Le Minor and colleagues provide a thoughtful reanalysis of two transport data sets to test and modify their earlier transport model (Le Minor et al. 2022). The two datasets (Shvidchenko et al., 2000, 2001 and Wilcock, Kenworthy, Crowe 2001) have not been analyzed together, as far as I know. Both datasets can be interpreted providing the grain size of the bed surface for the purpose of scaling fractional transport rates – an essential feature. The statistical analysis is clear and credible, as is the evaluation of the model fit. I support publication and my comments are primarily intended to provide perspective and points of interest for the authors in preparing the final version. In particular, I suggest that the authors include further discussion of the *interpretation* and *application* of the model relative to earlier models (basically my own: Wilcock and Crowe 2003 [WC2003]) This is not to say that the present model is inferior, but the choices made in developing the model have implications for its interpretation and application. I believe a discussion of these conceptual differences would be useful for the reader. They should also address the fact that their model in effect defines two different values for the reference stress for D_{50} (Point C below).

Here are three main points

(A) **The data used.** The two datasets have some important differences. Shvidchenko used very small transport rates that hardly modified the bed surface. Hence, the bed surface grain size from the start of the run was used to scale the transport rates (although he also demonstrated that the bed surface changed little over each run). Wilcock et al. used a wide range of transport rates (including very low transport rates) and much longer run times. The bed surface grain-size distribution was measured at the end of each run, such that the transport rates of each size fraction could be scaled by its proportion on the bed surface.

In both sets of experiments, the final bed surface and measured transport rate are sensitive to the initial bed grain-size distribution. No sediment was fed in the Shvidchenko experiments and sediment was recirculated in the Wilcock experiments. Parker and Wilcock (1993) show that the flume bed surface and transport are dependent on initial conditions in these cases. Hence, the manner of preparing the bed surface prior to each run becomes important. In both cases, the bed was screeded flat with a blade. This condition is particularly important in the case of the Shvidchenko data because the runs were short and involved very little transport, such that the bed remained relatively unchanged. The initial bed preparation has less of a direct effect on the Wilcock experiments because the runs were much longer (especially at small transport rates). Nonetheless, some of the coarser grains on the bed surface remained immobile throughout the run (the condition of partial transport). I emphasize this sensitivity to the initial, screeded bed because the larger grains on the bed surface were emplaced by the passage of a blade – a different mechanism than depositing from transport. I have no idea what the effect would be on entrainment of coarser grains from a screeded bed vs a water-laid bed, but the effect would be considerably greater in the Shvidchenko data than the Wilcock data. Even though both transport data sets are scaled by the grain size of the bed surface, the entrainment results could be different. As demonstrated in this paper, fitted values of τ_{ri} for the Shvidchenko data are consistently larger than those of the Wilcock data. The reason for this difference may well be methodological.

(B) **Conceptual basis of the model.** The author's new model (LM2025) revises their 2022 model. Some discussion of the conceptual differences with the Wilcock/Crowe (WC2003) model could be useful to the reader.

(1) WC2003 uses a single transport function in the determination of the reference stress for each size fraction τ_{ri}. This is for consistency in the model application of τ_{ri} with the same transport function. LM2025 find τ_{ri} using a function fitted to each fraction. This has the effect of conceptually separating the reference stress from the transport function. Not wrong, just different.

(2) LM2025 use a contant value of q^*_{bi} to define the reference shear stress; WC2003 use a constant value of W^*_i. Again, not wrong, just different. The effect on the measured values if τ_{ri} is clear: using a constant q^*_{bi} (10^{-4}) to define the reference transport rate leads to smaller values of τ_{ri} for the smallest sizes and larger values of τ_{ri} for the largest sizes, compared to using a constant value of W^*_I (0.002) to define the reference transport rate.

(3) WC2003 builds on previous efforts, dating to Egiazaroff (1965) and Ashida and Michue (1971) which use a similarity collapse to identify a single transport function that applies to all fractions. There is something both profound and convenient to the idea that a *single* transport function applies for all fractions in any sediment mixture, such that all differences in transport between fractions and/or between sediments can be accommodated in terms of the critical or reference shear stress. Although not perfect, decades of work have shown that dimensionless transport rate varies consistently with the excess of shear stress over critical. The LM model is more complex than this and loses this simple interpretation. It is not clear to me that LM2025 is parsimonious compared to models based on a similarity collapse using a universal transport function.

(4) LM2025 test the effect of sorting (s_g) and the fraction of sand (F_s) on the overall mobility of each sediment mixture (based on the reference stress for the median surface size). They find that s_g provides greater statistical explanation and do not include F_s in the model. What is lost here is the conceptual directness of evaluating the effect of sand on gravel transport, something that has been amply demonstrated over the years (Jackson and Beschta, 1984; Ikeda and Iseya, 1988, Curran and Wilcock, 2005; Hill et al., 2017). WC2003 predicts the transport of gravel, with or without sand. Inasmuch as the composition of a gravel bed may be expected to change much more slowly than the fraction of sand on the bed (which might come and go), it is useful to have a direct means of modeling the effect of sand content on gravel transport. One can, of course, calculate a new σ_g with the addition of sand to a gravel bed, but that seems an indirect way of accounting for an important controlling variable. I don't contest the author's statistical analysis but instead suggest that a discussion of the pros and cons of the different models would be relevant to the reader. Also, it is worth noting that the fit between the reference

Shields Number and σ_g (Figure 2a) is driven by the fact that all values of σ_g for Shvidchenko are smaller than for Wilcock and (as mentioned above) Shvidchenko τ_{ri} are consistently larger than WC2003 (real or a methodological consequence?).

(C) The proposed hiding function (Eq. 23, Eq. 24; Figure 2) has the unfortunate property that τ_{ri} does not equal τ_{r50} at $D_i = D_{50}$. See figure of hiding functions included below. Please explain how this can make sense.

Comments on specific parts of the text

Line xx (copied from text)
>>R> review comments

Line 42 there has been, to our knowledge, only one attempt at a continuous transport law that extends from bed load to suspended load for a wide range of flow strengths and sediment grain size distributions introduced by Le Minor et al. (2022)

>>R> There are a number of works on total load that give separate consideration to suspended load and bedload. A particularly thoughtful one considering the separate and combined effects of suspended and bedload is by Dade and Friend (1998).
>>R> The mixed-size data used in this paper to test the model are either entirely bed load (Shvidchenko) or include only low-flying sand suspension at he scale of the coarser components of a gravel bed (Wilcock, Kenworthy, Crowe). So the model presented here is not really tested against robust suspended transport of mixed-size sediment.

Line 80 Another issue, is that the reference shear stress measurement relates to a specific bed surface grain size composition and hydraulic conditions. The main limitations of existing definitions are that they were established based either on the grain size distribution of the initial bed surface, assuming that surface composition did not vary much between the initial and final run state (Shvidchenko et al., 2001) ***or the grain size distribution of the final bed surface averaged over several runs with similar initial bulk sediment*** (Wilcock and Crowe, 2003). These may not be comparable and could introduce inconsistencies in model calibration or validation using different datasets, especially for bed load transport predictions.

>>R> It is not just a matter of averaging "over several runs with similar initial bulk sediment", we demonstrated that the surface GSD for each of the five initial mixtures varied little with flow or transport rate (Wilcock, Kenworthy, & Crowe, 2001). We attributed this to a similar degree of kinetic sorting in each run (the runs with smaller transport rates extended for longer periods, such that all runs had greater than a minimum amount of transport and sorting).

Line 277 When the reference shear stress is not exceeded, we assume that the transport rate is so small that it can be neglected, and thus, the transport rate equals zero.

>>R> In coarser gravel natural systems, most of the transport occurs at stresses smaller than the reference stress.

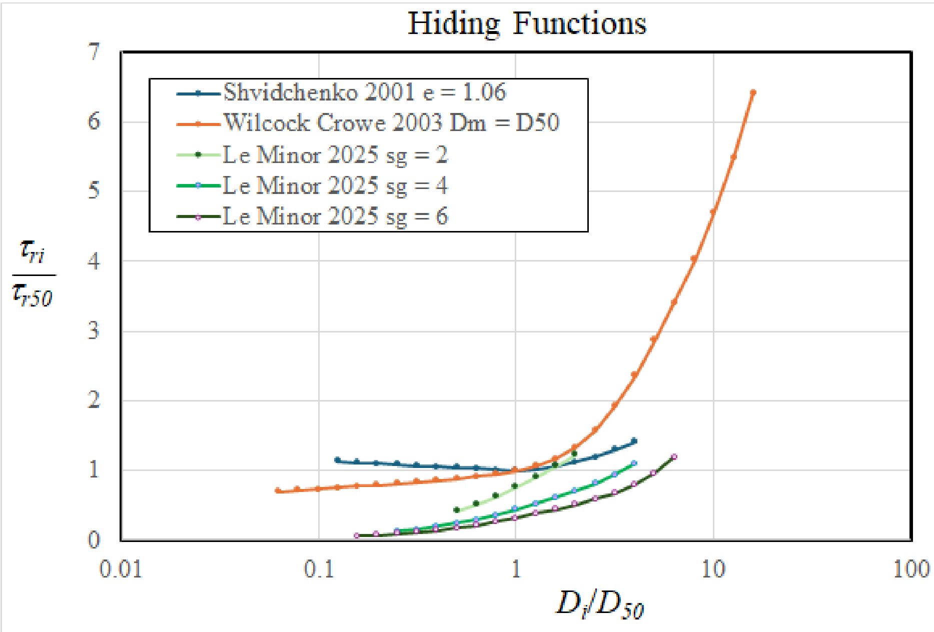
Line 374

Figure 2a shows that there is no clear influence of d_{50} on $\theta_{r,50}$ and that Eq. (22) holds for S2001 and WC2003. Using a functional relationship similar to WC2003, we found that the correlation between $\theta_{r,50}$ and the sand fraction was weaker ($\theta_{r,50}=0.049\exp\left(-0.97F_{sand}\right)$, $R^2=0.30$), so that we do not use F_{sand} subsequently.

>>R> The poorer fit as a function of F_s is due to the fact that the Shvidchenko reference stresses are all larger than the Wilcock reference stresses (by your fitting method). Also, some of the Shvidchenko mixtures have gravel sizes close to 2 mm, such that using a 2 mm boundary between coarse and fine sediment is not meaningful.

Line 405 The former two formalisms of Shvidchenko et al. (2001) and Wilcock and Crowe (2003) **cannot be shown on the same plot** as our new formalism since they are not equivalent, i.e., different variables and methods were used to parameterize and evaluate the reference shear stress.

>>R> Reasonable choices can be made to allow the different hiding functions to be placed on the same plot. After all, a user of these functions will do exactly that to evaluate them in comparison. I provide a plot below of the Shvidchenko, WC2003, and LM2025 hiding functions. I use e = 1.06 for the relation of Shvidchenko (2001); the variation of e is very limited for the data from his experiments; the variation of e for the other data sets examined by Shvidchenko is somewhat larger, but these data are not based on bed surface grain size and should therefore not be relied on. The Wilcock and Crowe (2003) model uses the mean size of the bed surface D_m rather than D_{50} but plotting the function using D_{50} allows a reasonable comparison. We see that the difference between the Shvidchenko and the Wilcock/Crowe hiding functions is not that large in their region of overlap (although small differences in reference shear stress can produce large differences in transport rate). The Le Minor hiding function has the unfortunate property that τ_{ri} does not equal τ_{r50} at $D_i = D_{50}$.



Svidchenko uses $e = 1.06$, which closely matches his experimental data. Wilcock and Crowe model uses the mean size of the bed surface size distribution; D_{50} used here. Grain-size range of plot matches the range used in Svidchenko and Wilcock/Kenworthy/Crowe experiments. Grain-size range shown for Le Minor trends equal to $D_i/D_{50} = \sigma_g$^2

Line 592 Despite significant improvements in model predictions, the multiple-size transport rates measured by Shvidchenko et al. (2001) are slightly overestimated compared to the ones of Wilcock and Crowe (2003), suggesting that second-order physical processes are not considered.

>>R> The entrainment and transport rates of the Shvidchenko and Wilcock data could be genuinely different, based on the much stronger dependence of the Shvidchenko data on the initial condition of the screeded bed.

Line 620 None of the entrainment relations published so far, to our knowledge, show a dependency of entrainment on the immobile fraction at the bed surface in the case of sediment mixtures.

>>R> almost the entire bed surface was immobile in the data of Shvidchenko. Wilcock and McArdell (1993) explore the extent of fractional immobility (termed partial transport) for the sandiest of the mixtures used by WC2003 and provide a basis for estimating partial transport.

Ashida, K., and Michue, M. 1971. ‘‘An investigation of river bed degradation downstream of a dam.’’ *Proc., 14th Int. Association of Hydraulic Research Congress*, Vol. 3, Wallingford, U.K., 247–255

Curran, J.C. and P.R. Wilcock, 2005, The effect of sand supply on transport rates in a gravel-bed channel, *J. Hydraulic Engineering*. DOI: 10.1061/(ASCE)0733-9429(2005)131:11(961)

Dade WB and PF Friend, 1998. Grain-Size, Sediment-Transport Regime, and Channel Slope in Alluvial Rivers, The Journal of Geology, 106(6), pp. 661-676)

Egiazaroff, I. V. 1965. ‘‘Calculation of nonuniform sediment concentrations.’’ J. Hydraul. Div., Am. Soc. Civ. Eng., 91(4), 225–247.

Hill, K. M., J. Gaffney, S. Baumgardner, P. Wilcock, and C. Paola (2017), Experimental study of the effect of grain sizes in a bimodal mixture on bed slope, bed texture, and the transition to washload, Water Resour. Res., 53, 923–941, doi:10.1002/2016WR019172.

Ikeda, H., and Iseya, F. , 1988. “Experimental study of heterogeneous sediment transport.” *Environmental Research Center Paper* No. 12, Univ. of Tsukuba, Tsukuba, Japan.

Jackson, W. L., and Beschta, R. L. , 1984. “Influences of increased sand delivery on the morphology of sand and gravel channels.” Water Resour. Bull., 20(4), 527–533.

Parker, G., and Wilcock, P.R., 1993. Sediment feed and recirculating flumes: a fundamental difference, *The Journal of Hydraulic Engineering*, 119(11):1192-1204. Discussion and closure published March, 1995

Wilcock, P.R. and Crowe, J.C., 2003 A surface-based transport model for sand and gravel, *J. Hydraulic Engineering*. 129(2), 120-128.

Wilcock, P.R., Kenworthy, S.T. and Crowe, J.C., 2001. Experimental study of the transport of mixed sand and gravel, *Water Resources Research*, 37(12), 3349-.3358.

Wilcock, P.R. and McArdell, B.W., 1993. Surface-based fractional transport rates: mobilization thresholds and partial transport of a sand-gravel sediment, Water Resources Research, 29(4):1297-1312