PENGARUH KECEPATAN ALIRAN TERHADAP GERUSAN LOKAL PADA PILAR JEMBATAN DENGAN PERLINDUNGAN GROUNDSILL

S u c i p t o

ursr an Teki Tp $FTnir ,UnaTeki $FTv $ksaShaTgkmks Spk(nsn mTEvgg) pGT

dk4r mT) KFT5n(I raTpkinsn Tdr r mI nUSpk(nsn mT0299. FTek,I 8TE29KGT1021: 29T

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Abstract: *Local scouring which occurred on a bridge pillar at the bottom of rivers that are granular (sand) can cause degradation of construction that result in instability of the bridge construction itself. Along with the influence liquifaction due to vibration from construction vehicles crossing the bridge, local scour will cause damage and the collapse of the bridge. The process of scouring characterized by the migration of sediment that covers the basic pillars of the bridge and river erosion that occurred would follow the pattern of flow. Effect of flow velocity will be more dominant so that the cause of exit and entry occurs elementary particles into the scour hole, but the depth is fixed or constant. In an equilibrium state the maximum depth will be greater than the mean depth of scour. Research the influence of flow velocity on local scour at bridge pier with groundsill protection is done in clear-water-Scour. The result showed that the maximum scour depth at cylindrical pillar for running the model (M1) occurred at a speed of 0.267 m / s is equal to 42 mm while the minimum scour depth occurs at a speed of 0.157 m / s is equal to 3 mm. At the same flow rate, placement on the downstream groundsill pillar causes the depth of the flow around a cylinder pillar is higher than the model (M1) so that the depth of scour around cylindrical pillar is smaller than the model (M1) with an average reduction rate of the overall running on various velocity variation of 61.49%.*

Keywords: *the flow velocity, local mashed, pillar bridge, groundsill*

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AbstrakoTdksr an T,yi n,Tj n mTUksbn4STI n4nTI $nsTbk(fnUh Tj n mTFksn4nTI n4nT4nansTar mnSTj n mT j n mTFksaShnUTmsn r ,ksTEnaSG4nI nUT(k jkfnfin TUksbn4S jnT4kmsn4naSTi y aUsriaSTj n mTFksni $nUT I n4nTikUS4niaUhf $n Tiy aUsriaSTbk(fnUh TSUTak 4SSThksan(nn T4k mn TI k mnsr PT*liquifaction*T ni $nUTmkUnsn T4nsSTik 4nsnn Tj n mT(k,S UnaSTiy aUsriaSTbk(fnUh FTmksr an T,yi n,Tnin T4nI nUT (k jkfnfin Tiksranin T4n Tiksr UrPn Tbk(fnUh 8Tcsyaka TUksbn4SjnTmksran T4SUh 4nST4k mn T fksI S4nP jnTak4S $k Tjn mT(k rUI STI $nsTbk(fnUh TaksUnTksyaST4nansTar mnSTj n mTUksbn4STnin T (k mSr USTy,nTn,Sn 8Tck mnsr PTikDkI nUh Tn,Sn Tnin T,kf $PT4y(Sn TakPS mmnT(k bn4STk jkfnfT Uksbn4STk,rnsT4n T(nari jnT nsUS k,T4nansTkT4n,n(T,rfn mTmksr an FT n(r Tk4n,n(n TUkUhI TnUhrT i y aUh 8Twn,n(Tkn4nn TakU $fn mTk4n,n(n T(nia $ r(Tnin T,kf $PTFkansT4nsSEksnUhTk4n,n(n T mksr an 8Tck k,SSh Tk mnsr PTkDkI nUh Tn,Sn TUksPn4nI Tmksr an Tyin,TI n4nT$nsTbk(fnUh T4k mn T I ks,S4r mn Tmsyr 4aS,TSS4$hirin TI n4nT*clear-water-scour*8Twns SPnaSTk k,SSh T4 $ksy,kPTFnPMnT ik4n,n(n Tmksr an T(nia $ r(TI n4nT$nsTaSS4ksTF UhiT(y4k,T*running*TE6 : GUksbn4STI n4nTkDkI nUh T 2F97/ T(3aTjn SUTakfkansTK9T((Tak4n mi n Tik4n,n(n Tmksr an T(S $ r(TUksbn4STI n4nTikDkI nUh T 2F. 0/ T(3aTjnSUTakfkansTFT((8Tcn4nTkDkI nUh Tn,Sn Tjn mTan(nFTk k(I nUh *groundsill*TI n4nTPSST I $nsT(k jkfnfin Tik4n,n(n Tn,Sn T4STakiShsTI $nsTaSS4ksT,kf $PTU $mnST4nsST(y4k,TE6 : GTakPS mmnT ik4n,n(n Tmksr an T4STakiShsTI $nsTaSS4ksT,kf $PTikDST4nsST(y4k,TE6 : GT4k mn Tn minTsk4riaSTsnUh% snUhT4nsSTkak,rsrPn T*running*TI n4nTFksfnmnSTNhsShaSTkDkI nUh Takfkans T7: FK. TH 8T

Keywords: *kecepatan aliran,* mksr an T,yi n,FT $nsTbk(fnUh FTmsyr 4aS,8T

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PENDAHULUAN

Latar belakang

ck k(I nUh T *groundsill*T 4ST PSST I $nsT fksUrbn TnmmsTak4S $ k Tjn mTUksfnMnTy,kPT n,Sn TnSTni $nUTmksran T,yi n,TI n4nTI $nsT bk(fnUh T 4nI nUTUksUhPn TakPS mmnT(nUksSn,T 4nansT 4ST akiShsT I $nsT US4niT (k mn,n(ST I k rsr n T jn mT aShnSSSn T jn mT 4nI nUT (k jkfnfin Tik US4niaUhf $n Tiy aUsriaSTI $nsT bk(fnUh 8T

dksr an T,yi n,T E*local scouring*G jn mT Uksbn4STI n4nTI $nsTbk(fnUh Tjn mTFksn4nTI n4nT 4nansTar mnSTjn mTjn mTFksaShnUT*granuler*TEnaSG 4nI nUT (k jkfnfin T Uksbn4S jnT 4kmsn4naST *liquifaction*

Gerusan Lokal

local scouring

Mekanisme Gerusan

(vertical velocity gradient)

(pressure gradient)

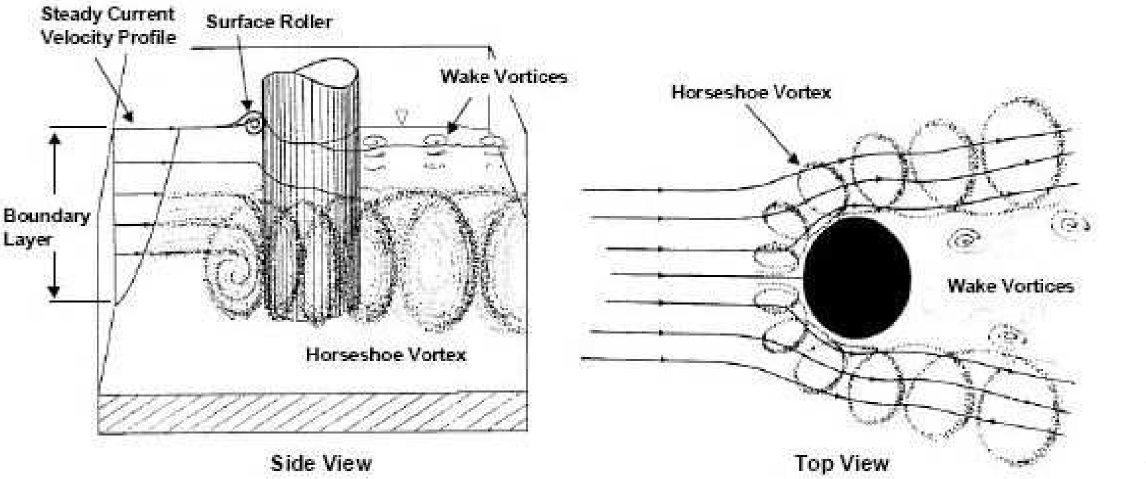
(pressure gradient)

bed

horseshoe

*vortex)*Fi nsk nT4$SPnUT4nsSTnUhaTf k Ui Tl ransn T S S(SS TUhl n,T r 4n8T

c n4nT ks(r i nn TnSFS UksniaSn,Sn T4n T aUsr i UsT(k(f k Ui Tf r ar sTy(f ni T*(bow wave)*T j n mT 4SakfrUT akfnmnST mr ,r mn T l ks(r i nn T *(surface roller).*Tc n4nTannUT Uksbn4STl k(SanPn T n,Sn Tl n4nTaUsr i UsTf nmSn T4n,n(TT(k mn,n(ST *wake vortices*8T



Gambar 1.T6 ki n Sa(kTdksr an TRi $nUcy,nTR,Sn TRST4Spki SUsTc SnsTEpr (fksTb6 S,ksF922- d7GT

c n4nTr (r (j nTUkmn mn TmkaksTE*shear stress*GT(k S mi nUT l n4nT f k4T f nmSn T 4kl n T aUsr i UsT h SnT*bed*T(r 4nPTUksmksr aT(ni nT,r f n mT mksr an T ni n T Uksf k Ui T 4Saki SUsT aUsr i Us8T t k y(k nTS ST4SakfrUTmksr an T,yi n,T*(local or structure-induced sediment scour).*TT

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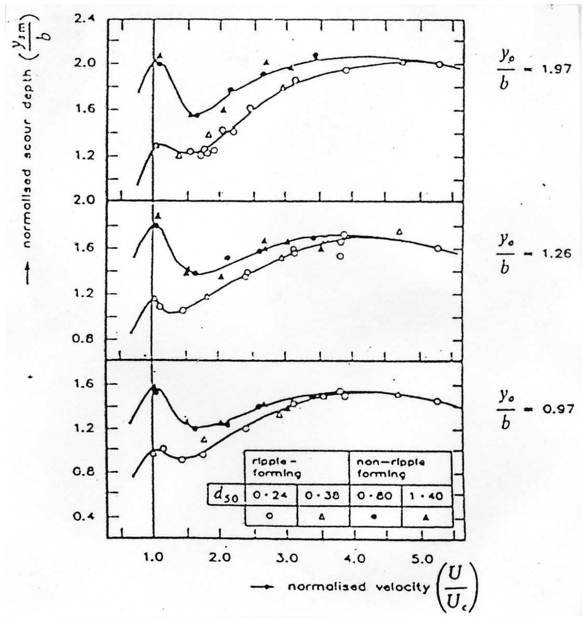
Kecepatan aliran pada alur sungai

5k4n,n(n TmksranT,yi n,T(ni a$ r (T sksnUhT4STaki SUsTl SnsTan mnUTUksmn Ui mT SnST sk,nUSBT i kDkl nUh T n,r sT ar mnST E ksfn 4S mn T n UhsnTi kDkl nUh TsksnUhTn,Sn T4n Ti kDkl nUh T mkaksGFT SnST4Sn(kUksTf r USn TE r USn Taksnmn(3T USni T aksnmn(GT 4n T ,kf nsT l Sns8T wk mn T 4k(SSn T(ni nTmksr an T,yi n,T(ni a$ r (TsksnUhT Uksakf r UT(ksr l ni n Tmksr an T,yi n,T(ni a$ r (T 4n,n(T y 4SaSakU$ f n m8T

c k mnsr PT i kDkl nUh T sk,nUSBT l n4nT mksr an T4nl nUT4Su brin T l n4nTE*U/U*$_c$GT l n4nT i k4n,n(n Tmksr an TUhi T ks4$ k aSE*y*$_s$*/b*GTakl ksUST 4$ks,SPnUn T n4nTm(f nsT98T



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Gambar 2.T5 k4n,n(n Tdksr an TWyi n,T6 ni a$ r (T CnUh%CnUhTr Ui TcSnsTp S S 4ksTEpr (fksT>PkkF . 19T 4n,n(Tnskr aksaT4n TCnr 4i SNF . . : d 7GT

c ks,r T4$ ksPnUSn TnPMnTbT

- Tnl nf SnT28 02T< *U/U*$_c$TUSni TUksbn4STn4n j nTl SnsT mksr an T,yi n,T4n TUSni TUksbn4STUn al ysUhaST ak4$ k T n4nT4nksnPTaki SUsT SnsFT
- Tnl nf SnT: F2T< *U/U*$_c$T< T28 02FTl k j kf nf TrUh(nT Uksbn4S j nTl syakaTmksr an Tn4n,nPT*clear water scour*T4n TS STni n TUksbn4STmksr an T,yi n,T4ST

4nksnPT aki SbhsT I SnsT n(r T U4ni T Uksbn4ST I syakaTUsn al ysUnaSTak4$ k 8Tc n4nTi y 4SaST U/U_cTVT: F2T(ni nTi kDkI nUn Tn,Sn Tan mnUT 4y(Sn T4n T(k rsrUpPk TE. / 9G4n Td snEBT E. . 0G4n,n(Tnks,Sn n4SE. . 1o - GoT ki r nUn T *horseshoe vortex*T4n Tn mi nTCkj y,4TI n4nT I SnsTn4n,nPToT

$$y_{se} = 0.00022\left(\frac{Ub}{v}\right)^{0.609}$$

- Tn I nf SnT: F2TVTU/U_cFTI k j kf nf Tr Un(nTn4n,nPT *live bed scour*Ti nsk nTI syakaTUsn al ysUnaST ak4$ k Tf ks,n mar mTUksr aTni n TUkUnI STU4ni T (k $ f r,i n T4n(I ni Tan(I nSTUksmksr a j nT 4nansT4STaki SbhsTI SnsTf ksnsUSTI n4nT4nksnPT UksakfrUT Uksbn4ST i kakU$ f n mn T n UnsnT I k mk 4nI n T4n TksyaS j n8T

METODE PENELITIAN

ck k,SSn T4Snian nin T4STWf ysnUys8(T LS4snr,$ nTur sr an Teki $ Tp $ STt nir,UnaTeki $T v $Nksa$bnaTgkmksSTpk(nsn m8Tv srUn TI k k,SSn T 4Snirin T(k bn4S4rnTf nmSn Tr Un(nFTj nSUToT

: 8Tc k k,SSn T akDnsnT EaFT 4Snirin T 4ST WnfysnUys8(TL S4snr,$ nTur sr an Teki $ Tp $ ST t nir,UnaT eki $T v $Nksa$bnaT gkmksST pk(nsn mT 4k mn T I k mn(nUn T 4n T I k DnUnUn TEk y(k nTj n mTn4nT4S(y4k,8T

98Tc k k,SSn T akDnsnT P$ yUkU$ T 4n T n n,S$FT 4Snian nin T 4k mn T Ubrn T (k k(rin T f kf ksnI nTNhsSnf ,kTj n mTan,S mTf ksI k mnsr P8T

ck k,SSn T EaT 4ST ,nf ysnUys8(T j n mT (k j n mi rUTUnPnI n TaU4ST,$UksnUsFTI ksaSnI n T n,nUFTI ksaSnI n TfnPn FTI k(f r nUn T(y4k,T4n T I k mr (I r,n T 4nUnT 4nsST I k j nbSn T (y4k,8T pk4n mi n T I k k,SSn T P$ yUkU$ T 4n T n n,S$T f ksr I nTn n,SaSaT4nUnT4n T(k(f r nUTi ka$ I r,n T PnaST k k,SSn TakDnsnTS mi na8T

Pelaksanan penelitian

cn4nT I k,ni an nn T I k k,SSn T 4Sk Dn ni n T4k mn T(k mmr ni n T9TE4rnGT (y4k,T I k k,SSn T 4k mn T: 7T Ek n(T f k,naGT NhsSnaSTi kDkI nUn Tn,Sn Tj n mT4$ ksy,kPT4nsSTKT Ek(I nUGTNhsSnaST4kf $Tn,Sn T4$ n nTakUSnI T4kf $UT Uks4SSTnUnaTKTEk(I nUGTNhsSnaSTi k4n,n(n Tn,Sn 8T R4nI r TNhsSnaSTk k,SSn j nTn4n,nPToT

n8TQnsSnaS(y4k,TE6 GT

ck k,SSn T4Snirin T4k mn T(k mmr ni n T9T E4rnGTNhsSnaS(y4k,T*running*Tj nSUToT

: 8Ten I nT(k mmr ni n T*groundsill*TE6 : GT

98T6 k mmr ni n T*groundsill*TE6 9GT

f 8TQnsSnaSTkDkI nUn Tn,Sn TEQGT

QnsSnaST i kDkI nUn T 4S4nI nUT 4nsST PnaST I ksPSU mn T f ks4nansi n T I nsn(kUks% I nsn(kUksTn,Sn Takf nmnSTksSr UToT

Tabel 1. TNhsSnaSTkDkI nUn Tn,Sn T

L / =	L: ; T28 2/ 0T(	L9 ; T28 2 1 2T(	L- ; T28 2 1 0T(	LK ; T28 . 2T(
=: ; T98 / 9T,34UT	V_1 ; T28 1 . T(3a	V_2 ; T28 / / T(3a	V_3 ; T28 7 7T(3a	V_4 ; T28 0/ T(3a
=9 ; T-8 01T,34UT	V_5 ; T289 : - T(3a	V_6 ; T289 2 2T(3a	V_7 ; T28 1 1T(3a	V_8 ; T28 / 1T(3a
=- ; T-8 K T,34UT	V_9 ; T289 - 1T(3a	V_{10} ; T289 9 - (3a	V_{11} ; T289 : 2T(3a	V_{12} ; T28 . 1T(3a
=K ; TK8 2K T,34UT	V_{13} ; T289 7/ T(3a	V_{14} ; T289 0 2T(3a	V_{15} ; T289 - 7T(3a	V_{16} ; T289 9 9T(3a

c. unsni T k k(I nUn T*groundsill*

Groundsill 4SUk(I nUn TI n4nTbnsni T9wT4nsST PSST SnsFT4$ n nTwTn4n,nPT4Sn(kUksT Snss8T

wnsST I nsn(kUks%nsn(kUksT 4SnUnaT 4S4nI nUT f kf ksnI nT (nDn(T NhsSnaST I k k,SSn T f ks4nansi n T k mnsr PTi kDkI nUn Tn,Sn Tj nSUToT

:8TQnsSnaST I k k,SSn T I n4nT 4kf SST = : T Un I nT I ks,S 4r mn T *groundsill*T E6 : GT oT 6 : = : Q: oT 6 : = : Q9oT6 : = : Q- oT6 : = : QKT

98TQnsSnaST I k k,SSn T I n4nT 4kf SST = 9T Un I nT I ks,S 4r mn T *groundsill*T E6 : GT oT 6 : = 9Q0oT 6 : = 9Q7oT6 : = 9Q/ oT6 : = 9Q1T

-8TQnsSnaST I k k,SSn T I n4nT 4kf SST = - T Un I nT I ks,S 4r mn T *groundsill*T E6 : GT oT 6 : = - Q. oT 6 : = - Q: 2oT6 : = - Q: : oT6 : = - Q: 9T

K8TQnsSnaST I k k,SSn T I n4nT 4kf SST = KT Un I nT I ks,S 4r mn T *groundsill*T E6 : GT oT 6 : = KQ: - oT 6 : = KQ: KoT6 : = KQ: 0oT6 : = KQ: 7T

08TQnsSnaST I k k,SSn T I n4nT 4kf SST = : T 4k mn T I ks,S 4r mn T *groundsill*T E6 9GT oT 6 9 = : Q: oT 6 9 = : Q9oT6 9 = : Q- oT6 9 = : QKT

78TQnsSnaST I k k,SSn T I n4nT 4kf SST = 9T 4k mn T I ks,S 4r mn T *groundsill*T E6 9GT 6 9 = 9Q0oT 6 9 = 9Q7oT6 9 = 9Q/ oT6 9 = 9Q1T

/8TQnsSnaST I k k,SSn T I n4nT 4kf SST = - T 4k mn T I ks,S 4r mn T *groundsill*T E6 9GT oT 6 9 = - Q. oT 6 9 = - Q: 2oT6 9 = - Q: : oT6 9 = - Q: 9T

18TQnsSnaST I k k,SSn T I n4nT 4kf SST = KT 4k mn T I ks,S 4r mn T *groundsill*T E6 9GT oT 6 9 = KQ: - oT 6 9 = KQ: KoT6 9 = KQ: 0oT6 9 = KQ: 7T

hks4nansin T NhsSnaSNhsSnaST I k k,SSn T 4SnUnaT(ni nTi kak,r sr Pn Tni n T4Shi r i n T-9Tn,ST *running*8T

R4nI r T,n minP%n minPT I k,ni an nn T I k k,SSn T (y4k,T : T E ShsT Un I nT *groundsill*GT n4n,nPTakf nmnST ks$r UoT

:8T6 y4k,T I ShsT aSS 4ksT 4SkUni i n T 4ST Uk mnPT *flume*T4k mn Tbnsni T-F0T(T4nsSPr ,r 8T

98T5sn T k mnUrsT4kf SST4$r i nT4n T4$r UnsTn4nT USSST j n mT Uk,nPT 4SUk Ur i n FT i k(r4Sn TnSST 4Sn,Si n T akDnsnT I ks,nPn T (k,n,r ST i sn T I k mn,SST I n4nT i y 4SaST I S UrT nSST UksUrUr I T PS mmnT(k DnI nSTkUS mmSn TUksUk Ur8T

-8Tpk Uk,nPT nSST (k DnI nST i kUS mmSn T UksUk UrT i sn T I k mn,SST 4SrUr I T i k(f n,SST i k(r4Sn T j n,ni n TI y(I nT4n Tf Snsi n TnSSTI n4nTf ni T Un(I r mn TUksSaST k r P8T

K8Tc S UrT nSST (r ,nST 4$r i nT akDnsnT I ks,nPn T f ksan(nn T4k mn T4$r i n j nTi sn TI k mn,SS8T c n4nTMni UrTI k(f r i nn Ti sn T4n TI S UrTnSFT I y(I nTnSSTbr mnT4$ naUSn T4n,n(Ti kn4nn T PSr I TakPS mmnTUn(I r mn TnSSTUkUnI T4n,n(T i y 4SaST k r P8T

08Tck mn(nUn Ti k4n,n(n Tmksr an FT4Shi r i n T (k,n,r ST I k mn(nUn T akUSnI T I ksDyf nn T 4k mn T(k DnUnUTi k4n,n(n Tmksr an T4nsST nMn,T*running*TakUSnI Tak,n mTMni UrTUksUk UrFT j nSrT: 2T(k SST ksUn(nT4SDnUnUTakUSnI Tak,n mT Mni UrT: T(k SFT(k SST i k%2TPS mmnT(k SST i k% 02T 4SDnUnUT akUSnI T ak,n mT Mni UrT 0T (k SFT (k SST i k%02T PS mmnT (k SST i k%2T 4SDnUnUT akUSnI Tak,n mTMni UrT: 2T(k SFT4n T(k SST i k% .2TPS mmnT(k SST k%12T4SDnUnUTakUSnI Tak,n mT Mni UrT : 0T (k SFT akPS mmnT i kak,r sr Pn T *running*T 4Shi an ni n T ak,n(nT - T bn(8T ck mn(nUn T i k4n,n(n T mksr an T 4SDnUnUT UksraT (k ksraT ak,n(nT Mni UrT i kakUS f n mn 8T

78Tck mn(f Sh T 4nUnT i y UrsFT 4nUnT i y UrsT mksr an T 4ST aki SnsT I ShsT 4$i r sT akUk,nPT *running*Tak,kan$T4k mn TDnsnT(k(I ksi kDST 4kf SSTn,Sn TakDnsnTI ks,nPn Tnmns Tmksr an T4ST aki SnsT I ShsT USni TUksmn mmr Ty,kPTn4n j nT I ksr f nPn T 4kf SST Ln,T S ST 4Shi r i n Tnmns T 4$ ksy,kPT4nUnTi y UrsTj n mT(kMni SSTmksr an T UksakfrUST wnUnT i y UrsT 4$i r sT 4k mn T (k mmr ni n T n,nUT *point gauge*8T wnksnPT mksr an Tj n mT4$i r sTk,kNhaS j nT4$ nmSTnUnaT f kf ksnI nTf nmSn Tj nSrTnsnPTakbnbnsTn,Sn T4n T nsnPT(k,S Un mTn,Sn 8T

/8Tpk Uk,nPT4Shi r i n TI k mr i rsn TUSmT4$ k aSFT I naSST4Sy,nPTr Uri Ti k(r4Sn T4SnUni n T4n T 4$ n4nUn Ti k(f n,ST4k mn Tk,kNhaST(nUksSn,T 4nansT akar nST 4k mn Tsk Dn nT I k k,SSn FT

I syakaTS ST4Shirin TakUSI Tnin T(k,nirin T IksDyfnn 8T 5k(r4Sh T r UdiT ak,n brUjnT 4Shirin T*running*T4k mn TNhsShaSTikDkInUh T fksSrUjnTI n4nT4kfSTjn mTan(n8T5k(r4Sh T 4k mn T,n minPTiksbnTjn mTan(nTr UdiT 4Shirin T *running*T In4nT ikDkInUh % ikDkInUh Tn,Sn TfksSrUjn8T

R4nIr T,n minP%n minPTIk,nian nn T Ik k,SSh T(y4k,T9TE ShsT4k mn T*groundsill*GT n4n,nPTakfnmnSTksSrUoT

:8T6 y4k,TIShsTaSS4ksT4SkUhiin T4STUk mnPT *flume*T4k mn TbnsniT-F0T(T4nsSPr,r8T

98T*Groundsill*T 4SkUhiin T (k(fk Uh mT In4nT *flume*T4k mn TbnsniTE9wGT4nsSPSSTShs8T

-8T6 kin Sh(kTiksbnTak,n brUjnTan(nT4k mn T (y4k,T6 :T4nsST,n minPT y8T9Tan(InST y8T/T 4n T 4Sh brUn T r UdiT NhsShaSNhsShaST ikDkInUh TfksSrUjn8T

T

HASIL PENELITIAN DAN PEMBAHASAN

Pengaruh Kecepatan Aliran Terhadap Kedalaman Gerusan

wnsST PnaSTIk mrbSh Tjn mT4Shirin T (k r briin T n4n jnT Ik mnsrPT n UhsnT ikDkInUh Tn,Sn T4k mn Tik4n,n(n Tmksran T ,yin,T4STakiShsTIShsTr UdiTik4rnTbk ShT(y4k,T *running*FIPn,TUksakfrUT4nInUT4SPnUT n4nTUhfk,T98T pk,nSTSbTIk mnsrPTUksakfrUTbrmT4nInUT4SPnUT 4nsSTPnaSTIk mrbShTIk mnsrPT4kfSTn,Sn T4n T fSh mn T*Froude*Tjn mT(k r briin Tn4n jnT Ik mnsrPTfkansTUksPn4nITik4n,n(n Tmksran FT ak4n min T4kfSTn,Sn T4n TfSh mn T*Froude*T aksUhTkDkInUh Tn,Sn T(k(SSSTnShTjn mTksnU8T

T5kDkInUh Tn,Sn Tan mnUTfksIk mnsrPT UksPn4nITik4n,n(n Tmksran T,yin,T4STakiShsT IShsTaSS4ksTakPSmnnT4k mn TikDkInUh Tn,Sn T jn mTfksfk4nTnin T(k mni$nUn TmnjnTjn mT fkiksbnTr UdiT(k mn mirUTfrUSh Tak4$k T fksfk4nTr,n8T

Tabel 2. Lrfr mn T5kDkInUh TR,Sn Twk mn T 5k4n,n(n Tdksran

gy8I	6 y4k,T	vT E(34UGT	v DT E(34UGT	v 3/ DT	wa3wyT
:T	6 : = : Q: T	28 1. T	2891/ T	2870. T	28922T
9T	6 : = : Q9T	28 / / T	2891/ T	287: / T	28211T
-T	6 : = : Q- T	28 77T	2891/ T	280/ 1T	2820. T
KT	6 : = : QKT	28 0/ T	2891/ T	280K/ T	282- - T
0T	6 : = 9Q0T	289: - T	2891/ T	28 K9T	2890- T
7T	6 : = 9Q7T	28922T	2891/ T	287. / T	28 11T
/T	6 : = 9Q/ T	28 11T	2891/ T	28700T	28 0- T
1T	6 : = 9Q1T	28 / 1T	2891/ T	28792T	28207T
.T	6 : = - Q. T	289- 1T	2891/ T	2819. T	28799T
:2T	6 : = - Q: 2T	2899- T	2891/ T	28 / / T	28722T
::T	6 : = - Q: : T	289: 2T	2891/ T	28 - 9T	28K1. T
:9T	6 : = - Q: 9T	28 . 1T	2891/ T	287. 2T	28K22T
:-T	6 : = KQ: - T	2897/ T	2891/ T	28 - 2T	28 - - T
:KT	6 : = KQ: KT	28902T	2891/ T	281/ : T	2817/ T
:0T	6 : = KQ: 0T	289- 7T	2891/ T	28199T	280- - T
:7T	6 : = KQ: 7T	28999T	2891/ T	28 / KT	28K1. T
:/T	6 9= : Q: T	28 1. T	2891/ T	2870. T	2829KT
:1T	6 9= : Q9T	28 / / T	2891/ T	287: / T	28222T
:.T	6 9= : Q- T	28 77T	2891/ T	280/ 1T	28222T
92T	6 9= : QKT	28 0/ T	2891/ T	280K/ T	28222T
9:T	6 9= 9Q0T	289: - T	2891/ T	28 K9T	28999T
99T	6 9= 9Q7T	28922T	2891/ T	287. / T	28922T
9-T	6 9= 9Q/ T	28 11T	2891/ T	28700T	282KKT
9KT	6 9= 9Q1T	28 / 1T	2891/ T	28792T	28222T
90T	6 9= - Q. T	289- 1T	2891/ T	2819. T	28- - - T
97T	6 9= - Q: 2T	2899- T	2891/ T	28 / / T	2891. T
9/T	6 9= - Q: : T	289: 2T	2891/ T	28 - 9T	28999T
91T	6 9= - Q: 9T	28 . 1T	2891/ T	287. 2T	28 / 1T
9.T	6 9= KQ: - T	2897/ T	2891/ T	28 - 2T	2877/ T
-2T	6 9= KQ: KT	28902T	2891/ T	281/ : T	28007T
-:T	6 9= KQ: 0T	289- 7T	2891/ T	28199T	28K22T
-9T	6 9= KQ: 7T	28999T	2891/ T	28 / KT	28- 07T

pr(fksToLnaSTck k,SSh T

5kUksn mn TT oTT

vTT ;T5kDkInUh Tn,Sn TE(34UGT
v_{DT} ;T5kDkInUh TsSSSTE(34UGT
4aT ;T5k4n,n(n Tmksran TE(GT
fT ;T,kfnsTShsTE(GT

T

Pengaruh Jarak Penempatan *Groundsill* Terhadap Kedalaman Gerusan

cn4nTsr SmT(k mmr nin T*groundsill*T iy 4SaST 4n T ikDkInUh T n,Sn T aksUhT ,n(nT Ik mn(nUh Tmksran TjnmTUksbn4ST4STakiShsTShsT aSS4ksT an(nT 4k mn T *running*T Uh InT (k mmr nin T*groundsill*TE6 : GTR4nIr TUSSS%SSST Ik mn(nUh Tik4n,n(n Tmksran T4STakiShsTShsT aksUhT(y4k,TIk k(InUh T*groundsill*T4nInUT4SPnUT In4nTm(fnsT-8T

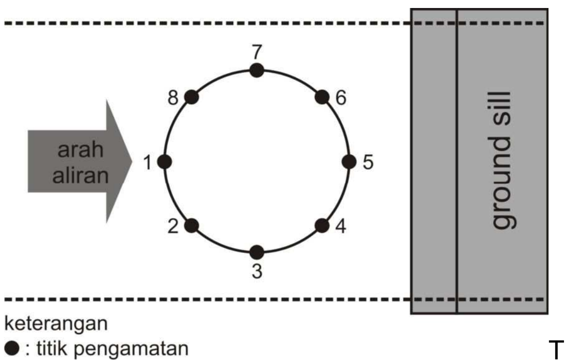
hks4nansin TPnaSTIk mn(nUh T*running* (y4k,T6 9TakDnsnTikak,rsrPn T(k r briin T f nPMnT4k mn T4$Uk(I nUIn jnT*groundsill*TI n4nT P$SSTI $nsTa$S4ksTnin Tfksl k mnsrPTUksPn4nI T I y,nTn,$n T4n Tfkans jnTik4n,n(n Tmksran T jn mTUksbn4S4Sakt$bhsT$nsTT

LnaSTI k mn(nUh T(k r briin TfnPMnT 4$Uk(I nUIn jnT*groundsill* I n4nTfnm$n TPSSTI $nsT a$S4ksT(n(I rT(ksk4riaSmksran Tjn mTUksbn4ST PSmmnT(k DnI nST syak UhakT:22H Tjn mTfksnsUST In4nT ikDkI nUh T UksUk UhT (nUks$n,T 4nansT 4ST aki$bhsT I $nsT USAniT (k mn,n(ST I syakaT IksI S4nPn TnUhrTfksn4nTI n4nTiy 4$aSTjn mT UkUhI T4nsSnMn,TPSmmnTniPSSTMniUhTI k mn(nUh 8T hkansTn minTI syak UhakTsk4riaSmksran Tr UhiT (naSm%naSmTNhs$naSTikDnI nUh T4nI nUT4$PnUT In4nTUhf k,T-8TfksSrUSSBT

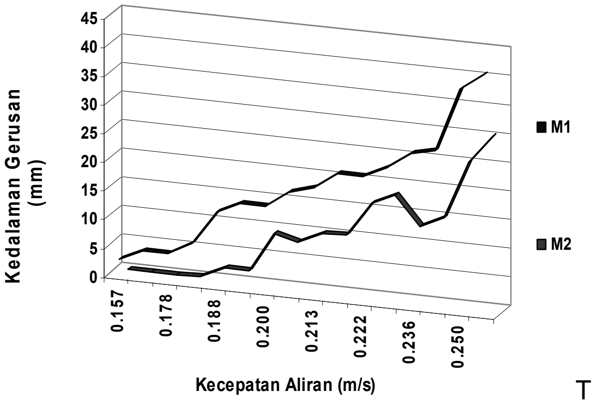
Tabel 3. cksfn 4Smn T5k4n,n(n Tdksran T 6nia$r(TEwaGT

5kDkI nUh E(34UGT	5k4n,n(n Tdksran E4aGE((GT		csyak UhakT sk4riaSmksran T EHGT
	6:T	69T	
280/T	-T	2T	:2282T
2877T	0T	2T	:2282T
28/1T	0T	2T	:2282T
28//T	/T	2T	:2282T
2811T	:-T	9T	1K879T
281.T	:0T	9T	1787/T
28922T	:0T	.T	K2822T
28.1T	:1T	1T	00807T
289:-T	:.T	:2T	K/8-/T
289:2T	99T	:2T	0K800T
28999T	99T	:7T	9/89/T
2899-T	9KT	:1T	90822T
289-7T	9/T	:-T	0:810T
289-1T	91T	:0T	K78K-T
28902T	-.T	90T	-082T
2897/T	K9T	-2T	9180/T

pr(fksoTLnaSTk k,$$n T



Gambar 3. cya$SUSST k mn(nUh T n4nT $nsTa$S4ksT 4k mn T ks,S4r mn T*groundsill*T



Gambar 4. Tcksfn 4Smn T5k4n,n(n Tdksran T 6nia$r(TEwaGTn4nT6naSm%6naSmTQns$naST 5kDkI nUh TR,$n T

hks4nansin T enfk,T-8T(k r briin T fnPMnTUksbn4STI ksfk4nn Tik4n,n(n Tmksran T (nia$r(Tjn mTDrirITa$n $$n Tn Uhsn T*running*T In4nT(y4k,TI $nsTUh I nT*groundsill*TE6:GT4k mn T I $nsT(k mmr nin T *groundsill* E69GT4$n nT n minT sk4riaST snUh%nUhT 4nsST ikak,rsrPn T *running*T (k DnI nST 7:FK.T H8T hnPin TI n4nT fkfksnI nT Nhs$naST ikDkI nUh T jn$UT In4nT ikDkI nUh TQ9FTQ.FTQKT4n TQ1Tfkans jn Tsk4riaST mksran T(k DnI nST:22TH 8TLn,TSST4$nsk nin T I k k(I nUh T *groundsill* In4nT PSSST I $nsT (k jkfnfin T ik n$n T (rinT nST 4n T (k bn4$n T ,rnaT Uh(I n mT fnanPT an,rsn T ak(niST fkansTakPSmmnTbnsniTNksU$n,T(rinTnST UksPn4nI T4nansTan,rsn Tnin Tak(niSTUSmm8T esn al ysTak4$k Tnin Tak(niST,k(nPT4n T UksPn,n mT y,kPT n4n jnT*groundsill*TakPSmmnT 4k mn TI k mrirsn TikDkI nUh TI n4nTUSSTjn mT an(nFTik4n,n(n Tmksran T4ST aki$bhsTI $nsT a$S4ksT4k mn TI ks,S4r mn T*groundsill* nin T ,kf$PTikD,T4nsSTik4n,n(n Tmksran T4STaki$bhsT I $nsT a$S4ksT Uh I nT *groundsill*8T wnsST PnaST I k k,$$n TSST(k(fri$n TfnPMnTI k k(I nUh T *groundsill*T an mnUT kBkiUSBT4n,n(T(k mrsn mST fkans jnTmksran Tjn mTUksbn4ST4STaki$bhsTI $nsT a$S4ks8T

Perhitungan Empiris Kedalaman Gerusan Lokal

wnUhT ik4n,n(n T mksr an T PnaŞT l k mr bSn Tak,n br U j n Tni n T4$ Nh,r naSTUksPn4nl T l ksan(nn T k(l SSaT j n mT 4$rr ni n T y,kPT t sykP,$DPFd ns4kT4n TCnbr Tr Ui T(y4k,T*running*T Uh l nT l ks,S 4r mn T *groundsill*T E6 : G8T R4nl r T l ksan(nn T k(l SSaT j n mT 4$ ni ar 4T n4n,nPT akf nmnST ksS r USS8T

Kedalaman Gerusan Lokal Menurut Persamaan Froehlich (1987), dalam Hanwar (1999)

cksan(nn Ti k4n,n(n Tmksr an Tr Ui T l Şhs T a$S 4ks T l n4n T i y 4$aST *clear water scour* (k r sr UI sykP,$DPTE . 1/ Gakf nmnST ksS r UbT

$$\frac{D_s}{D_o} = 0{,}78\ K1\ K2 \left(\frac{L_A}{D_o}\right)^{0{,}63} Fr^{1{,}16} \left(\frac{D_o}{d_{50}}\right)^{0{,}43} \sigma^{-1{,}87}$$ T

Kedalaman Gerusan Lokal Menurut Persamaan Garde dan Raju (1977), dalam Hanwar (1999)

$$\frac{d}{d_o} = \frac{4{,}0}{\alpha}\eta_1\eta_2\eta_3\eta_4 \left(\frac{U}{\sqrt{g\, d_o}}\right)^{n^*}$$ T

wnUhT PnaŞT l k mr bSn T i k4n,n(n T mksr an TUksPn4nl T l ksan(nn Tk(l SSaT4STnUhaT 4nl nU4$PnUT n4nTUnf k,T7T4n TUnf k,T7 T ksS r UbT

T

Tabel 6.T5k4n,n(n Td ksr an T(k r sr UI sykP,$DPT

running	wyT	WhT	t sT	ηT	i : T	i 9T	402T	wa3wyT	waT	wa3WhT	wy3WhT
6 : = : Q: T	282/ 01	282K01	289921	981: 11	: T	: T	282220: 1	28 92T	2822. T	2892: T	: 877/ T
6 : = : Q9T	282121	282K01	289221	981: 11	: T	: T	282220: 1	28 27T	28221T	28 1. T	: 8/ / 1T
6 : = : Q- T	282101	282K01	28 191	981: 11	: T	: T	282220: 1	282. KT	28221T	28 / 1T	: 811. T
6 : = : QKT	282. 21	282K01	28 7/ 1	981: 11	: T	: T	282220: 1	2821KT	28221T	28 7. T	98222T
6 : = 9Q0T	282/ 01	282K01	289K11	981: 11	: T	: T	282220: 1	28 - 1T	282: 2T	289- : T	: 877/ T
6 : = 9Q7T	282121	282K01	289971	981: 11	: T	: T	282220: 1	28 99T	282: 2T	289: 1T	: 8/ / 1T
6 : = 9Q/ T	282101	282K01	289271	981: 11	: T	: T	282220: 1	28 2. T	2822. T	28920T	: 811. T
6 : = 9Q1T	282. 21	282K01	28 1. 1	981: 11	: T	: T	282220: 1	282. / T	2822. T	28 . 0T	98222T
6 : = - Q. T	282/ 01	282K01	289/ / 1	981: 11	: T	: T	282220: 1	28 0/ T	282: 9T	28979T	: 877/ T
6 : = - Q: 2T	282121	282K01	289091	981: 11	: T	: T	282220: 1	28 - . T	282: : T	289K/ T	: 8/ / 1T
6 : = - Q: : T	282101	282K01	289- 21	981: 11	: T	: T	282220: 1	28 9- T	282: 2T	289- - T	: 811. T
6 : = - Q: 9T	282. 21	282K01	289: : 1	981: 11	: T	: T	282220: 1	28 : 2T	282: 2T	2899: T	98222T
6 : = KQ: - T	282/ 01	282K01	28- : : 1	981: 11	: T	: T	282220: 1	28 12T	282: - T	28- 22T	: 877/ T
6 : = KQ: KT	282121	282K01	289191	981: 11	: T	: T	282220: 1	28 01T	282: - T	28919T	: 8/ / 1T
6 : = KQ: 0T	282101	282K01	289011	981: 11	: T	: T	282220: 1	28 K: T	282: 9T	2897/ T	: 811. T
6 : = KQ: 7T	282. 21	282K01	289- 71	981: 11	: T	: T	282220: 1	28 97T	282: : T	28909T	98222T

TTTTTpr (f ksToL naŞTc ksPSU mn T

Tabel 7.T5k4n,n(n Td ksr an T(k r sr Ud ns4kT4n TCnbr T

running	wyT	* : T	* 9T	* - T	* KT	v T	αT	YT	t sT	WhT	w3wyT	wT	waT	wa3wyT	wy3WhT	wa3WhT
6 : = : Q: T	282/ 01	: 82. / 1	: T	: 891	: T	28 1. 1	281021	28/ 171	289921	282K01	: 810- 1	28 - . 1	2827K1	2810- T	: 877/ T	: 8K9: T
6 : = : Q9T	282121	: 82. / 1	: T	: 891	: T	28 / / 1	281021	28/ 171	289221	282K01	: 8/ 201	28 - 71	282071	28/ 20T	: 8/ / 1T	: 890- T
6 : = : Q- T	282101	: 82. / 1	: T	: 891	: T	28 771	281021	28/ 171	28 191	282K01	: 80/ - 1	28 - K1	282K. 1	280/ - T	: 811. T	: 821- T
6 : = : QKT	282. 21	: 82. / 1	: T	: 891	: T	28 0/ 1	281021	28/ 171	28 7/ 1	282K01	: 8K7K1	28 - 91	282K91	28K7KT	98222T	28 9. T
6 : = 9Q0T	282/ 01	: 82. / 1	: T	: 891	: T	289: - 1	281021	28/ 171	289K11	282K01	9820: 1	28 0K1	282/ . 1	: 820: T	: 877/ T	: 8/ 09T
6 : = 9Q7T	282121	: 82. / 1	: T	: 891	: T	289221	281021	28/ 171	289971	282K01	: 81. : 1	28 0: 1	282/ : 1	281. : T	: 8/ / 1T	: 8010T
6 : = 9Q/ T	282101	: 82. / 1	: T	: 891	: T	28 111	281021	28/ 171	289271	282K01	: 8/ K. 1	28 K. 1	2827K1	28/ K. T	: 811. T	: 8K: 0T
6 : = 9Q1T	282. 21	: 82. / 1	: T	: 891	: T	28 / 11	281021	28/ 171	28 1. 1	282K01	: 879. 1	28 K/ 1	2820/ 1	2879. T	98222T	: 890. T
6 : = - Q. T	282/ 01	: 82. / 1	: T	: 891	: T	289- 11	281021	28/ 171	289/ / 1	282K01	9890K1	28 7. 1	282. K1	: 890KT	: 877/ T	982. 2T
6 : = - Q: 2T	282121	: 82. / 1	: T	: 891	: T	2899- 1	281021	28/ 171	289091	282K01	982/ 01	28 771	282171	: 82/ 0T	: 8/ / 1T	: 8 : : T
6 : = - Q: : T	282101	: 82. / 1	: T	: 891	: T	289: 21	281021	28/ 171	289- 21	282K01	: 8 9: 1	28 7- 1	282/ 11	28 9: T	: 811. T	: 8/ K2T
6 : = - Q: 9T	282. 21	: 82. / 1	: T	: 891	: T	28 . 11	281021	28/ 171	289: : 1	282K01	: 8/ 1K1	28 7: 1	282/ : 1	28/ 1KT	98222T	: 8071T
6 : = KQ: - T	282/ 01	: 82. / 1	: T	: 891	: T	2897/ 1	281021	28/ 171	28- : : 1	282K01	98K101	28 171	28 : : 1	: 8K10T	: 877/ T	98K/ 0T
6 : = KQ: KT	282121	: 82. / 1	: T	: 891	: T	289021	281021	28/ 171	289191	282K01	989171	28 1- 1	28 2- 1	: 8917T	: 8/ / 1T	9891/ T
6 : = KQ: 0T	282101	: 82. / 1	: T	: 891	: T	289- 71	281021	28/ 171	289011	282K01	98 991	28 121	282. 01	: 8 99T	: 811. T	98 : . T
6 : = KQ: 7T	282. 21	: 82. / 1	: T	: 891	: T	289991	281021	28/ 171	289- 71	282K01	: 8 771	28 / / 1	2821/ 1	28 77T	98222T	: 8 - 9T

Tpr (f ksToL naŞTc ksPSU mn T

Tabel 8. cksfn 4Smn T6k4n,n(n Tdksran Tn4nTck mrb$h T4k mn Tcksan(nn Tk(I S$$aT

Running	wa3wyT		
	t sykP,$DPT	d ns4kT4n T CnbrT	L naŞT ck k,$$h T
6 : = : Q: T	28 92T	2810- T	28922T
6 : = : Q9T	28 27T	28 20T	28211T
6 : = : Q- T	282. KT	280/ - T	2820. T
6 : = : QKT	2821KT	28K7KT	282- - T
6 : = 9Q0T	28 - 1T	: 820: T	2890- T
6 : = 9Q7T	28 99T	281. : T	28 11T
6 : = 9Q/ T	28 2. T	28 K. T	28 0- T
6 : = 9Q1T	282. / T	2879. T	28207T
6 : = - Q. T	28 0/ T	: 890KT	28 / - T
6 : = - Q: 2T	28 - . T	: 82/ 0T	28 - 1T
6 : = - Q: : T	28 9- T	28 9: T	2890. T
6 : = - Q: 9T	28 : 2T	28 1KT	28922T
6 : = KQ: - T	28 12T	: 8K10T	28072T
6 : = KQ: KT	28 01T	: 8917T	28K11T
6 : = KQ: 0T	28 K: T	: 8 99T	28919T
6 : = KQ: 7T	28 97T	28 77T	289KKT

pr(fksbTL naŞTcksP$U mn T

Tabel 9. Tcksfn 4Smn TPnaŞT k k,$$h T4k mn T k k,$$h Takfk,r(jnT

ck k,$$T	5nsni Ukls$U$ Tn,$n T	uk $aTc Şns T	wa3 T Ef b$Tnf GE	wa3 T Eksa Tk(I S$$aG
R$aj nPFp TE922KGT	= TTT; T/ T,U4kUT PTTT; T28210T(I c Şns Tp,$S 4ksT4k mn T4$h(kUksT 4$_{02TT}$; T28 KT((T d aT,TT981- T EGT; TK2T((T	: 8 - T	-
pkUjn Smsr(FIC6 T E922- GT	= TTT; T/ T,U4kUT PTTT; T28 2T(T c Şns Tp,$S 4ksT4n T$$n$T4m T 4$_{02TT}$; T28 2T((T d aT,TT981- T 4$h(kUksT EGT; T12T((T	2807T	-
I n rnsFIR TE9220GT	= TTT; TK80T,U4kUT PTTT; T28270T(I c Şns Tp,$S 4ksT4k mn T4$h(kUksT 4$_{02T}$; T28K- T((T d aT,TT981: T EGT; TK2T((T	28 / T	-
Rmr alU$ nFIRp TE9227GT	= TTT; T- 80KT,U4kUT PTTT; T282. 2T(I 4$_{02T}$; T28 . T((T d aT,TT98K7T c Şns Tp,$S 4ksT4k mn T4$h(kUksTbT :8Tf T; T9: 8 0T((T 98Tf T; T97890T((T - 8Tf T; T- 98 0T((T K8Tf T; TK: 8 0T((T 08Tf T; TK/ 802T((T	T 28 9T 28 KT 28 - T 28 1T 28K9T	-
L naŞTck k,$$h T4ST Wnf ysnUys$(T	= TTT; TK892KT,U4kUT PTTT; T282. 2T(I c Şns Tp,$S 4ksT4k mn T4$h(kUksTbT 4$_{02TT}$; T280: T((T d aT,TT98 . T EGT; TK0T(T	2890T	%T

hks4nansi n Tenfk,T. 8T4STnUhaTUks,$PnUT fnPMnTPnaŞTIksP$U mn Tik4n,n(n Tmksran T 4k mn T(k mmr nin Tsr(raTk(I S$$aT4n TPnaŞT Ik k,$$h T4ST,nf ysnUys$(T4$ksy,kPTIksfk4nn T jn mTDrirI Ta$n $$n 8TL n,TS STakDnsnTr(r(T 4nI nUT4$akfnfin Ty,kPTfkfksnI nTBni UysFIn UnsnT ,nS TIk mnsrPT4nsSTIn sn(kUks%nsn(kUksTjn mT 4$m nin Tjn$UT4kf$UTn,$n FIik4n,n(n Tn,$n FT ikDkI nUh Tn,$n FTrirsn Tfr U$n FTfk UriT4n T rirsn TI Şns8Twn,n(TPn,TS $FTIn4nTIksP$U mn T 4k mn Tsr(raTk(I S$$aFTInsn(kUks%nsn(kUksT jn mT(k(I k mnsrPST4$ksy,kPTfks4nansi n T Ik(fnDnn TUhfk,T4n TmsnE$8Tpk4n min TPnaŞT Ik k,$$h T4ST,nf ysnUys$(T4nI nUT4$k mnsrPST y,kPTfn jni TPn,FIT4$h UnsnT jn Tn4n,nPTar Pr T4n T Uki n n TF4nsnT4$Esr n mT,nf ysnUys$(8T

KESIMPULAN DAN SARAN

Kesimpulan

L naŞT jn mT 4$4nI nUT 4nsST I k k,$$h T mksran TIn4nTI ŞnsTa$S 4ksT4k mn Tfksfnmn$T Nhs$haSTikDkI nUh Tn,$n TS Sh4n,nPbT

:8Tck mrb$h Tdksran T(nia$ r(TIn4nTI Şns T a$S 4ksTIn4nTfksfnmn$T Nhs$haSTikDkI nUh T Uksbn4STIn4nTU$$ST9FT- FT/ T4n T1Tjn$UTjn mT Uks,kUhiTIn4nTa$a$Tin n T4n TiS$$TI ŞnsTjn mT 4ki nUT4k mn TnsnPT4nUh m jnTn,$n T4n T Ik r(Irin T(nUks$h,TUksbn4STIn4nTU$$ST0T jn mTUks,kUhiT n4nTPSST Shs8T

98T5k4n,n(n Tmksran T(nia$ r(TIn4nTI ShsT aSS4ksTr UiT(y4k,T *running* TE6 : GT Uksbn4ST In4nTikDkInUh T2F97/ T(3aTjnSUTakfkansTK9T ((T ak4n min T ik4n,n(n T mksran T (S$ r(TUksbn4ST In4nTikDkInUh T2F 0/ T(3aT jnSUTakfkansT-T((8T

-8Tcn4nT ikDkInUh T n,Sn T jn mT an(nFT Ik k(InUh *groundsill* T In4nT PSST IShsT (k jkfnfin Tik4n,n(n Tn,Sn T4STakiSUhsT IShsTaSS4ksT,kfPTUmmST4nsST(y4k,TE6 : GT akPSmmTik4n,n(n Tmksran T4STakiSUhsTIShsT aSS4ksT,kf$PTikDST4nsST(y4k,TE6 : GT4k mn T n minTsk4riaST snUh%nUhT4nsST ikak,rsrPn T *running* T In4nT fksfnmnST NhsSnaST ikDkInUh T akfkansT7: FK. TH 8T

T

Saran

:8TwShian nin jnT Ik k,SSn T ,n brUh T (k mk nSTIk mmsrPTInsn(kUksTn,Sn T4n T Ik k(InUh T *groundsill* T UksPn4nI Tmksran T ,yin,T4SakiSUhsTIShsT4k mn Tfk UiTIShsTjn mT fksfk4nTfn$TIn4nTiy 4SaST *clear water scour* T nUhrIr T *live bed scour* FTaksUhTIks,rTn4n jnT Ik mk(fn mn T ,kf$PT ,n brUT (k mk nST *groundsill* Tjn mT(k,$rUSTNhsSnaSTfk UiT4n T (kUy4kTIk mnI,SnaSn jn8TpkPSmmnT4nInUT 4Sn4$n T Ik(fn 4SmT fkans jnT mksran T jn mTUksbn4STn4nT(naSm%naSmTShs8T

98Twn,n(TIksk Dn nn Tiy aUsriaST4Snsn in T nmnsTfk UiT4n TmsniTIk k(InUh T *groundsill* T 4Sn Dn mT4k mn Takfn$T(r miSTr UiT (k(nia$ n,in TB maST4n Tik(n(Irn jnT akfnmnSTk mk 4n,Sak4$ k 8T

T

DAFTAR PUSTAKA

R MnsFTI 8T922K8T *Pengaruh Kecepatan Aliran terhadap Kedalaman Gerusan Lokal di Hilir Bed Protection* 8T pis$aST ursran T eki TpSTv SNksaSUhaTgkmksSTpk(nsn mT oTpk(nsn m8T

T

hskraks8T L8g8>8T n 4T Cnr4i$NST R8u8T : . . : 8T *Scouring.* T GRLCT Lj4snr,SDT T pUsrDUrskT wkaSn T6 n rn,8TCyUks4n(ToRRTnn,ik(n8T

T

wSnaT cpwRT csyN8T unUk m8T : . . 78T *Hidrolika Terapan* 8Tpk(nsn m8T

T

dr nMn FTL8R8T92278T *Pengaruh Lebar Pilar Segiempat terhadap Perilaku Gerusan Lokal* 8T pis$aST ursran T eki $T p$ST v SNksaSUhaT gkmksST pk(nsn mT oT pk(nsn m8T

T

)(nMn FTL8c8T92278T *Mekanisme Perilaku Local Scouring Akibat Perubahan Kecepatan Aliran pada Pilar Dengan Chasing* 8Tpis$aST ursran Teki TpSTv SNksaSUhaTgkmksST pk(nsn mToTpk(nsn m8T

T

6 S,ksTusFTA 8T922-8T *Model For The Time Rate Of Local Sediment Scour At A Cylindrical Structure* 8T *Disertasi* 8T t,ys4n8T ccpT v SNksaSUhaT,ys4n8T

T

csnakUSFT p8c8T 922: 8T *Model Pengendalian Gerusan Lokal Akibat Aliran Superkritik di Hilir Pintu Air* 8T *Tesis* 8TIymjninsUhoTccpT vd6 T

T

prDSUyT4n TgrsT=r4ra8T922K8T *Analisis Gerusan Lokal di Hilir Bed Protection* 8T urs n,T eki TpST4n Tcksk Dn nn T8Tgy(ksT: T Qy,r(kT78Tun rnsST922K8Tpk(nsn mToT vgg)pT

T

esSU(y4byFTh8T: . . -8T *Hidraulika I* 8TIymjninsUh8T hkUhT□EBakU8T

T

esSU(y4byFTh8T: . . -8T *Hidraulika II* 8TIymjninsUh8T hkUhT□EBakU8T

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