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Effect of Texture, Rainfall and Slope on Rainfall Interrill Sediment Transport

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Experiments were conducted with rainfall intensities of 45.0 and 140.0 mm/hr at slopes of 2, 9 and 20 per cent to separate the dominant effect of rainfall intensity on sediment transport capacity. The effect of sediment size on rain-intensity contribution to unit sediment transport capacity was also investigated. Regression models for rain-intensity contribution to unit sediment transport capacity Y were developed including median particle diameter X of sediment as an additional independent variable. The constants of power relationships of the form $Y \equiv a X^b$ were found to vary with the median particle diameter of the soil.

Introduction

The mechanics of interrill soil erosion has been well explored in last few years. Researchers on interrill soil erosion have also explained the process of soil detachment and subsequent transport of soil particles and aggregates. These processes are a result of the combined energy of rainfall intensity and flowing water. The importance of the rain-intensity component in interrill soil erosion, particularly with reference to providing the energy for soil detachment, has been described by Young and Wiersma (1973), Walker *et al.* (1977 and 1978), and Meyer (1981). These processes do not consider the separate effect of rain-intensity contribution to unit sediment transport capacity in interrill flow.

The research on interrill erosion in detached soils has revealed that the transport capacity may be related to the overland flow discharge, ground slope and rainfall intensity. Further the rainfall enhancement may be the dominant agent. It has also been suggested that the particle or aggregate sizes available for transport affect the capacity for transport (Guy 1987). However, the nature of these relationships and effects is unclear, particularly the effect of sediment particle size on rainfall induced sediment transport capacity and on the roles of slope, discharge and rainfall intensity in determining that capacity.

The objective of this study was to develop a relationship between the rain-intensity contribution to unit sediment transport capacity and land slope and show that the coefficients of the fitted model vary with the sediment size. Also to develop a transport model which includes sediment size in addition to rainfall intensity and flume slope.

Experimental Methods and Analysis

The rainfall simulation system used for the experiments consisted of Guelph rainfall simulator II, a single-nozzle rainfall simulator described by Tossell (1987). Equations describing the spatial distribution of the rainfall intensity over the flume surface was given by Guy (1987) for 9.52 mm (3/8″) and 12.7 mm (1/2″) nozzles operating at heights above the flume of 1.0, 1.5 and 2.0 m at an operating pressure of 48 kPa to simulate rainfall intensities. For a rainfall intensity of 45.0 mm/h, nozzle size of 9.52 mm was operated at 2.0 m above the flume slope and for 140.0 mm/h, nozzle of 12.7 mm was used at 1.5 m above the flume slope.

The flume slope was set at 2, 9 and 20 per cent. The soil separates were dry sieved into three textural groups S1, S2 and S3. Soil material below very fine sand size (0.1 mm) formed S1 soil group, material in the fine sand to medium sand size (0.1 to 0.5 mm) formed S2 group and material of coarse sand size (0.5 to 1.0 mm) the S3 soil group. The soil was classified by Presant and Wicklund (1971) as a Lisbon sandy with 4.5 per cent clay, 6.8 per cent silt and 87.4 per cent sand. The particle size distribution of textural groups S1, S2 and S3 along with the dry sieving of S2 and S3 soils are reported in Table 1.

The experimental system, including a fixed-bed flume 690.0 mm wide by 1,500.0 mm long, a flow collection system and a soil supply system used in the study, was basically the same as that used by Guy (1987). The predetached soil was injected at the middle of the flume length (x = 750.0 mm). The soil injection rate was adjusted to just match or be slightly greater than the visually determined sediment transport capacity. Details are reported by Agarwal (1989).

The particles and aggregates of finer soil fractions (S1) were injected as soil slurry to break the surface tension of water, which could not be obtained when

Table 1 – Particle size distribution of original soil, soil groups S1, S2 and S3 used in transport experiments

Soil	Clay	Silt	Very fine sand	Fine sand	Medium sand	Coarse sand	Very coarse sand	Gravel
original	4.5	6.8	5.7	42.0	35.3	4.4	0.5	0.9
S1*	15.2	51.7	31.4	0.9	0.4	0.2	0.1	0.0
S1*	15.1	52.7	30.5	1.5	0.5	0.2	0.0	0.0
S2*	2.4	2.4	3.9	55.9	35.0	0.3	0.0	0.0
S2	2.4	3.2	3.8	62.1	28.3	0.2	0.0	0.0
S2!				62.3	37.5	Nil		
S3*	4.5	9.0	4.4	15.3	30.0	36.4	0.3	0.0
S3	4.9	9.0	4.0	15.0	34.3	32.3	0.5	0.0
S3!				Nil	Nil	100.0		

*: By mechanical and chemical dispersion (hygrometer/pipette)

!: By dry sieving analysis

injected in dry phase because of a tendency to float on the water surface. The soil slurry was composed of 40 and 60 per cent soil and water by weight, respectively. The slurry injection system and the collection of transported sediment are reported by Agarwal (1989). A schematic diagram of the experimental set-up is reported in Fig. 1.

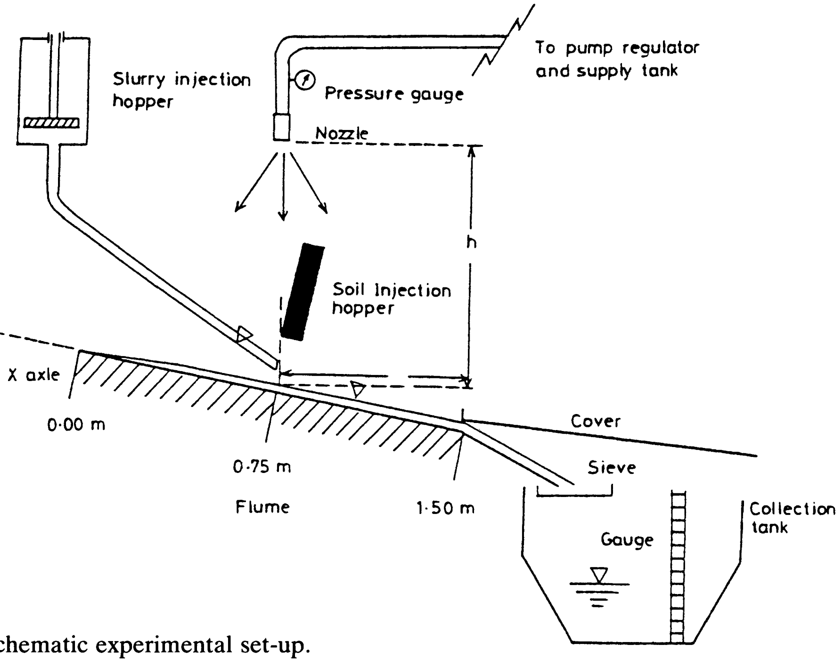

Fig. 1. Schematic experimental set-up.

Experiments were made with two simulated rainfalls, three textural sediment groups, three flume slopes and two or more replications, to explore the effect of rainfall impact on sediment transport capacity. Experimental runs were randomly conducted and sequentially reported in Table 2.

Table 2 – Experimental design, data of unit discharge, unit sediment transport capacity and rain-intensity contribution to unit sediment transport capacity

Experimental design				C.S.T.$^{\#}$ rate	F.S.T.$^{!}$ rate	U.S.T.C.$^{\$}$ at $x \equiv 75$ cm	Rain-intensity contribution to U.S.T.C.$^{\$}$
Soil	Flume slope %	I* mm/h	Rep.	gm/min	gm/min	$q_{st}\times10^{-6}$ kg/ms	$q_{sr}\times10^{-6}$ kg/ms
S1	2	55.6	1	0.00	27.10	654.7	585.0
S1	2	55.8	2	0.00	26.82	647.9	578.0
S1	2	139.7	1	0.00	96.42	2329.0	2166.0
S1	2	146.0	2	0.00	77.12	1863.0	1694.0
S1	9	56.1	1	0.00	98.90	2389.0	2166.0
S1	9	56.6	2	0.00	83.74	2023.0	1633.0
S1	9	147.6	1	0.00	224.93	5433.0	4158.0
S1	9	147.6	2	0.00	273.07	6596.0	5319.0
S1	20	56.7	1	0.00	221.86	5359.0	4006.0
S1	20	56.8	2	0.00	344.98	8333.0	6980.0
S1	20	61.8	3	0.00	312.00	7536.0	6030.0
S1	20	161.4	1	0.00	1217.78	29420.0	24460.0
S1	20	161.4	2	0.00	1059.46	25590.0	20630.0
S1	20	164.1	3	0.00	1192.73	28810.0	23740.0
S1	20	166.0	4	0.00	1587.30	38340.0	33200.0
S2	2	54.9	1	0.23	0.13	8.7	8.1
S2	2	55.3	2	0.15	0.15	7.4	6.7
S2	2	145.5	1	3.77	0.63	106.3	103.9
S2	2	146.7	2	3.46	0.67	99.0	96.9
S2	9	54.4	1	7.55	0.64	197.8	139.4
S2	9	55.2	2	7.98	0.88	214.0	153.9
S2	9	146.5	1	74.59	2.58	1864.0	1511.0
S2	9	141.9	2	82.70	3.08	2072.0	1739.0
S2	20	50.3	1	70.78	3.02	1783.0	1394.0
S2	20	49.9	2	81.80	2.55	2037.0	1654.0
S2	20	49.5	3	67.85	2.79	1706.0	1325.0
S2	20	52.4	4	8.58	2.82	2449.0	2026.0
S2	20	142.1	1	477.32	10.09	11770.0	9873.0
S2	20	140.0	2	450.00	10.15	11120.0	8584.0
S3	2	48.1	1	0.03	0.22	6.1	5.6
S3	2	47.7	2	0.03	0.21	5.8	5.3

Table 2 cont.

Experimental design				C.S.T.# rate	F.S.T.! rate	U.S.T.C.$ at $x \equiv 75$ cm	Rain-intensity contribution to U.S.T.C.$
Soil	Flume slope %	I* mm/h	Rep.	gm/min	gm/min	$q_{st}\times10^{-6}$ kg/ms	$q_{sr}\times10^{-6}$ kg/ms
S3	2	146.0	1	1.06	0.67	42.0	39.7
S3	2	147.5	2	1.74	1.78	85.0	82.7
S3	9	54.4	1	2.99	0.97	95.6	68.3
S3	9	47.9	2	2.84	1.18	97.1	76.4
S3	9	141.9	1	38.37	3.07	1001.0	788.2
S3	9	141.2	2	53.08	6.12	1430.0	1219.0
S3	20	51.5	1	32.70	1.49	825.8	652.8
S3	20	52.4	2	26.84	3.10	723.2	544.1
S3	20	137.9	1	253.15	24.52	6707.0	5437.0
S3	20	137.9	2	216.54	15.80	5612.0	4341.0
S3	20	134.5	3	278.60	14.50	7080.0	5874.0
S3	20	139.6	4	228.70	15.79	5906.0	4603.0

Rep.: Replications
* : Rainfall intensity at the middle of flume, $x = 75$ cm
\# : Coarse sediment transport (sediment size 0.053 to 1.00 mm)
! : Fine sediment transport (sediment size less than 0.053 mm)
$: Unit sediment transport capacity

Results and Discussion

Experimental Data

Experimental data of rainfall intensity I, sediment transport rate in coarse and fine fraction, and unit sediment transport capacity q_{st} are reported in Table 2. This unit sediment transport capacity includes both the effect of flow and the effect of rain-intensity. At the flume cross-section of $x = 750$ mm, the estimated rainfall intensity was observed to vary from 47.7 to 166.0 mm/h, approximating the design intensities of 48.0 and 147.0 mm/h (*i.e.* 0.013 and 0.041 kg m^2/s). The unit discharges corresponding to these experimental intensities were estimated at 0.356 and 1.264 l/min (8.61×10^{-6} and 30.57×10^{-6} m^2/s) approaching the range of unit discharges produced in experiments without rainfall (Agarwal 1989).

Analysis of Variance

An analysis-of-variance was carried out to determine the effects of rainfall intensity, flume slope, median particle diameter and the interaction terms on unit sediment transport capacity. The results of this analysis are reported in Table 3.

Table 3 - Analysis-of-variance results for unit sediment transport capacity

Source	d.f.	P-value	F-ratio	Per cent contribution
Rep.	1	0.15	2.2	0.2
I	1	0.00	268.8	20.1
S_o	2	0.00	325.6	48.8
D_{50}	2	0.00	154.3	23.1
$I \times S_o$	2	0.17	1.9	0.3
$I \times D_{50}$	2	0.04	3.7	0.6
$S_o \times D_{50}$	4	0.00	17.8	5.3
Residual	21	–	–	1.6

Rep.: Replication
d.f. : Degree of freedom
I : Rainfall intensity
S_0 : Flume slope
D_{50} : Median particle diameter

Rainfall intensity, flume slope and median particle diameter were found to be significant. The interactions $I \times D_{50}$ and $S_o \times D_{50}$ were also significant. The per cent contribution of interaction $S_o \times D_{50}$ is higher as compared to other interactions, suggesting that the effect of median particle diameter on unit sediment transport capacity is influenced by the flume slope.

Comparative Results

To evaluate the rain-intensity contribution to unit sediment transport capacity, it was assumed that the unit sediment transport capacity of the rainfall-induced flow runs consisted of a rain-intensity component q_{sr} and a flow component q_s. The unit sediment transport capacity for unit discharge alone was estimated by using a power relationship of the form $q_s = a\, q^b$, where q is the unit discharge produced by the average rainfall intensity up to the flume length of 0.75 m. This relationship was developed for the uniform flow runs conducted without rainfall for all soils and flume slopes (Agarwal 1989). The constants a and b for all conditions of soil and flume slope are reported in Table 4. The q_{sr} reported in Table 2 could therefore be expressed as

$$q_{sr} = q_{st} - q_s \tag{1}$$

Preliminary observations revealed that the rain-intensity contribution to unit sediment transport capacity appeared to increase with rainfall intensity and flume slope, and to decrease with soil aggregate size.

The rain-intensity component to unit sediment transport capacity for the S1 soil in the present experiments appears to be somewhat greater than those reported by

Table 4 – Constants of the relationship between unit sediment transport capacity and unit discharge for the uniform flow runs

Soil	Slope %	Constant *a*	Constant *b*	Confidence limit of *b*	Correlation coefficient
S1	2	3.0	0.928	0.75 to 1.10	0.99
S1	9	697.4	1.254	1.01 to 1.49	0.99
S1	20	2511.6	1.260	1.17 to 1.39	0.99
S2	2	23.8	1.310	1.20 to 1.42	0.99
S2	9	682000.0	2.015	1.89 to 2.13	0.99
S2	20	209400.0	1.736	1.11 to 2.35	0.98
S3	2	59.2	1.398	1.25 to 1.53	0.99
S3	9	1919100.0	2.168	1.86 to 2.47	0.99
S3	20	3514500.0	2.054	0.90 to 3.20	0.96

Guy (1987) Fig. 2. This may be possible because the finer electrically charged soil particles normally are in suspension and electrostatic forces keep them in suspension requiring no additional energy. The computed rain-intensity component to unit sediment transport capacity for S3 soils at the 2 per cent slope was lower in magnitude than the values reported by Guy (1987) Fig. 3. It is possibly because the S3 was sieved soil and did not have sediment below 0.5 mm in size. The values at the 9 and 20 per cent slopes were expected to be lower than Guy's experimental data; however, they were greater. This result is possibly due to the problem of flow capacity to transport the maximum particle diameter, limiting the injection of soil at the capacity rate in some of Guy's experimental observations. Similar behaviour was observed with S2 soil.

Effect of Slope on Rain-Intensity Contribution to Unit Sediment Transport Capacity

A power relationship, commonly used in the literature, was explored, *i.e.* between rain-intensity contribution to unit sediment transport capacity and flume slope at two rainfall intensities of 48.0 and 147.0 mm/h. The form of the relationship considered was $q_{sr} = a\ S_0{}^b$, where q_{sr} is rain-intensity contribution to unit sediment transport capacity, S_0 is flume slope, a and b are fitted constants. The statistical analysis of regression coefficients rejects the null hypotheses in almost all the cases. The present results thus indicate a power relationship between the two variables at selected rainfall intensities, see Table 5.

A further analysis of intercepts of developed power relationships suggests that they are different from one another in the cases 48.0 and 148.0 mm/h. These results tend to confirm the effect of soil texture on unit sediment transport capacity.

Regression lines along with the data of Guy (1987) are reported in Figs. 4 and 5. At 2 per cent slope the observation of Guy (1987) is higher than those of S2 and S3 soils. A higher value reflects disaggregation of poor aggregates into finer particles

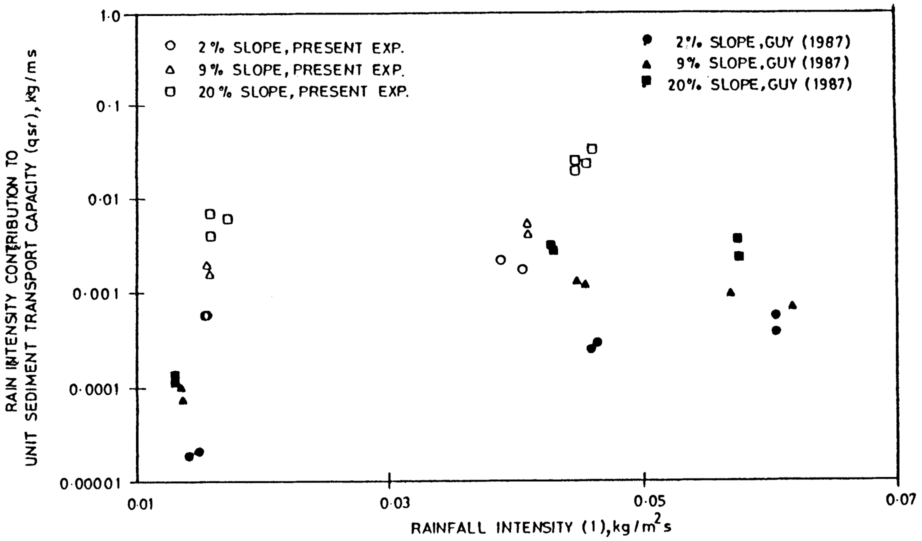

Fig. 2. Rain intensity contribution to unit sediment transport capacity of S1 soil versus rainfall intensity at injection site.

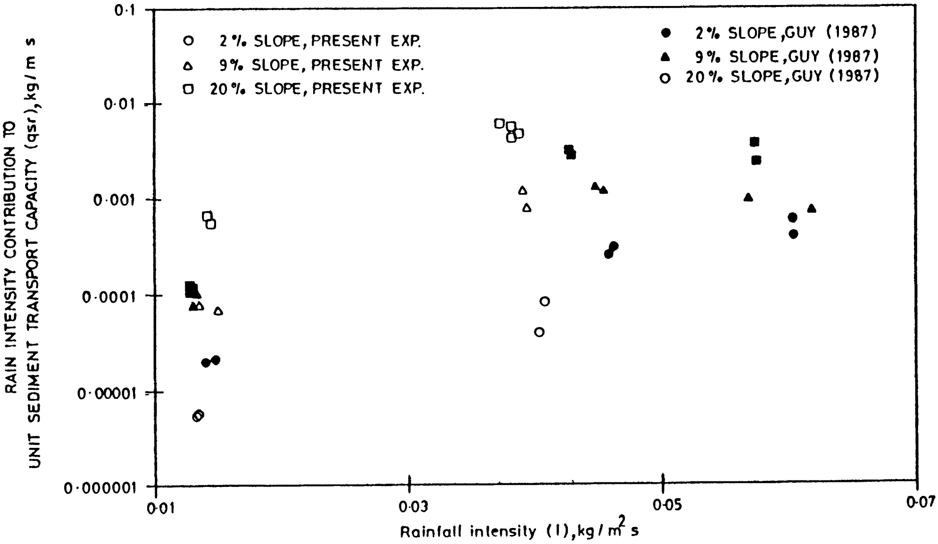

Fig. 3. Rain intensity contribution to unit sediment transport capacity of S3 soil versus rainfall intensity at injection site.

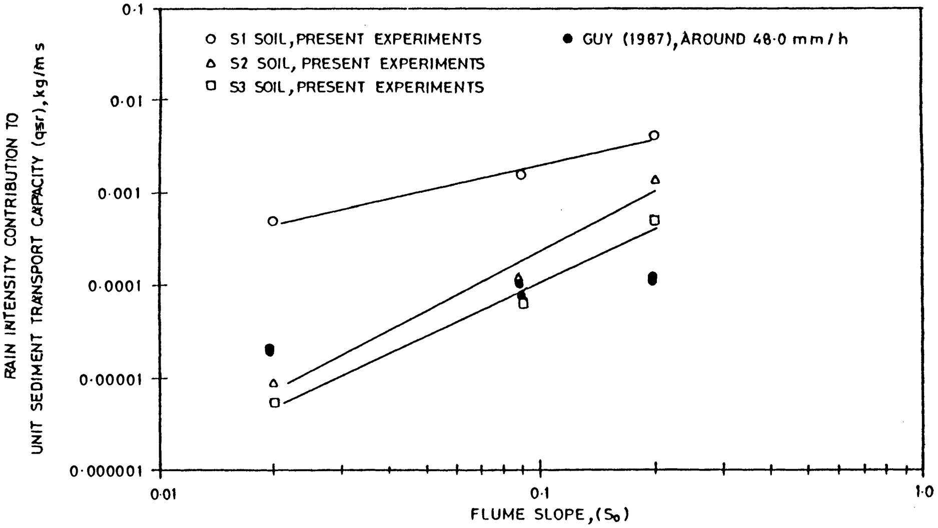

Fig. 4. Rain intensity contribution to unit sediment transport capacity versus flume slope at low rainfall intensity (around 48.0 mm/h).

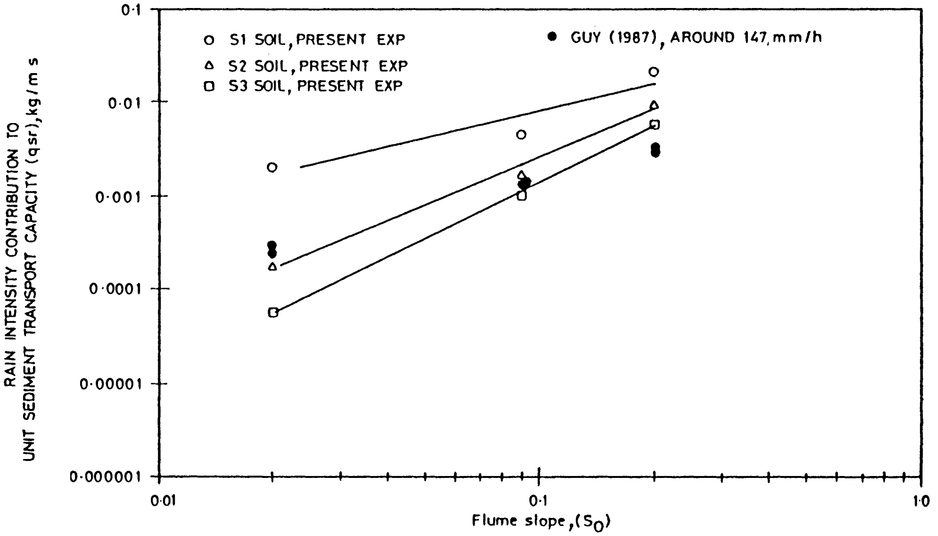

Fig. 5. Rain intensity contribution to unit sediment transport capacity versus flume slope at high rainfall intensity (around 147.0 mm/h).

Table 5 – Constants of the relationship between rain-intensity contribution to unit sediment transport capacity and flume slope

Soil	Rain intensity mm/h	Constant $a \times 10^{-4}$	Constant b	Confidence limit of b	r^2
S1	48.3	161.2	0.91	0.52 to 1.30	0.99
S1	147.4	771.5	0.98	−0.04 to 2.00	0.94
S2	48.3	310.6	2.13	0.91 to 3.34	0.98
S2	147.4	1259.0	1.69	1.19 to 2.19	0.99
S3	48.3	89.7	1.92	1.19 to 2.65	0.99
S3	147.4	1384.0	2.00	1.85 to 2.13	0.99

r^2: Correlation coefficient

during transport. At 9 per cent slope the inverse is observed and reflects the problem of flow capacity to transport maximum particle size thus restricting soil injection rate.

Effect of Median Soil Particle Diameter on Unit Sediment Transport Capacity

Unit sediment transport capacity was considered in relation to the mean, median and maximum soil particle diameter of respective soil group. The median soil particle diameter (D_{50}) of the experimental soil was observed best related with unit sediment transport capacity. The measurements, reported in Table 2, indicate that weaker soil aggregates in the soil, when introduced into the flow broke down to finer aggregates and particles during transport. Further, the percentage of the soil aggregates being broken down into fine sand appears to be different for the different soil groups and for the different discharge and slope conditions.

Due to these experimental results, the unit sediment transport capacity was related to the soil median diameters in two different ways. First, the weaker aggregates present in the added soil were assumed being broken down during the transport process, and this soil was referred to as the SAB soil. The D_{50} estimates of the SAB soils associated with the S1, S2 and S3 soil groups were 0.0165, 0.148 and 0.287 mm respectively based on the particle size distribution of the respective group. Secondly, it was assumed that weak soil aggregates were not being broken down, but remained intact during transport. This soil was referred to as the *S* soil. Estimates of median diameters D_{50} associated with S1, S2 and S3 soil groups, were done with the help of particle size distribution of dry sieved S2 and S3 soils as 0.0165, 0.175 and 0.75 mm respectively.

Estimation of the median particle diameters of the *S* version of the S1, S2 and S3 soil groups was a little hypothetical. For the *S* version of S1 soil, the median particle diameter was taken to be that of the S1 soil, since it was injected in the form of soil slurry and could not disaggregate significantly. In the case of the *S*

Table 6 – Constants and statistics of the relationship between rainfall-intensity component to unit sediment transport capacity and median particle diameter of soil

Soil S2, S3	Slope %	Rainfall intensity mm/h	Constant $a \times 10^{-7}$	Constant b	Confidence limits of b	t value	r^2
S	2	48.3	24.2	−0.65			87.9
SAB*	2	48.3	5.7	−0.88	−2.86 to −0.38	− 8.3	96.4
S	2	147.4	406.0	−0.42			82.9
SAB*	2	147.4	151.0	−0.58	−1.95 to −0.44	−10.0	93.3
S	9	48.3	372.0	−0.65			98.9
SAB*	9	48.3	134.0	−0.84	−1.68 to −0.62	−13.7	99.7
S*	9	147.4	9400.0	−0.20	−0.47 to −0.25	−21.0	97.1
SAB	9	147.4	6430.0	−0.25			89.2
S*	20	48.3	4810.0	−0.45	−1.00 to −0.07	− 7.3	99.5
SAB	20	48.3	2860.0	−0.57			94.5
S*	20	147.4	73700.0	−0.08	−0.73 to +0.24	− 3.2	91.4
SAB	20	147.4	55200.0	−0.10			80.2

* : Best-fit regression equations
r^2: Coefficient of determination

version of the S2 soil, the median particle diameter for this class was taken as median diameter of the fine sand group on the basis of dry sieve analysis of S2 soil, which indicated 62.3 per cent sand. For the S3, *S* version, the median diameter was taken to be the median of the coarse sand group, on the basis of dry sieve analysis which indicated 100 per cent of aggregates/particles in the coarse sand group.

The form of the relationship explored was $q_{sr} = a\, D_{50}{}^{b}$, where q_{sr} is rain-intensity contribution to unit sediment transport capacity, D_{50} is median particle diameter of the soil separate, and a and b are fitted parameters of the equation. The estimated constants for the regression equations and statistical analysis of exponents for best-fit equations are reported in Table 6.

The regression equations at 2 and 20 per cent are presented in Figs. 6 and 7. The statistical analysis reported in Table 6 reveals that the exponents of the developed regression equations are different from zero. The fitted parameters were further compared with one another and an effect of rainfall intensity and flume slope was observed on the fitted constants of the equation.

Interpretation of Exponents

Literature about sediment transport considering sediment transport without detachment is scarce, contrary to literature considering detachment and transport subsequently. Mostly the work on sediment transport considering soil detachment and subsequent transport is on sandy soils with very low clay content. Therefore,

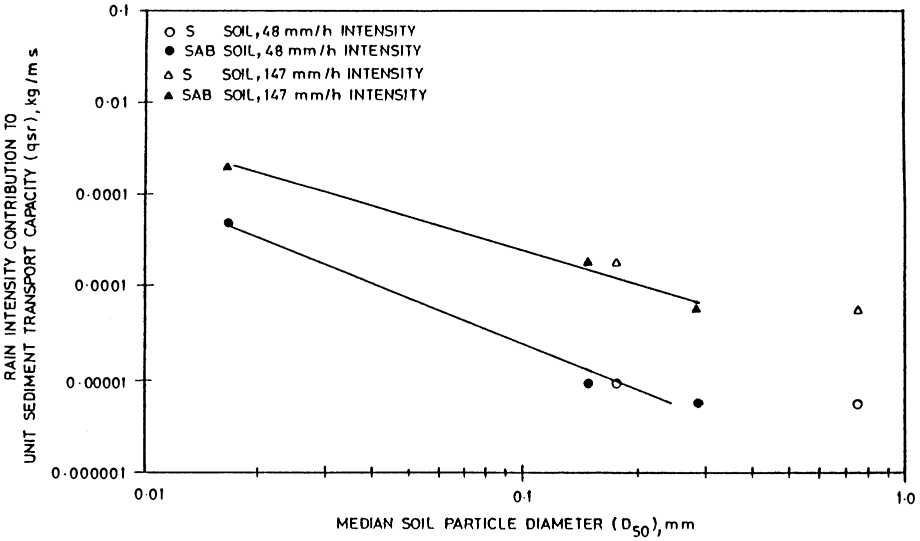

Fig. 6. Rain intensity contribution to unit sediment transport capacity versus median soil particle diameter at 2% flume slope.

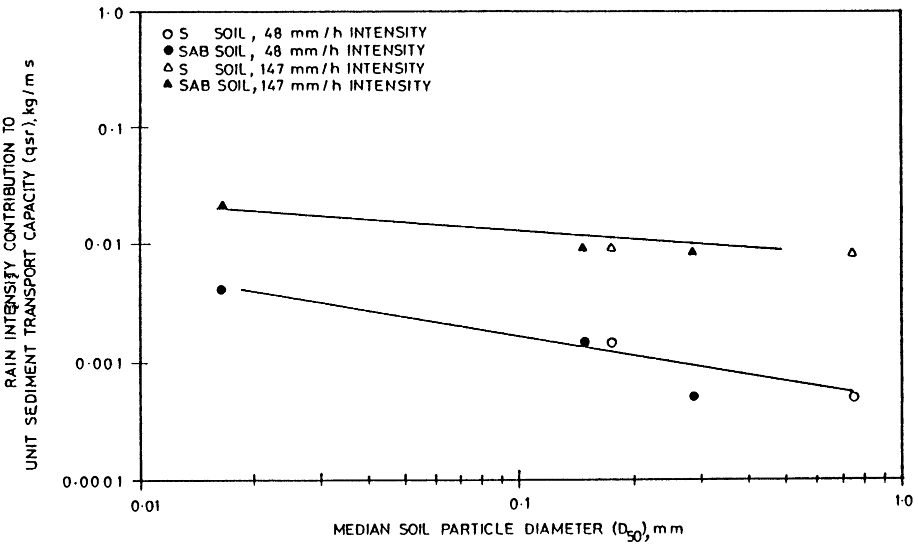

Fig. 7. Rain intensity contribution to unit sediment transport capacity versus median soil particle diameter at 20% flume slope.

the energy required for soil detachment is normally rather small. In fact these experiments may be considered nearly representing a sediment transport which requires no energy for soil detachment for the sake of comparison with present experiments. The flume slope exponent in the present experiment was observed to vary from 0.91 to 2.13. However, Zingg (1940) reported 1.49, within the range of the present experiments. The value of slope exponent reported by Mutchler and Young (1975), with about 82 per cent of the soil being below sand size, was reported as 0.74. This value compares very well with those for the present experiments for the S1 soil, *i.e.* 0.91 and 0.98.

Meyer and Wischmeier (1969) reported 1.667 as value for the exponent on slope in a multiple model, while Kilinc and Richardson (1973) obtained 1.664. Julien and Simons (1985), summarizing a number of equations, reported numerical values of the exponents on slope from 1.21 to 1.90. They also modified the exponents of Kilinc and Richardson (1973) by separating the excess discharge contributions due to rill formation and reported a new value of the slope exponent as 1.31 for interrill sheet flow. The experimental situations reported by Guy (1987) yielded results similar to the present experiments. The reported values on the exponent on slope ranged from 0.79 to 1.03.

The exponent on median particle diameter in the present experiments varies from −1.627 to −0.246. The value reported by Meyer and Monke (1965) was −0.50 in a simple power model for the conditions of smaller slope steepness and slope lengths.

The exponent for rainfall intensity in the rainfall intensity component to unit sediment transport capacity equation varied from 0.998 to 2.67 in the present experiment. Walker *et al.* (1978) studied the effect of rain intensity on erosion of non-cohesive bed material and the exponent on intensity ranged from 0.76 to 2.22. The low values around 0.76 were observed at a 0.5 per cent flume slope. At a 5.0 per cent flume slope, the exponent value varied from 0.76 to 2.22. a similar range in the exponents was observed in the present analysis, but the values of Walker *et al.* (1978) around 0.76 were slightly lower than all determined for the present experiments. The value of 0.76 corresponded to experiments conducted with particles less than 0.31 mm in diameter, indicating less movement of such soil. This result may have been due to the presence of a high clay content, the transport being restricted by limited soil detachment.

Meyer (1981) reported the exponent of intensity to vary from 1.9 to 2.1 for silt, silt loam and sandy loam soils. These values also compare well with those for the S2 and S3 soils of the present work. A decrease in the intensity exponent was proposed by Meyer (1981) when the clay content was greater than 20 per cent. Soils with 50 per cent clay yielded an exponent around 1.6 for the equation proposed by him. The value of 1.6 is comparable with the exponents for the S1 soil of the present experiments. Watson and Laflen (1986) reported the exponents of rain intensity to vary from 1.36 to 2.54. Meyer (1981) reported a value 1.85, and

Watson and Laflen (1986) reported 1.47, 2.54 and 1.36 for 10, 20 and 50 per cent slope runs for a Monona soil (95 per cent of the particles less than sand size). These values are comparable to those for the S1 soil, which were 0.99 to 1.47.

The variability of exponents in the literature and in the present experiments reflects the complexity of the sediment transport process, and suggests, the involvement of more variables to define sediment transport in interrill flow. The formation of rills may sometimes be responsible for the variability in the numerical values of the exponents, as observed by Meyer and Monke (1965) and by Kilinc and Richardson (1973).

Sediment Transport Models

Since the experiments were designed to explore the effect of soil median particle diameter (D_{50}), and the results above have indicated that particle diameter is significant, median particle diameter was included as a third independent variable in a set of three-variable multiple model. The model coefficients were compared with those reported in literature. The rain-intensity contribution to unit sediment transport capacity was considered to vary with rainfall intensity, flume slope and median particle diameter of soil. The models can be expressed as

$$q_{sr} \equiv Co\, I^{d1}\, S_0^{d2}\, D_{50}^{d3} \tag{2}$$

where q_{sr} is rain-intensity contribution to unit sediment transport capacity, I is rainfall intensity, S_0 is flume slope, D_{50} is median particle diameter of soil separate and *Co, d*1, *d*2 and *d*3 are fitted coefficients of the multiple model reported in Table 7. The table includes significance level and percentage explained in the model by each variable. The coefficients of determination seem to be reasonably high.

The fitted parameter associated with median particle diameter is somewhat greater than −0.50 in rainfall-induced flow situations, being −0.52 and −0.68 respectively. These values are comparable to the fitted estimate of −0.50 reported by Meyer and Monke (1965) in a three-factor multiple model.

Table 7 – Estimated parameters of multiple power model and their statistics

Constants	Estimated parameter	Std. error	Per cent explained by parameter	95 per cent confidence interval
ln Co	−4.63	1.14		−6.96 to −2.31
d1	2.10	0.28	25.85	1.52 to 2.68
d2	1.76	0.15	53.93	1.45 to 2.07
d3	−0.68	0.10	20.21	−0.89 to −0.48

Model $F_{(0.05;3,32)} = 79.9$ Coefficient of determination $r^2 \equiv 0.864$

Summary and Conclusion

The rain-intensity contribution to unit sediment transport capacity can be related to rainfall intensity, flume slope and median particle diameter. A power relationship was developed between rain-intensity contribution to unit sediment transport capacity and the variables rainfall intensity, flume slope and median particle diameter of the soil. A three-variable power model for rain-intensity contribution to unit sediment transport capacity was developed including median soil particle diameter in addition to rainfall intensity and flume slope.

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