.* [online] Available at: https://roymech.org/Useful_Tables/Matter/shear_tensile.html: [Accessed: 27/09/26].

[9] Modulus Metal. (2025). Wrought iron mechanical properties. [online] Available at: https://www.modulusmetal.com/wrought-iron-mechanical-properties/: [Accessed: 27/09/26].

[10] Studio, I.E. (2026). Lead. [online] Industrial Engineering Studio. Available at: https://www.industrialengineeringstudio.com/materials/lead: [Accessed: 30/09/26].

[11] OpenAI (2025). ChatGPT. [online] ChatGPT. Available at: https://chatgpt.com/: [Accessed: 27/09/26]. (Generative AI was used solely for proofreading and improving the clarity and grammar of the author's own writing.)