

## SAND - Structural Analysis and Design, & SCALE - Structural CALculations Ensemble, Information sheet 39; Jan 2013.

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### Support

(1) **Technical support**, for technical support for all aspects of SAND and SCALE please email Dr Ian Brown, [ian@fitzroy.com](mailto:ian@fitzroy.com) tel 01284 754240.

(2) **Accounts**, if you have changed address or if there is a new contact person, please email: Jeanette Brown, [jeanette@fitzroy.com](mailto:jeanette@fitzroy.com) or post to Lark Lodge, Fornham St Martin, Bury St Edmunds, Suffolk IP31 1SR, tel 01284 754 240.

### Eurocodes

We have made significant progress in 2012 with an additional 43 proformas now having Eurocode versions. There are now over 350 proformas which show full calculations to the Eurocodes or full calculations to the British Standards, or are analytical and applicable to both codes.

We have completed the majority of all reinforced concrete, piling, composite buildings, timber and masonry proformas, and have made substantial progress with the steel proformas as more guidance on them has become available. In 2013 we will continue development of the steel proformas and the bridge proformas.

### Windows 8

All programs in the SAND and SCALE suites are fully supported and operational on all 32-bit and 64-bit desktop/laptop versions of Windows 8, Windows 8 Pro and Windows 8 Enterprise, as well as on all 32-bit and 64-bit versions of Windows 7, Windows Vista and Windows XP.

(Please note, there is also a new version of Windows called Windows RT for tablets with ARM processors – however it is not possible to install any existing Windows software on a Windows RT tablet, and this includes SAND and SCALE! If Windows RT tablets prove popular then we would take that into account when considering future platforms.)

### List of SCALE proformas

To view the full list of SCALE proformas, click on the menu option File→Display File (or File→Print File to print); then in the File name box type scale.mnu and click Open. Proformas which have full Eurocode versions or are applicable to both are marked with an “(E)”.

## The SCALE user interface

In 2012 development has continued on improving the user friendliness of the next version of SCALE to make it behave more intuitively like a Windows program. Consideration has also been given to take into account possible future platforms on which SCALE may run, namely on tablet computers and on the web, to provide for a consistent user interface across all platforms. This work is still on-going and is not present in the January update, it will be available for download later in 2013. These changes will include for example: improving the discoverability of proformas in the main menu, not interpreting Backspace at the start of the line as a fast forward, ability to use any directories for the installation and working directories, not writing to any files in the installation directory, adding ability to navigate solely with mouse or solely with the keyboard, making it easier to view and edit the calcs during a calculation, ignoring clicks outside buttons or text fields, and allowing SCALE to run NL-STRESS & SCALE and allowing NL-STRESS to run SCALE as at present but without the jumps between different windows.

## Looking to the future – tablet computers.

As part of this development, all the SCALE and NL-STRESS software has been converted from Fortran to C to improve maintainability and allow executables to be built for other platforms. As a feasibility study we have compiled and tested a development version of SCALE, LUCID and SPADE on iPads, iPhones and iPod touches, these all have ARM processors. An option in this development version instructs SCALE to run through all the proformas using the 3000 sets of default answers (i.e. ans=1,2,3...) one after the other, generating PDFs which can be viewed, emailed, printed or copied to your computer. This it does without any errors, and with identical output to the existing Windows version at a comparable speed to Windows computers. More extensive testing regimes will be implemented in 2013. To gauge interest, if anyone is interested in an iPad/iPhone version of SCALE, or in being a beta tester later this year, please email [ian@fitzroy.com](mailto:ian@fitzroy.com).

## Changes to SCALE program (Latest version is 4.81)

In addition to the 43 proformas which have had the option for full Eurocode calculations added in 2012, we have made amendments to a further 500 proformas as listed below.

Many proformas have been restructured to allow batch running of ans=1,2,3... for all proformas. All of these default values are now run before updating to the website to reduce the possibility of any problems being introduced by changes to the program and proformas. The aim in 2013 is to extend this automated testing to include parametric testing for all proformas before every website update.

- EC3CONT correction to definition of 'hw', removal of 'lateral'. cosmetic changes to buckling resistance, added IF Mcm=0 then Mcm=0.01, replaced restraints with lateral restraints, added brchan and brtee made cosmetic improvements. Added iltb1, iltb2 and ndsl, revised Wely expression.
- EC3COM Correction to slender sections comments, cosmetic improvements, replaced references to Table 5 with Table 5.2. Correction to slender section limits in bending. Changes to subroutine 'webres' Added wbres subroutine. Allowing for Grade S275 hollow sections, correction to defining max shear force VzEd, set gamG=gammaG, gamQ=gammaQ, replaced FRd>VzEd with FRd>=VzEd.
- EC3SEC Added Zx=Z Sx=S Ix=I to Ccdp to accommodate sc437.pro, term 'C' for RHS now referred to as 'Wt', dimensions added to cold formed rhs, term "H" amended to "Iw" for Eurocode, angles and structural Tee section tables added, cosmetic improvements.
- SC072 Cosmetic improvements, replaced fy with fyk, revised range for fck.
- SC073, 074, Cosmetic improvements, replaced fy with fyk, revised range for fck and added warning when fcu exceeds 60 N/mm<sup>2</sup>.

SC075 Cosmetic improvements, replaced fy with fyk and yield with cylinder, revised range for fck range, added warning when fcu exceeds 60 N/mm<sup>2</sup>.

SC076 **Added EC2 design option**, made cosmetic improvements.

SC073 added dslab=0, revised b default example values.

SC074, 075, added bw'.

SC080 revised limit for crack control check, replaced moment with design moment and made cosmetic improvements.

SC081 revised limit for crack control check, added As2' and As2'', 'Loading' heading with 'Design moment' and Moment with Design BM.

SC082 revised limit for crack control check, replaced moment with design moment.

SC083 made cosmetic improvements, replaced fy with fyk and yield with cylinder and revised range for fck.

SC085 cosmetic improvements, removed munits.

SC086 limit for crack control check revised, corrected errors associated with expression substitution when checking shear and cracking, enhanced green screen display information.

SC087 removed lines not associated with SI units.

SC094 made cosmetic improvements.

SC097, 099, 100, revised example default values.

SC102 replaced fy with fyk and made cosmetic improvements.

SC106, 107, revised example default values, d value now offered on screen and added bw'.

SC110 replaced N, M & V with NEd, MEd & VEd', made cosmetic improvements.

SC112 removed lines not associated with SI units.

SC114, 115, 116, changed ans1 to ans.

SC117 replaced h<200 with h<=200, V with VEd, removed rho=per, added option for accurate method for F3 and made cosmetic improvements.

SC122, 123, 128, 132, 133, changed ans0 to ans.

SC134 changed ans0 to ans, added ELSE ans7=1 to line 995.

SC135 changed ans0 to ans.

SC137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, 155, 156, 157, 158 changed ans1 to ans.

SC160 **Added EC2 design option**, made cosmetic improvements, repositioned +Es=200000 N/mm<sup>2</sup>, replaced example default value for exposure to expos=4, added tables to ec2t3, removed text relating to Table A5, removed trz & crz, replaced horizontal steel with secondary steel, added option to select mean concrete tensile strength, added wk4s, wk4l, wk5s wk5l and K1.

SC162 **Added EC2 design option**, replaced reinforcement with links, added units to link diameter made cosmetic improvements, added chkrng 1 0.65 K1 and set K1=0.65 to examples.

SC165 changed ans1 to ans.

SC189 removed lines not associated with SI units.

SC193 changed ans1 to ans fixed "min>= 0" line 1188.

SC194 changed ans1 to ans, fixed "min>= 0" line 743, correction to diagram plotting.

SC195 changed ans1 to ans, fixed "min>= 0" line 955.

SC210 increased example beam size, added fr and accrec.

SC212, 214, 216, 218, 220, added fr and accrec default values to examples and set fc=0.75.

SC222 corrected diagram splitting, Mplb expression revised, replaced EA with NA.

SC224 added default value direct=1, replaced EA with NA, revised expression for Mplb, added default value Grade=355 value to example.

SC225, 226, changed ans0 to ans.

SC250, 251, 252, removed lines not associated with SI units.

- SC253 removed lines not associated with SI units, added eushea and added ksh to expression for fvd, made reference to BS EN 338:2009(E).
- SC254 removed 14 mm deflection limit and lines not associated with SI units, made reference to BS EN 338:2009(E). SC255 removed 14 mm deflection limit, removed lines not associated with SI units, added default value  $Q_{cal}=0$  to example.
- SC256 removed lines not associated with SI units, made reference to BS EN 338:2009(E), modified expressions for Ayy, Ayt, Azt and Azz for type=3 & type=4.
- SC257 removed lines not associated with SI units.
- SC258 added default value  $Q_{a(1)}=0.6$  to example, removed 14 mm deflection limit, removed lines not associated with SI units, made reference to BS EN 338:2009(E).
- SC259 set  $NNt=0$  before Start, removed 14 mm deflection limit, removed lines not associated with SI units, added eushea and ksh to expression for fvd, made reference to BS EN 338:2009(E), corrected deflections associated with point loads.
- SC260, 262, 266, 267, 268, 269, 271, removed lines not associated with SI Units.
- SC272 removed lines not associated with SI units, repositioned ply density pk1.
- SC273 added variables comp1 and comp2.
- SC280, 284, 286, removed lines not associated with SI units.
- SC288 removed lines not associated with SI units, made cosmetic improvements.
- SC290, 292, 351, removed lines not associated with SI units.
- SC355 removed sc400.pro, added Tables 1 and 2, made cosmetic improvements, added chkrng to variables and subroutine sc4800.
- SC361 changed an to ans.
- SC364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, changed ans1 to ans.
- SC384 **Added EC3 design option**, made cosmetic improvements, removed imperial units, added gamM0 to McRd expression, defined  $W_{pl}=S$  &  $W_{el}=Z$ , removed a STOP not required, revised headings, added ncomp1 and comp2, removed S and Z from EC version, added reference to Table 5.1.
- SC385 **Added EC3 design option**, added expression for ez when classw<>4 and made cosmetic improvements, replaced ssd1 with ssD1, revised seccla, description for alpha revised, made reference to Table 5.1, added option to input RHS with either side vertical.
- SC386 removed lines not associated with SI units.
- SC387 **Added EC3 design option**, made cosmetic improvements removed Imperial units, replaced mesage with text, added date on line 1 and line 4, when stype=5 values for alphay, alphaz and Lamo are now defined by user.
- SC388 **Added EC3 design option**, made cosmetic improvements, introduced outstand C, revised expression for Lam1, replaced Pv with Pz in BS expression for Lam1, removed > appearing in BS output, made cosmetic improvements, removed EC NcrTF check for stype=1 (i.e. non-symmetrical sections).
- SC390 **Added EC3/EC4 design option**, cosmetic improvements, removed Lkrhs as CHS is not a valid option, removed k1=1 before MEd expressions, added  $L_{cry}/h>15$ ,  $L_{crz}/b>15$ , axisb and Unity2=0, added intdia, BUCres, replaced MRdy & MRdz with MyRd, MzRd added shear check, alpha values for BUCres revised.
- SC391 **Added EC3/EC4 design option**, made cosmetic improvements, updated text of green display Table 24, axib=2 and Unity2=0. Added intdia & BUCres, replaced MRdy & MRdz with MyRd, MzRd, added shear check, alpha values in BUCres.

SC407 **Added EC3 design option**, made cosmetic improvements.

SC408 **Added EC3 design option**, made cosmetic improvements.

SC409 **Added EC3 design option**, made cosmetic improvements.

SC410 Cosmetic changes. Repositioning of term NRd. Added channel 'Pull-thru' commands, replaced Appendix with Annex, added sect, chan, pic, brchan and CHANdp, made Lkus an internal subroutine, replaced iltb with iltb1, fixed Location: line (BS version), kzy scenarios revised.

SC411 **Added EC3 design option**, made cosmetic improvements, replaced Appendix with Annex and  $ry=(Iy/A)$  with  $ry=(Iy/A)^{0.5}$ , modified diagrams, removed area A from the Dimensions list, added example default values  $kc=1$  and  $Lm=975$ . revised kzy scenarios.

SC412 Extra assignments added for code=1 ans=3, correction to LTB terms Et and Gt, cosmetic changes.

SC414 extra assignments added for code=2 ans=2, Cosmetic changes.

SC428 **Added EC3 design option**, made cosmetic improvements, replaced references to Table 10 with Table 14, added STOP for class 4, replaced unity with unitb, when Ltb=1 set unitb=1, revised hw expression and definition, ndsl is now an external subroutine.

SC429 **Added EC3 design option**, made cosmetic improvements, replaced references to TABLE 10 with Table 14, removed A from Dimensions group. Corrected channel 'Pull-thru', kzy & hw, added CHANdp, Iy replaced with Iz in expressions for Iw, Et, Gt & Sr added ChiLT=1 when Ltb=1.

SC438 **Added EC3 design option**, made cosmetic improvements, removed Imperial units, replaced  $Mcx=py*Zy/10^3$  kNm with  $Mcx=py*Zx/10^3$ kNm, added Section type (1 - 3) to BS & EC options, removed ec4800, added ndsl and removed sc402.pro.

SC439 **Added EC3 design option**, made cosmetic improvements, added subroutines to ec3sec, replaced SECTION with DESIGN in SUMMARY, restricted output to three pages, removed sc403.pro.

SC440 code=1 ans=5 set My=0, revised kzy scenarios, cosmetic changes.

SC441 **Added EC3/EC4 design option**, made cosmetic improvements, removed Imperial units, program now stops when  $F \leq 0$ .

SC442 revised kzy scenarios, cosmetic improvements, added missing NRESP=0 for Location.

SC444 proforma title modified, typos corrected.

SC445 **Added EC3 design option**, made cosmetic improvements, added chkrng, replaced Appendix with Annex, added area A in properties list, removed references to BS110-1, revised kzy scenarios.

SC446 **Added EC3 design option**, Imperial units removed and made cosmetic improvements, added torsional-flexural buckling check, added expression for Lam<sub>eff</sub>, removed NcrTF as this is not applicable for non-symmetrical sections, replaced SECTION with DESIGN in SUMMARY, replaced Constant e with Parameter e.

SC447 **Added EC3 design option**, made cosmetic improvements, added effective length subroutine effLe, removed Lvalue added irect, removed G=80770, added Iw and Sr, modified M<sub>cr</sub> expression, added gamm0 to expression for M<sub>crDy</sub>, removed references to Clause 4.8.3.2 for EC, hw redefined, added scenario uf<sub>≥</sub>Unity1 and uf<sub>≥</sub>Unity2, bibend subroutine is now only used when class<3.

SC448 **Added EC3 design option**, made cosmetic improvements, added ellLe, subroutine, replaced hsdp, csdp, crdp with Hsdp, Csdp and Crdp, added Lemax, replaced fyval with fyrhs.

SC449 **Added EC3 design option**, made cosmetic improvements, removed Imperial units, replaced Mb=Mx with Mb=Mcx, effLe subroutine, Mx moment increased to account for axial force induced in the beam from the vertical loading, removed fy', added Lemax, revised EC diagram text, replaced fyval with fyrhs.

SC451 proforma title modified.

SC454 **Added EC3 design option**, made cosmetic improvements, replaced IF Va>Va with Va>Vb, updated chkrng for NL, removed sc4010.pro.

SC456 **Added EC3 design option**, removed Imperial units made cosmetic improvements, added IF sc<0, added ndsl.

SC457 **Added EC3 design option**, made cosmetic improvements, removed option for CHS, and replaced fyval with fyrhs.

SC458 **Added EC3 design option**, made cosmetic improvements, added kc values for simply supported case, removed CmLT and replaced fyval with fyrhs.

SC459 **Added EC3 design option**, made cosmetic improvements, replaced diagram axis xx with zz, added missing Location, added more values for kc, made reference to 'Design of Curved steel' by SCI, chkrng for Ly and Lz revised, redefined hw to depth between flanges, updated classification section, removed area A from Sections list, revised kzy scenarios.

SC463 **Added EC3 design option**, Imperial units removed, cosmetic changes.

SC464 **Added EC3 design option**.

SC465 **Added EC3 design option**, Correction to shear stress due to torsion calc (tt).

SC468 **Added EC3 design option**, made cosmetic improvements, revised expression for Av, replaced Constant e with Parameter e.

SC470 **Added EC3 design option**, made cosmetic improvements, corrected Fsw expression when Fq>0, replaced mmm units with mm Vcr.ep with Vcrep, renamed several variable names, Table 37 no longer used for EC, added expression for fwd, renamed FRd to NbRd.

SC472 **Added EC3 design option**, made cosmetic improvements, replaced references to z-axis with x-axis, when lam'y>lam'x, replaced lambda=lam'x with lambda=lam'y, corrected expression for lam'y2, when Iy>Ix LTB cannot occur section updated accordingly, added DESIGN SUMMARY wording, added flag1, & flag2, removed bures and added brtee, revised kzy scenarios, added lamzz.

SC474 **Added EC3 design option**, made cosmetic improvements, replaced 'tension flange' with 'top flange', Zplat is now used when option=1 and not Zy, bibend subroutine is now only used when class<3.

SC477 **Added EC3 design option**, made cosmetic improvements, removed EDIT's to enable forces to be visible on screen, enhanced green display and diagrams, replaced beta < bchk with beta > bchk and added -ve sign in front of 0.3\*sig'p at 2 locations, replaced D2<D0-2\*t0 with D2<=D0-2\*t0 at 2 locations, application limits updated, added fn to NSW expressions, revised POPUP display, added chkrng, added Class to application limits check, further brace class checks.

SC478 **Added EC3 design option**, made cosmetic improvements, removed run, revised lksct to guide user accordingly, application limit scenarios revised, enhanced screen display diagrams, added Mx2=0.001 and Mx=0.001, replaced picmmt with pict1 & pict2, modified fnp & mb1, added sine2=SIN(RAD(theta2)) and n1=py0\*t0^2/sine2 when xjt<>0, replaced My with My2 in DESIGN SUMMARY, added further application limits check, example steel Grade set to 355, H'tl2 no longer reported for T & Y joints, repositioned fy2= +fy2 N/mm<sup>2</sup>.

SC479 **Added EC3 design option**, made cosmetic improvements, removed EDIT's, enhanced diagrams, added chkrng, revised fnp expression, added variable name kn, replaced ubdp and ucdp with Ubdp & Ucdp, class check when gusset=3 considered.

SC480 Amended formula for length for structural integrity bn1 not bn.

SC481 **Added EC3 design option**, Eurocode version added.

SC484 **Added EC3 design option**.

SC485 **Added new EC3 design proforma**, Full-depth end plate connection.

SC492 pbs corrected to Table 32 values.

SC493 **Added EC3 design option**, made cosmetic improvements, removed munits, added chkrng to variables, modified expressions for no1, no2, Mic1 & Mic2, removed ucalsec as not used, added IF joint<>2 to Applications limit check section.

SC497 **Added EC3 design option**, removed munits, made cosmetic improvements, added more text.

SC503, 505, 506, 510, 511, 512, 515, 519, 520, removed lines not associated with SI units.

SC521, 525, 528, 529, 530, 532, 535, 536, 537, 538, Imperial units removed.

SC543 \$2000 removed, incorporated sc543a into sc543, replaced batch calls with WIN calls.

SC546 \$2000 removed, incorporated sc546a into sc546, replaced batch calls with WIN calls.

SC547 \$2000 removed, incorporated sc547a into sc547, replaced batch calls with WIN calls.

SC548 End-of-file character removed.

SC554, 594, Imperial units removed.

SC652, 653, changed ans1 to ans.

SC659 logic of subproformas 659a-h brought into main proforma, tables left in 659a-h, no changes to logic.

SC701 Imperial units removed.

SC702 added several chkrng to variables and default values for Zo(0) & Zo(90).

SC726 added EQU limit state to cantilever beam, replaced Qk with Gk for EQU load combinations, made cosmetic improvements, expanded on note at start of proforma, revised text for steel frames and removed lines not associated with SI units.

SC750 added default values L=1.0, x=0.25 dp=0 to Ex7, distance x is no longer offered on screen and set t1=h/15, removed lines not associated with SI units made cosmetic improvements.

SC751, 752, 754, Imperial units removed.

SC755 removed lines not associated with SI units, made cosmetic improvements, added subroutine popup.

SC776, 792, 793, Imperial units removed.

SC795 removed lines not associated with SI units, made cosmetic improvements, updated firms and websites.

SC4010 cosmetic improvements.

SC4030 Table 3.4 altered, Flowdrill and Hollo-bolt tables updated.

SC4050 cosmetic improvements.

SC4200 cosmetic improvements.

SC4400 cosmetic improvements.

SC4600 Eurocode terminology added.

SC4800 use of UNITS removed, correction to equal angle name, Non-standard channel formula for Sy changed, lines added to sfig3 'vu(14)', correction to chkrng-quasi. Correction to UKB table. Diagram introduced for non-standard beam sections. Cosmetic improvements. Added CHANdp.

SC4860 Eurocode terminology added, cosmetic improvements.

## Downloading updates during 2013

Further updates in 2013 will be posted to the download website at the beginning of April, July and October, please visit the download website for the latest version of 2013.EXE.