Dear Reviewer:

Thank you for taking the time to review our manuscript entitled "Rill Erosion on Slope of Spoil tips: experimental study of runoff scouring erosion in multiple times" (ID: hess-2021-399), and provide constructive comments. These comments are valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our further researches. We have studied and analyzed comments carefully and have made many corrections which we hope meet with approval. To clearly respond all comments, point by point, these comments from reviewers were classified by authors based on the specific meanings and listed as following (Q1, Q2, Q3…). The main revisions in the paper and the responds to the reviewer's comments are as following.

Reviewer #RC3:

Hydrology and Earth System Sciences

Manuscript Number: hess-2021-399

Article Type: Research paper

Q1. it is not clear why only three slopes were considered and why those and not others.

Response: we are so sorry for our unclear expression. In fact, we have investigated the material composition, slope and slope length of 368 spoil tips in different regions of China. The production and construction projects which were selected for the survey are all highly representative in the regions where they are located, and the results of the survey can reflect the basic conditions of the regional spoil tips in more comprehensively. The survey results show that the slope range of the spoil tips is generally between 25-40°, with 28-36° accounting for more than 75 % of the total survey. Therefore, we have gradients to set three slopes of 28°, 32° and 36° respectively. In any field experiments of this nature, one has to select some typical slopes that best represent the real-world situation and in our case the choice of the three slopes was made based on survey of real-world spoil tips.

Q2. it is not clear why only three types of inflow rates (surprisingly not rainfall) are considered.

Response: Spoil tips are a unique man-made mound landform formed by production and construction activities, with a "platform-steep slope" structure. Under field conditions, the runoff collected by the compaction platform of spoil tips is an important factor causing slope scour erosion and accelerating erosion of engineered landscapes. The infiltration rate of the platform formed by heavy mechanical rolling is significantly reduced. Under rainfall conditions, the platform produces large concentrated runoff preferentially over the slope, and concentrated runoff rapidly flows along the edge of the platform to the steep slope, thus causing severe slope erosion. Therefore, the runoff collected by platform of spoil tips is an important factor causing slope scour erosion and accelerating erosion of engineered landscapes (Zhang et al. 2015, Zhang et al. 2016). The amount of runoff from the platform is determined by the rainfall intensity. Three rainfall intensities of 1.6, 2, and2.4 mm min^{-1} were used to mimic typical erosive rainfall from heavy, torrential and extremely heavy rain in study area, respectively. Rainfall intensities of 1.6, 2 and2.4 mm min^{-1} were converted to equivalent inflow rate of 8, 10 and12 L min^{-1} according to the amount of water, respectively.

- Zhang LT, Gao ZL, Yang SW, Li YH, Tian HW (2015) Dynamic processes of soil erosion by runoff on engineered landforms derived from expressway construction: A case study of typical steep spoil heap. Catena 128, 108-121. https://10.1016/j.catena.2015.01.020.
- Zhang LT, Gao ZL, Li ZB, Tian HW (2016) Downslope runoff and erosion response of typical engineered landform to variable inflow rate patterns from upslope. Nat Hazards 80, 775-796. https://10.1007/s11069-015-1996-z.

Q3. the soil is clay loam; therefore, the entire work is soil type-specific (as however all the papers published on a similar approach).

Response: Clay loamy soil is a typical soil texture in study area (Guanzhong Plain of Loess Plateau) (Wu et al. 2021). Therefore, clay loam be used to simulate soil erosion of the spoil tips, and the research results are representative of the soil properties in the area.

- Wu J, Qi Y B, Chang Q R, Liu M Y, Bai L M (2021) Attribution of Lou Soil in

Chinese Soil Taxonomy and Establishment of Representative Soil Series in Guanzhong Area. Acta Pedologica Sinica, 58 (2):357-371. https://10.11766/trxb201906240325.

Q4. The real natural conditions where also vegetation play a role in soil erosion due to the roots are not considered, therefore the work is affected at its basis by a lack of representativeness of real conditions, and overall is affected by an "anthropogenic" setting of soil into a given plot. Differently, the approaches with natural soil, where also vegetation is present, with natural rainfall scenarios and more or less natural slope, are more representative of reality.

Response: We are in complete agreement with you. Natural slopes often have vegetation growing on the surfaces because there are no human influences. Under natural rainfall conditions, vegetation can effectively prevent the occurrence of soil erosion on slopes due to vegetation roots. However, spoil tips are a unique geomorphological unit which is formed by the artificial accumulation and remodeling of soil generated during the production and construction activities, which results in non-vegetation growth on the slope of the spoil tips at the early stage of formation, and it takes some time for the vegetation to recover naturally. In addition, the construction time of production and construction projects always rain heat synchronization, which lead to this stage that is the most serious stage of soil erosion in the spoil tips (no or little vegetation cover). In addition, serious erosion rates induce sediment and nutrients losses on discarded soils which make the disturbed soil accumulation vegetation reconstruction very difficult (Cerdà and García-Fayos2002). Therefore, soil erosion was often dominated by bare slope of the spoil tips, we mainly study and focus on the soil erosion of the spoil tips without vegetation cover stage. In addition, we thank for your suggestion and will focus on the effect of vegetation in the subsequent study to manage the erosion of the slope of the spoil tips.

The way in which spoil tips is formed causes it to differ from the natural slope or soil. Spoil tips has unique underlying surface conditions, for instance, destruction of soil structure, the vegetation degeneration, soil organic matter and plant root system deficiency, which result in its poor scouring resistance(Zhang et al.2015). The two

different subsurface conditions lead to differences in erosion. In addition, the driving force of soil erosion on natural slopes is mainly slope runoff formed by rainfall, while runoff from platforms is the main driving force of slope erosion on spoil tips. Therefore, we used runoff plots to study soil erosion on the slopes of spoil tips using artificial soil mounding and runoff scouring.

- Cerdà A, GarcíA-Fayos P (2002) The influence of seed size and shape on their removal by water erosion. Catena 48(4):293–301. https://doi.org/ 10.1016/S0341-8162(02)00027-9.
- Zhang, L.T., Gao, Z.L., Yang, S.W., Li, Y.H., Tian, H.W(2015). Dynamic processes of soil erosion by runoff on engineered landforms derived from expressway construction: a case study of typical steep spoil heap. Catena 128, 108–121.https://doi.org/10.1016/j.catena.2015.01.020.

Q5. However, the work in its present form doesn't meet the high standard required for HESS, where too limited studies are not welcomed. Second, the work is too narrow and site-specific in its purpose, a fact that is given at the eyes of the readers an idea of a not representative analysis, therefore with findings impossible to generalize.

Response: Thank you for your valuable comments. These have not only greatly improved our work, but also learned more knowledge of experimental research and future research directions that need attention from your comments. We also believe that the article can be revised according to your comments to reach the hess publication level.

Soil erosion is a global environmental problem that has greatly hindered region's sustainable socioeconomic development. Especially nowadays, artificial soil erosion often results in severe environmental and economic problems such as degradation of agricultural soil and surface water quality, and damage to infrastructure and transportation corridors. Spoil tips are now the most significant type of artificial soil erosion in the world. The erosion of spoil tips has caused a large number of environmental problems. On the one hand, spoil tips are new landforms created by man-made action, which have destroyed the original surface structure (Zhang et al.2015; Migońand Latocha 2018), and caused geological disasters such as landslides

and mudslides (Iqbal et al.2018; Jiang et al.2018). These disasters thus seriously threaten the safety of human life (Nearing et al.2017; Conforti and Ietto 2020). For example, a large landslide accidentally occurred in Shenzhen City (China) in 2018, resulting in a death toll of 73(Gao et al. 2019). On the other hand, soil and water loss from spoil tips leads to substantial sediment yields transported into rivers, affecting river flood safety and water quality. Therefore, there is an urgent need to investigate the soil erosion for spoil tips because they cause serious damage and threaten human lives. Therefore, this study has a strong international dimension and has many readers. In addition, our study focuses on the erosion processes and mechanisms of spoil tips, which is consistent with the scope reported by hess.

- Zhang LT, Gao ZL, Yang SW, Li YH, Tian HW (2015) Dynamic processes of soil erosion by runoff on engineered landforms derived from expressway construction: a case study of typical steep spoil heap. Catena 128:108–121.https://doi.org/10.1016/j.catena.2015.01.020.
- MigońP, Latocha A (2018) Human impact and geomorphic change through time in the Sudetes, Central Europe. Quat Int 470:194–206.https://doi.org/10.1016/j.quaint.2018.01.038.
- Iqbal J, Dai FC, Hong M, Tu XB, Xie QZ (2018) Failure mechanism and stability analysis of an active landslide in the Xiangjiaba Resevoir area, Southwest China. J Earth Sci 29(3):646–661.https://doi.org/10.1007/s12583-017-0753-5.
- Jiang YH, Lin LJ, Chen LD, Ni HY (2018) An overview Nearing of the resources and environment conditions and major geological problems in the Yangtze River economic zone, China. China Geol 1(3):435–449.https://doi.org/10.31035/cg2018040
- Nearing MA, Xie Y, Liu BY, Ye Y (2017) Natural and anthropogenic rates of soil erosion. Int Soil Water Conserv 2:77–84. https://doi.org/10.1016/j.iswcr.2017.04.001.
- Conforti M, Ietto F (2020) Influence of tectonics and morphometric features on the landslide distribution: a case study from the Mesima Basin (Calabria, South Italy). J Earth Sci 31(2):393–409.https://doi.org/10.1007/s12583-019-1231-z.

- Gao Y, Yin YP, Li B, He K, Wang XL (2019) Post-failure behavior analysis of the Shenzhen"12.20" CDW landfill landslide. Waste Manag 83:171–183https://doi.org/10.1016/j.wasman.2018.11.015.

Q6. On the other hand, in the case of an established plot on natural soil (even covered by vegetation) respecting the real geomorphologic conditions (usually for these sites, few non-invasive fences and one outled/tank collecting water/sediment are enough to guarantee the experiment), the analysis is conducted with real rainfall conditions (not with forced inflow rate), even for one year.

Response: We are in complete agreement with you. The construction of runoff plots on natural soil by using natural rainfall observation is one of the methods to study soil erosion of spoil tips, but there are many disadvantages: first of all, spoil tips are usually located in sparsely populated ravines, and the roads are often damaged (because of flash floods and landslides) after rainfall, especially heavy rainfall, so that people are not able to arrive in the first place, which affects the accurate acquisition of test monitoring data. Second, the lack of electricity and signals makes it impossible to provide energy and data transmission for monitoring equipment. Third, in heavy rainfall conditions, field site monitoring may pose a threat to personal safety. Comprehensive consideration, we did not use the method of constructing runoff plots on natural slopes to study soil erosion of spoil tips. Based on the field investigation (slope, slope length, soil bulk density and soil type), the designed runoff plots are able to more realistically approximate the natural conditions in the field. It is feasible to study the rill erosion on the slope of the spoil tips by designing runoff plots.

Under field conditions, the runoff collected by the compaction platform of spoil tips is an important factor causing slope scour erosion and accelerating erosion of engineered landscapes (Zhang et al. 2015, Zhang et al. 2016). Runoff from the platform has a greater impact on soil erosion than rainfall in the spoil tips. Therefore, we used runoff scouring to study the effect of runoff from the platform on the erosion of the spoil tips.

- Zhang LT, Gao ZL, Yang SW, Li YH, Tian HW (2015) Dynamic processes of soil erosion by runoff on engineered landforms derived from expressway construction:

A case study of typical steep spoil heap. Catena 128, 108-121. https://10.1016/j.catena.2015.01.020.

- Zhang LT, Gao ZL, Li ZB, Tian HW (2016) Downslope runoff and erosion response of typical engineered landform to variable inflow rate patterns from upslope. Nat Hazards 80, 775-796. https://10.1007/s11069-015-1996-z.

Thanks-note: We really thank you for providing so many review comments. We have a deeper understanding of how to make the simulation experiment research fit the actual situation and apply the research results to reality. We thank you very much. Due to our limited level of research, if our answer is not good enough, and our responses makes you dissatisfied, we hope to get further suggestions. Thank you very much!