

Appendice 10.1

Matrice di rigidezza per elemento finito LC

```
DEFINT I-N
DEFDBL A-H, O-Z
SUB STIFFALC
REM
REM Subroutine STIFFALC
REM
REM *****
REM *
REM *           S T I F F A L C
REM *
REM *****
REM
REM *****
REM *
REM *      Questa subroutine calcola la matrice globale di rigidezza per archi
REM *      archi piani, usando un elemento finito lineare in u e cubico in w.
REM *
REM *****
REM
DIM MEMDIS(6) AS DOUBLE, ESTIF(6, 6) AS DOUBLE, ESTT(6, 6) AS DOUBLE
FOR IELEM = 1 TO NELEM
  IEND = LNODS(IELEM, 1)
  JEND = LNODS(IELEM, 2)
  XPROJ = COORD(JEND, 1) - COORD(IEND, 1)
  YPROJ = COORD(JEND, 2) - COORD(IEND, 2)
  SPAN = SQR(XPROJ * XPROJ + YPROJ * YPROJ)
  XL = XPROJ / SPAN
  YM = YPROJ / SPAN
```

```

REM
REM *****
REM *
REM *          Calcolo matrice elementare di rigidezza
REM *
REM *****
REM
LPROP = MATN(IELEM)
YOUNG = PROPS(LPROP, 1)
QINERZ = PROPS(LPROP, 2)
AREA = PROPS(LPROP, 3)
RADIUS = PROPS(LPROP, 4)
BETA = PROPS(LPROP, 5) * 1.74532925199433D -02
SPAN = RADIUS * BETA
EI = YOUNG * QINERZ
EA = YOUNG * AREA
ESTIF(1, 1) = EA / SPAN + EI / (SPAN * RADIUS ^ 2)
ESTIF(2, 1) = EA / (2 * RADIUS)
ESTIF(3, 1) = (12 * EI + EA * SPAN ^ 2) / (12 * SPAN * RADIUS)
ESTIF(4, 1) = -ESTIF(1, 1)
ESTIF(5, 1) = ESTIF(2, 1)
ESTIF(6, 1) = -ESTIF(3, 1)
ESTIF(2, 2) = 12 * EI / SPAN ^ 3 + 13 * EA * SPAN / (35 * RADIUS ^ 2)
ESTIF(3, 2) = 6 * EI / SPAN ^ 2 + 11 * EA * SPAN ^ 2 / (210 * RADIUS ^ 2)
ESTIF(4, 2) = -ESTIF(2, 1)
ESTIF(5, 2) = -12 * EI / SPAN ^ 3 + 9 * EA * SPAN / 70 / RADIUS ^ 2
ESTIF(6, 2) = 6 * EI / SPAN ^ 2 - 13 * EA * SPAN ^ 2 / 420 / RADIUS ^ 2
ESTIF(3, 3) = 4 * EI / SPAN + EA * SPAN ^ 3 / 105 / RADIUS ^ 2
ESTIF(4, 3) = -ESTIF(3, 1)
ESTIF(5, 3) = -ESTIF(6, 2)
ESTIF(6, 3) = 2 * EI / SPAN - EA * SPAN ^ 3 / 140 / RADIUS ^ 2
ESTIF(4, 4) = ESTIF(1, 1)
ESTIF(5, 4) = ESTIF(4, 2)
ESTIF(6, 4) = ESTIF(3, 1)
ESTIF(5, 5) = ESTIF(2, 2)
ESTIF(6, 5) = -ESTIF(3, 2)
ESTIF(6, 6) = ESTIF(3, 3)
FOR I = 1 TO NEVAB
FOR J = I + 1 TO NEVAB
ESTIF(I, J) = ESTIF(J, I)
NEXT J
NEXT I

```

```

REM
REM *****
REM *
REM *          Assembla la matrice elementare nella matrice globale
REM *
REM *****
REM
FOR IDOFN = 1 TO NDOFN
MEMDIS(IDOFN) = NODFRE(IEND, IDOFN)
MEMDIS(IDOFN + NDOFN) = NODFRE(JEND, IDOFN)
NEXT IDOFN
FOR IEVAB = 1 TO NEVAB
NEWROW = MEMDIS(IEVAB)
IF NEWROW = 0 THEN 111
FOR JEVAB = 1 TO NEVAB
IF MEMDIS(JEVAB) = 0 THEN 121
NEWCOL = MEMDIS(JEVAB) - NEWROW + 1
IF NEWCOL > 0 THEN
GSTIF(NEWROW, NEWCOL) = GSTIF(NEWROW, NEWCOL) + ESTIF(IEVAB,
JEVAB)
END IF
121 NEXT JEVAB
111 NEXT IEVAB
NEXT IELEM
END SUB

```

Appendice 10.2.

Matrice di rigidezza per elemento finito CC

```
DEFINT I-N
DEFDBL A-H, O-Z
SUB STIFFACC
REM
REM Subroutine STIFFACC
REM
REM *****
REM *
REM *           S T I F F A C C
REM *
REM *****
REM
REM *****
REM *
REM *           Questa subroutine calcola la matrice globale di rigidezza
REM *           per archi piani, usando un elemento finito cubico in u e w
REM *
REM *****
REM
DIM MEMDIS(NEVAB) AS DOUBLE, ESTIF(NEVAB, NEVAB) AS DOUBLE
DIM ESTT(NEVAB, NEVAB) AS DOUBLE
FOR IELEM = 1 TO NELEM
  IEND = LNODS(IELEM, 1)
  JEND = LNODS(IELEM, 2)
  REM
  REM *****
  REM *
  REM *           Calcolo matrice elementare di rigidezza
  REM *
```

```

REM *
REM *****
REM
LPROP = MATN(IELEM)
YOUNG = PROPS(LPROP, 1)
QINERZ = PROPS(LPROP, 2)
AREA = PROPS(LPROP, 3)
R = PROPS(LPROP, 4)
BETA = PROPS(LPROP, 5) * 1.74532925199433D-02
SPAN = R * BETA
EI = YOUNG * QINERZ
EA = YOUNG * AREA
ESTIF(1, 1) = 6 * (EI + EA * R ^ 2) / (5 * SPAN * R ^ 2)
ESTIF(2, 1) = EA / 10 + EI / (10 * R ^ 2)
ESTIF(3, 1) = EA / (2 * R)
ESTIF(4, 1) = (10 * EI + EA * SPAN ^ 2) / (10 * SPAN * R)
ESTIF(5, 1) = -ESTIF(1, 1)
ESTIF(6, 1) = ESTIF(2, 1)
ESTIF(7, 1) = ESTIF(3, 1)
ESTIF(8, 1) = -EI / (SPAN * R) + EA * SPAN / (10 * R)
ESTIF(2, 2) = 2 * SPAN * (EI + EA * R ^ 2) / (15 * R ^ 2)
ESTIF(3, 2) = ESTIF(8, 1)
ESTIF(4, 2) = -EI / (2 * R)
ESTIF(5, 2) = -EA / 10 - EI / (10 * R ^ 2)
ESTIF(6, 2) = -SPAN * (EI + EA * R ^ 2) / (30 * R ^ 2)
ESTIF(7, 2) = (10 * EI + EA * SPAN ^ 2) / (10 * SPAN * R)
ESTIF(8, 2) = -(30 * EI + EA * SPAN ^ 2) / (60 * R)
ESTIF(3, 3) = 12 * EI / SPAN ^ 3 + 13 * EA * SPAN / (35 * R ^ 2)
ESTIF(4, 3) = 6 * EI / SPAN ^ 2 + (11 * EA * SPAN ^ 2) / (210 * R ^ 2)
ESTIF(5, 3) = -ESTIF(3, 1)
ESTIF(6, 3) = (10 * EI + EA * SPAN ^ 2) / (10 * SPAN * R)
ESTIF(7, 3) = -12 * EI / SPAN ^ 3 + (9 * EA * SPAN) / (70 * R ^ 2)
ESTIF(8, 3) = 6 * EI / SPAN ^ 2 - 13 * EA * SPAN ^ 2 / (420 * R ^ 2)
ESTIF(4, 4) = 4 * EI / SPAN + EA * SPAN ^ 3 / 105 / R ^ 2
ESTIF(5, 4) = -EI / (SPAN * R) + EA * SPAN / (10 * R)
ESTIF(6, 4) = (30 * EI + EA * SPAN ^ 2) / (60 * R)
ESTIF(7, 4) = -6 * EI / SPAN ^ 2 + 13 * EA * SPAN ^ 2 / (420 * R ^ 2)
ESTIF(8, 4) = 2 * EI / SPAN - EA * SPAN ^ 3 / (140 * R ^ 2)
ESTIF(5, 5) = 6 * (EI + EA * R ^ 2) / (5 * SPAN * R ^ 2)
ESTIF(6, 5) = -EA / 10 - EI / (10 * R ^ 2)
ESTIF(7, 5) = -EA / 2 / R
ESTIF(8, 5) = (10 * EI + EA * SPAN ^ 2) / (10 * SPAN * R)

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ESTIF(6, 6) = 2 * SPAN * (EI + EA * R ^ 2) / (15 * R ^ 2)
ESTIF(7, 6) = - EI / (SPAN * R) + EA * SPAN / (10 * R)
ESTIF(8, 6) = EI / (2 * R)
ESTIF(7, 7) = ESTIF(3, 3)
ESTIF(8, 7) = -ESTIF(4, 3)
ESTIF(8, 8) = ESTIF(4, 4)
FOR I = 1 TO NEVAB
FOR J = I + 1 TO NEVAB
ESTIF(I, J) = ESTIF(J, I)
NEXT J
NEXT I
REM
REM *****
REM *
REM *           Assembla la matrice elementare nella matrice globale
REM *
REM *****
REM
FOR IDOFN = 1 TO NDOFN
MEMDIS(IDOFN) = NODFRE(IEND, IDOFN)
MEMDIS(IDOFN + NDOFN) = NODFRE(JEND, IDOFN)
NEXT IDOFN
FOR IEVAB = 1 TO NEVAB
NEWROW = MEMDIS(IEVAB)
IF NEWROW = 0 THEN 111
FOR JEVAB = 1 TO NEVAB
IF MEMDIS(JEVAB) = 0 THEN 121
NEWCOL = MEMDIS(JEVAB) - NEWROW + 1
IF NEWCOL > 0 THEN
GSTIF(NEWROW, NEWCOL) = GSTIF(NEWROW, NEWCOL) + ESTIF(IEVAB,
JEVAB)
END IF
121 NEXT JEVAB
111 NEXT IEVAB
NEXT IELEM
END SUB

```

Appendice 10.3

Matrice di rigidezza per elemento finito CQ

```
DEFINT I-N
DEFDBL A-H, O-Z
SUB STIFFACQ
REM
REM Subroutine STIFFACQ
REM
REM *****
REM *
REM *           S T I F F A C Q
REM *
REM *****
REM
REM *****
REM *
REM *   Questa subroutine calcola la matrice globale di rigidezza per archi
REM *   piani, usando un elemento finito cubico in u e quintico in w.
REM *
REM *****
DIM MEMDIS(NEVAB) AS DOUBLE, ESTIF(NEVAB, NEVAB) AS DOUBLE
DIM ESTT(NEVAB, NEVAB) AS DOUBLE
FOR IELEM = 1 TO NELEM
  IEND = LNODS(IELEM, 1)
  JEND = LNODS(IELEM, 2)
  REM
  REM *****
  REM *
  REM *           Calcolo matrice elementare di rigidezza
  REM *
```

```

REM *****
REM
LPROP = MATN(IELEM)
YOUNG = PROPS(LPROP, 1)
QINERZ = PROPS(LPROP, 2)
AREA = PROPS(LPROP, 3)
R = PROPS(LPROP, 4)
BETA = PROPS(LPROP, 5) * 1.74532925199433D-02
SPAN = R * BETA
EI = YOUNG * QINERZ
EA = YOUNG * AREA
ESTIF(1, 1) = 6 * (EI + EA * R ^ 2) / (5 * SPAN * R ^ 2)
ESTIF(2, 1) = EA / 10 + EI / (10 * R ^ 2)
ESTIF(3, 1) = EA / (2 * R)
ESTIF(4, 1) = (168 * EI + 17 * EA * SPAN ^ 2) / (140 * SPAN * R)
ESTIF(5, 1) = (28 * EI + 3 * EA * SPAN ^ 2) / (280 * R)
ESTIF(6, 1) = -ESTIF(1, 1)
ESTIF(7, 1) = ESTIF(2, 1)
ESTIF(8, 1) = ESTIF(3, 1)
ESTIF(9, 1) = -ESTIF(4, 1)
ESTIF(10, 1) = ESTIF(5, 1)
ESTIF(2, 2) = 2 * SPAN * (EI + EA * R ^ 2) / (15 * R ^ 2)
ESTIF(3, 2) = -EI / SPAN / R + 3 * EA * SPAN / (28 * R)
ESTIF(4, 2) = -(336 * EI + EA * SPAN ^ 2) / (840 * R)
ESTIF(5, 2) = (84 * EI * SPAN + EA * SPAN ^ 3) / (1680 * R)
ESTIF(6, 2) = -ESTIF(2, 1)
ESTIF(7, 2) = -(EI * SPAN + EA * SPAN * R ^ 2) / (30 * R ^ 2)
ESTIF(8, 2) = (28 * EI + 3 * EA * SPAN ^ 2) / (28 * SPAN * R)
ESTIF(9, 2) = -(504 * EI + 19 * EA * SPAN ^ 2) / (840 * R)
ESTIF(10, 2) = (28 * EI * SPAN + EA * SPAN ^ 3) / (560 * R)
ESTIF(3, 3) = 120 * EI / (7 * SPAN ^ 3) + 181 * EA * SPAN / (462 * R ^ 2)
ESTIF(4, 3) = 60 * EI / (7 * SPAN ^ 2) + (311 * EA * SPAN ^ 2) / (4620 * R ^ 2)
ESTIF(5, 3) = 3 * EI / (7 * SPAN) + 281 * EA * SPAN ^ 3 / (55440 * R ^ 2)
ESTIF(6, 3) = -EA / (2 * R)
ESTIF(7, 3) = ESTIF(8, 2)
ESTIF(8, 3) = -120 * EI / (7 * SPAN ^ 3) + 25 * EA * SPAN / (231 * R ^ 2)
ESTIF(9, 3) = 60 * EI / (7 * SPAN ^ 2) - 151 * EA * SPAN ^ 2 / (4620 * R ^ 2)
ESTIF(10, 3) = -3 * EI / (7 * SPAN) + 181 * EA * SPAN ^ 3 / (55440 * R ^ 2)
ESTIF(4, 4) = 192 * EI / (35 * SPAN) + 52 * EA * SPAN ^ 3 / 3465 / R ^ 2
ESTIF(5, 4) = 11 * EI / 35 + 23 * EA * SPAN ^ 4 / (18480 * R ^ 2)
ESTIF(6, 4) = -(168 * EI + 17 * EA * SPAN ^ 2) / (140 * SPAN * R)
ESTIF(7, 4) = (504 * EI + 19 * EA * SPAN ^ 2) / (840 * R)

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```

ESTIF(8, 4) = -ESTIF(9, 3)
ESTIF(9, 4) = 108 / 35 * EI / SPAN - 19 / 1980 * EA * SPAN ^ 3 / R ^ 2
ESTIF(10, 4) = -4 / 35 * EI + 13 / 13860 * EA * SPAN ^ 4 / R ^ 2
ESTIF(5, 5) = 3 * EI * SPAN / 35 + EA * SPAN ^ 5 / (9240 * R ^ 2)
ESTIF(6, 5) = -(28 * EI + 3 * EA * SPAN ^ 2) / (280 * R)
ESTIF(7, 5) = (28 * EI * SPAN + EA * SPAN ^ 3) / (560 * R)
ESTIF(8, 5) = -3 / 7 * EI / SPAN + 181 * EA * SPAN ^ 3 / (55440 * R ^ 2)
ESTIF(9, 5) = 4 / 35 * EI - 13 / 13860 * SPAN ^ 4 / R ^ 2
ESTIF(10, 5) = EI * SPAN / 70 + EA * SPAN ^ 5 / (11088 * R ^ 2)
ESTIF(6, 6) = ESTIF(1, 1)
ESTIF(7, 6) = -ESTIF(2, 1)
ESTIF(8, 6) = -ESTIF(3, 1)
ESTIF(9, 6) = ESTIF(4, 1)
ESTIF(10, 6) = -ESTIF(5, 1)
ESTIF(7, 7) = ESTIF(2, 2)
ESTIF(8, 7) = ESTIF(3, 2)
ESTIF(9, 7) = -ESTIF(4, 2)
ESTIF(10, 7) = ESTIF(5, 2)
ESTIF(8, 8) = ESTIF(3, 3)
ESTIF(9, 8) = -ESTIF(4, 3)
ESTIF(10, 8) = ESTIF(5, 3)
ESTIF(9, 9) = ESTIF(4, 4)
ESTIF(10, 9) = -ESTIF(5, 4)
ESTIF(10, 10) = ESTIF(5, 5)
FOR I = 1 TO NEVAB
FOR J = I + 1 TO NEVAB
ESTIF(I, J) = ESTIF(J, I)
NEXT J
NEXT I
REM
REM *****
REM *
REM *           Assembla la matrice elementare nella matrice globale
REM *
REM *****
FOR IDOFN = 1 TO NDOFN
MEMDIS(IDOFN) = NODFRE(IEND, IDOFN)
MEMDIS(IDOFN + NDOFN) = NODFRE(JEND, IDOFN)
NEXT IDOFN
FOR IEVAB = 1 TO NEVAB
NEWROW = MEMDIS(IEVAB)
IF NEWROW = 0 THEN 111

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```
FOR JEVAB = 1 TO NEVAB
IF MEMDIS(JEVAB) = 0 THEN 121
NEWCOL = MEMDIS(JEVAB) - NEWROW + 1
IF NEWCOL > 0 THEN
GSTIF(NEWROW, NEWCOL) = GSTIF(NEWROW, NEWCOL) + ESTIF(IEVAB,
JEVAB)
END IF
121 NEXT JEVAB
111 NEXT IEVAB
NEXT IELEM
END SUB
```

Appendice 10.4

Matrice di rigidezza per elemento finito QC

```
DEFINT I-N
DEFDBL A-H, O-Z
SUB STIFFAQC
REM
REM Subroutine STIFFAQC
REM
REM *****
REM *
REM *           S T I F F A Q C
REM *
REM *****
REM
REM *****
REM *
REM *      Questa subroutine calcola la matrice globale di rigidezza per archi
REM *      piani, usando un elemento finito quintico in u e cubico in w.
REM *
REM *****
REM
DIM MEMDIS(NEVAB) AS DOUBLE, ESTIF(NEVAB, NEVAB) AS DOUBLE
FOR IELEM = 1 TO NELEM
  IEND = LNODS(IELEM, 1)
  JEND = LNODS(IELEM, 2)
  REM
  REM *****
  REM *
  REM *      Calcolo matrice elementare di rigidezza
  REM *
```

```

REM *****
REM
LPROP = MATN(IELEM)
YOUNG = PROPS(LPROP, 1)
QINERZ = PROPS(LPROP, 2)
AREA = PROPS(LPROP, 3)
R = PROPS(LPROP, 4)
BETA = PROPS(LPROP, 5) * 1.74532925199433D-02
S = R * BETA
EI = YOUNG * QINERZ
EA = YOUNG * AREA
CC = EI + EA * R ^ 2
ESTIF(1, 1) = 10 * CC / (7 * S * R ^ 2)
ESTIF(2, 1) = 3 * CC / (14 * R ^ 2)
ESTIF(3, 1) = S * CC / (84 * R ^ 2)
ESTIF(4, 1) = EA / (2 * R)
ESTIF(5, 1) = (28 * EI + 3 * EA * S ^ 2) / (28 * S * R)
ESTIF(6, 1) = -ESTIF(1, 1)
ESTIF(7, 1) = ESTIF(2, 1)
ESTIF(8, 1) = -ESTIF(3, 1)
ESTIF(9, 1) = ESTIF(4, 1)
ESTIF(10, 1) = -EI / (S * R) + (3 * EA * S) / (28 * R)
ESTIF(2, 2) = 8 * S * CC / (35 * R ^ 2)
ESTIF(3, 2) = S ^ 2 * CC / (60 * R ^ 2)
ESTIF(4, 2) = -(168 * EI + 17 * EA * S ^ 2) / (140 * S * R)
ESTIF(5, 2) = (504 * EI - EA * S ^ 2) / (840 * R)
ESTIF(6, 2) = -ESTIF(2, 1)
ESTIF(7, 2) = -S * CC / (70 * R ^ 2)
ESTIF(8, 2) = S ^ 2 * CC / (210 * R ^ 2)
ESTIF(9, 2) = (168 * EI + 17 * EA * S ^ 2) / (140 * S * R)
ESTIF(10, 2) = -(504 * EI + 19 * EA * S ^ 2) / (840 * R)
ESTIF(3, 3) = S ^ 3 * CC / (630 * R ^ 2)
ESTIF(4, 3) = -(28 * EI + 3 * EA * S ^ 2) / (280 * R)
ESTIF(5, 3) = -S * (84 * EI + EA * S ^ 2) / (1680 * R)
ESTIF(6, 3) = -S * CC / (84 * R ^ 2)
ESTIF(7, 3) = -S ^ 2 * CC / (210 * R ^ 2)
ESTIF(8, 3) = S ^ 3 * CC / (1260 * R ^ 2)
ESTIF(9, 3) = -ESTIF(4, 3)
ESTIF(10, 3) = -S * (28 * EI + EA * S ^ 2) / (560 * R)
ESTIF(4, 4) = 12 * EI / S ^ 3 + 13 * EA * S / (35 * R ^ 2)
ESTIF(5, 4) = 6 * EI / S ^ 2 + 11 * EA * S ^ 2 / (210 * R ^ 2)
ESTIF(6, 4) = -EA / 2 / R

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ESTIF(7, 4) = (168 * EI + 17 * EA * S ^ 2) / (140 * S * R)
ESTIF(8, 4) = ESTIF(4, 3)
ESTIF(9, 4) = -12 * EI / S ^ 3 + 9 * EA * S / (70 * R ^ 2)
ESTIF(10, 4) = 6 * EI / S ^ 2 - 13 * EA * S ^ 2 / (420 * R ^ 2)
ESTIF(5, 5) = 4 * EI / S + EA * S ^ 3 / (105 * R ^ 2)
ESTIF(6, 5) = -EI / S / R + 3 * EA * S / (28 * R)
ESTIF(7, 5) = (504 * EI + 19 * EA * S ^ 2) / (840 * R)
ESTIF(8, 5) = -S * (28 * EI + EA * S ^ 2) / (560 * R)
ESTIF(9, 5) = -6 * EI / S ^ 2 + 13 * EA * S ^ 2 / (420 * R ^ 2)
ESTIF(10, 5) = 2 * EI / S - EA * S ^ 3 / (140 * R ^ 2)
ESTIF(6, 6) = ESTIF(1, 1)
ESTIF(7, 6) = -ESTIF(2, 1)
ESTIF(8, 6) = ESTIF(3, 1)
ESTIF(9, 6) = -ESTIF(4, 1)
ESTIF(10, 6) = ESTIF(5, 1)
ESTIF(7, 7) = ESTIF(2, 2)
ESTIF(8, 7) = -ESTIF(3, 2)
ESTIF(9, 7) = ESTIF(4, 2)
ESTIF(10, 7) = -ESTIF(5, 2)
ESTIF(8, 8) = ESTIF(3, 3)
ESTIF(9, 8) = -ESTIF(4, 3)
ESTIF(10, 8) = ESTIF(5, 3)
ESTIF(9, 9) = ESTIF(4, 4)
ESTIF(10, 9) = -ESTIF(5, 4)
ESTIF(10, 10) = ESTIF(5, 5)
FOR I = 1 TO NEVAB
FOR J = I + 1 TO NEVAB
ESTIF(I, J) = ESTIF(J, I)
NEXT J
NEXT I
REM *****
REM *
REM * Assembla la matrice elementare nella matrice globale *
REM *
REM *****
REM
FOR IDOFN = 1 TO NDOFN
MEMDIS(IDOFN) = NODFRE(IEND, IDOFN)
MEMDIS(IDOFN + NDOFN) = NODFRE(JEND, IDOFN)
NEXT IDOFN
FOR IEVAB = 1 TO NEVAB
NEWROW = MEMDIS(IEVAB)

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```
IF NEWROW = 0 THEN 111
FOR JEVAB = 1 TO NEVAB
IF MEMDIS(JEVAB) = 0 THEN 121
NEWCOL = MEMDIS(JEVAB) - NEWROW + 1
IF NEWCOL > 0 THEN
GSTIF(NEWROW, NEWCOL) = GSTIF(NEWROW, NEWCOL) + ESTIF(IEVAB,
JEVAB)
END IF
121 NEXT JEVAB
111 NEXT IEVAB
NEXT IELEM
END SUB
```

Appendice 10.5

Matrice di rigidezza per elemento finito QQ

```
DEFINT I-N
DEFDBL A-H, O-Z
SUB STIFFAQQ
REM
REM Subroutine STIFFAQQ
REM
REM *****
REM *
REM *           S T I F F A Q Q
REM *
REM *****
REM
REM *****
REM *
REM *   Questa subroutine calcola la matrice globale di rigidezza per archi
REM *   piani, usando un elemento finito quintico in u e w.
REM *
REM *****
REM
DIM MEMDIS(NEVAB) AS DOUBLE, ESTIF(NEVAB, NEVAB) AS DOUBLE
FOR IELEM = 1 TO NELEM
  IEND = LNODS(IELEM, 1)
  JEND = LNODS(IELEM, 2)
  REM
  REM *****
  REM *
  REM *   Calcolo matrice elementare di rigidezza
  REM *
```

```

REM *****
LPROP = MATN(IELEM)
YOUNG = PROPS(LPROP, 1)
QINERZ = PROPS(LPROP, 2)
AREA = PROPS(LPROP, 3)
R = PROPS(LPROP, 4)
BETA = PROPS(LPROP, 5) * 1.74532925199433D-02
S = R * BETA
EI = YOUNG * QINERZ
EA = YOUNG * AREA
COST = EA + EI / R ^ 2
ESTIF(1, 1) = 10 / (7 * S) * COST
ESTIF(1, 2) = 3 / 14 * COST
ESTIF(1, 3) = S / 84 * COST
ESTIF(1, 4) = -ESTIF(1, 1)
ESTIF(1, 5) = ESTIF(1, 2)
ESTIF(1, 6) = -S / 84 * COST
ESTIF(2, 2) = 8 * S / 35 * COST
ESTIF(2, 3) = S ^ 2 / 60 * COST
ESTIF(2, 4) = -ESTIF(1, 2)
ESTIF(2, 5) = -S / 70 * COST
ESTIF(2, 6) = S ^ 2 / 210 * COST
ESTIF(3, 3) = S ^ 3 / 630 * COST
ESTIF(3, 4) = -ESTIF(1, 3)
ESTIF(3, 5) = -S ^ 2 / 210 * COST
ESTIF(3, 6) = S ^ 3 / 1260 * COST
ESTIF(4, 4) = ESTIF(1, 1)
ESTIF(4, 5) = -ESTIF(1, 2)
ESTIF(4, 6) = -ESTIF(1, 6)
ESTIF(5, 5) = ESTIF(2, 2)
ESTIF(5, 6) = -ESTIF(2, 3)
ESTIF(6, 6) = ESTIF(3, 3)
ESTIF(1, 7) = EA / (2 * R)
ESTIF(1, 8) = 11 * EA * S / (84 * R) - 9 * EI / (7 * S * R)
ESTIF(1, 9) = EA * S ^ 2 / (84 * R) - EI / (7 * R)
ESTIF(1, 10) = EA / (2 * R)
ESTIF(1, 11) = - 11 * EA * S / (84 * R) + 9 * EI / (7 * S * R)
ESTIF(1, 12) = EA * S ^ 2 / (84 * R) - EI / (7 * R)
ESTIF(2, 7) = - 11 * EA * S / (84 * R) + 9 * EI / (7 * S * R)
ESTIF(2, 8) = - EI / (2 * R)
ESTIF(2, 9) = EA * S ^ 3 / (1008 * R) - 9 * EI * S / (140 * R)
ESTIF(2, 10) = 11 * EA * S / (84 * R) - 9 * EI / (7 * S * R)

```


$$\begin{aligned}
\text{ESTIF}(2, 11) &= -13 * \text{EA} * \text{S}^2 / (420 * \text{R}) + 11 * \text{EI} / (14 * \text{R}) \\
\text{ESTIF}(2, 12) &= 13 * \text{EA} * \text{S}^3 / (5040 * \text{R}) - 11 * \text{EI} * \text{S} / (140 * \text{R}) \\
\text{ESTIF}(3, 7) &= -\text{EA} * \text{S}^2 / (84 * \text{R}) + \text{EI} / (7 * \text{R}) \\
\text{ESTIF}(3, 8) &= -\text{EA} * \text{S}^3 / (1008 * \text{R}) + 9 * \text{EI} * \text{S} / (140 * \text{R}) \\
\text{ESTIF}(3, 9) &= 0 \\
\text{ESTIF}(3, 10) &= \text{EA} * \text{S}^2 / (84 * \text{R}) - \text{EI} / (7 * \text{R}) \\
\text{ESTIF}(3, 11) &= -13 * \text{EA} * \text{S}^3 / (5040 * \text{R}) + 11 * \text{EI} * \text{S} / (140 * \text{R}) \\
\text{ESTIF}(3, 12) &= \text{EA} * \text{S}^4 / (5040 * \text{R}) - \text{EI} * \text{S}^2 / (140 * \text{R}) \\
\text{ESTIF}(4, 7) &= -\text{EA} / (2 * \text{R}) \\
\text{ESTIF}(4, 8) &= -11 * \text{EA} * \text{S} / (84 * \text{R}) + 9 * \text{EI} / (7 * \text{S} * \text{R}) \\
\text{ESTIF}(4, 9) &= -\text{EA} * \text{S}^2 / (84 * \text{R}) + \text{EI} / (7 * \text{R}) \\
\text{ESTIF}(4, 10) &= -\text{EA} / (2 * \text{R}) \\
\text{ESTIF}(4, 11) &= 11 * \text{EA} * \text{S} / (84 * \text{R}) - 9 * \text{EI} / (7 * \text{S} * \text{R}) \\
\text{ESTIF}(4, 12) &= -\text{EA} * \text{S}^2 / (84 * \text{R}) + \text{EI} / (7 * \text{R}) \\
\text{ESTIF}(5, 7) &= 11 * \text{EA} * \text{S} / (84 * \text{R}) - 9 * \text{EI} / (7 * \text{S} * \text{R}) \\
\text{ESTIF}(5, 8) &= 13 * \text{EA} * \text{S}^2 / (420 * \text{R}) - 11 * \text{EI} / (14 * \text{R}) \\
\text{ESTIF}(5, 9) &= 13 * \text{EA} * \text{S}^3 / (5040 * \text{R}) - 11 * \text{EI} * \text{S} / (140 * \text{R}) \\
\text{ESTIF}(5, 10) &= -11 * \text{EA} * \text{S} / (84 * \text{R}) + 9 * \text{EI} / (7 * \text{S} * \text{R}) \\
\text{ESTIF}(5, 11) &= \text{EI} / (2 * \text{R}) \\
\text{ESTIF}(5, 12) &= \text{EA} * \text{S}^3 / (1008 * \text{R}) - 9 * \text{EI} * \text{S} / (140 * \text{R}) \\
\text{ESTIF}(6, 7) &= -\text{EA} * \text{S}^2 / (84 * \text{R}) + \text{EI} / (7 * \text{R}) \\
\text{ESTIF}(6, 8) &= -13 * \text{EA} * \text{S}^3 / (5040 * \text{R}) + 11 * \text{EI} * \text{S} / (140 * \text{R}) \\
\text{ESTIF}(6, 9) &= -\text{EA} * \text{S}^4 / (5040 * \text{R}) + \text{EI} * \text{S}^2 / (140 * \text{R}) \\
\text{ESTIF}(6, 10) &= \text{EA} * \text{S}^2 / (84 * \text{R}) - \text{EI} / (7 * \text{R}) \\
\text{ESTIF}(6, 11) &= -\text{EA} * \text{S}^3 / (1008 * \text{R}) + 9 * \text{EI} * \text{S} / (140 * \text{R}) \\
\text{ESTIF}(6, 12) &= 0 \\
\text{ESTIF}(7, 7) &= 181 * \text{EA} * \text{S} / (462 * \text{R}^2) + 120 * \text{EI} / (7 * \text{S}^3) \\
\text{ESTIF}(7, 8) &= 311 * \text{EA} * \text{S}^2 / (4620 * \text{R}^2) + 60 * \text{EI} / (7 * \text{S}^2) \\
\text{ESTIF}(7, 9) &= 281 * \text{EA} * \text{S}^3 / (55440 * \text{R}^2) + 3 * \text{EI} / (7 * \text{S}) \\
\text{ESTIF}(7, 10) &= 25 * \text{EA} * \text{S} / (231 * \text{R}^2) - 120 * \text{EI} / (7 * \text{S}^3) \\
\text{ESTIF}(7, 11) &= -151 * \text{EA} * \text{S}^2 / (4620 * \text{R}^2) + 60 * \text{EI} / (7 * \text{S}^2) \\
\text{ESTIF}(7, 12) &= 181 * \text{EA} * \text{S}^3 / (55440 * \text{R}^2) - 3 * \text{EI} / (7 * \text{S}) \\
\text{ESTIF}(8, 8) &= 52 * \text{EA} * \text{S}^3 / (3465 * \text{R}^2) + 192 * \text{EI} / (35 * \text{S}) \\
\text{ESTIF}(8, 9) &= 23 * \text{EA} * \text{S}^4 / (18480 * \text{R}^2) + 11 * \text{EI} / 35 \\
\text{ESTIF}(8, 10) &= 151 * \text{EA} * \text{S}^2 / (4620 * \text{R}^2) - 60 * \text{EI} / (7 * \text{S}^2) \\
\text{ESTIF}(8, 11) &= -19 * \text{EA} * \text{S}^3 / (1980 * \text{R}^2) + 108 * \text{EI} / (35 * \text{S}) \\
\text{ESTIF}(8, 12) &= 13 * \text{EA} * \text{S}^4 / (13860 * \text{R}^2) - 4 * \text{EI} / 35 \\
\text{ESTIF}(9, 9) &= \text{EA} * \text{S}^5 / (9240 * \text{R}^2) + 3 * \text{EI} * \text{S} / 35 \\
\text{ESTIF}(9, 10) &= 181 * \text{EA} * \text{S}^3 / (55440 * \text{R}^2) - 3 * \text{EI} / (7 * \text{S}) \\
\text{ESTIF}(9, 11) &= -13 * \text{EA} * \text{S}^4 / (13860 * \text{R}^2) + 4 * \text{EI} / 35 \\
\text{ESTIF}(9, 12) &= \text{EA} * \text{S}^5 / (11088 * \text{R}^2) + \text{EI} * \text{S} / 70 \\
\text{ESTIF}(10, 10) &= 181 * \text{EA} * \text{S} / (462 * \text{R}^2) + 120 * \text{EI} / (7 * \text{S}^3)
\end{aligned}$$

```

ESTIF(10, 11) = -311 * EA * S ^ 2 / (4620 * R ^ 2) - 60 * EI / (7 * S ^ 2)
ESTIF(10, 12) = 281 * EA * S ^ 3 / (55440 * R ^ 2) + 3 * EI / (7 * S)
ESTIF(11, 11) = 52 * EA * S ^ 3 / (3465 * R ^ 2) + 192 * EI / (35 * S)
ESTIF(11, 12) = -23 * EA * S ^ 4 / (18480 * R ^ 2) - 11 * EI / 35
ESTIF(12, 12) = EA * S ^ 5 / (9240 * R ^ 2) + 3 * EI * S / 35
FOR I = 1 TO NEVAB
FOR J = I + 1 TO NEVAB
ESTIF(J, I) = ESTIF(I, J)
NEXT J
NEXT I
REM
REM *****
REM *
REM *           Assembla la matrice elementare nella matrice globale
REM *
REM *****
REM
FOR IDOFN = 1 TO NDOFN / 2
MEMDIS(IDOFN) = NODFRE(IEND, IDOFN)
MEMDIS(IDOFN + NDOFN) = NODFRE(IEND, IDOFN + NDOFN / 2)
NEXT IDOFN
FOR IDOFN = 1 TO NDOFN / 2
MEMDIS(IDOFN + NDOFN / 2) = NODFRE(JEND, IDOFN)
MEMDIS(IDOFN + NDOFN / 2 + NDOFN) = NODFRE(JEND, IDOFN + NDOFN
/ 2)
NEXT IDOFN
FOR IEVAB = 1 TO NEVAB
NEWROW = MEMDIS(IEVAB)
IF NEWROW = 0 THEN 111
FOR JEVAB = 1 TO NEVAB
IF MEMDIS(JEVAB) = 0 THEN 121
NEWCOL = MEMDIS(JEVAB) - NEWROW + 1
IF NEWCOL > 0 THEN
GSTIF(NEWROW, NEWCOL) = GSTIF(NEWROW, NEWCOL) + ESTIF(IEVAB,
JEVAB)
END IF
121 NEXT JEVAB
111 NEXT IEVAB
NEXT IELEM
END SUB

```

Appendice 10.6

Matrice di rigidezza per elemento finito SS

```
DEFINT I-N
DEFDBL A-H, O-Z
SUB STIFFASS
REM
REM Subroutine STIFFASS
REM REM
REM *****
REM *
REM *          S T I F F A S S
REM *
REM *****
REM
REM *****
REM *
REM *      Questa subroutine calcola la matrice globale di rigidezza per archi
REM *          piani, usando un elemento finito septico in u e w.
REM *
REM *****
REM
DIM MEMDIS(NEVAB) AS DOUBLE, ESTIF(NEVAB, NEVAB) AS DOUBLE
FOR IELEM = 1 TO NELEM
IEND = LNODS(IELEM, 1)
JEND = LNODS(IELEM, 2)
REM
REM *****
REM *
REM *          Calcolo matrice elementare di rigidezza
REM *
```

```

REM *****
REM
LPROP = MATN(IELEM)
YOUNG = PROPS(LPROP, 1)
QINERZ = PROPS(LPROP, 2)
AREA = PROPS(LPROP, 3)
R = PROPS(LPROP, 4)
BETA = PROPS(LPROP, 5) * 1.74532925199433D-02
S = R * BETA
EI = YOUNG * QINERZ
EA = YOUNG * AREA
COST = EA + EI / R ^ 2
ESTIF(1, 1) = 700 / 429 / S
ESTIF(1, 2) = 271 / 858
ESTIF(1, 3) = S * 23 / 858
ESTIF(1, 4) = 5 / 5148 * S ^ 2
ESTIF(1, 5) = -ESTIF(1, 1)
ESTIF(1, 6) = ESTIF(1, 2)
ESTIF(1, 7) = -ESTIF(1, 3)
ESTIF(1, 8) = ESTIF(1, 4)
ESTIF(2, 2) = 300 * S / 1001
ESTIF(2, 3) = S ^ 2 * 123 / 4004
ESTIF(2, 4) = 25 * S ^ 3 / 18018
ESTIF(2, 5) = -ESTIF(1, 2)
ESTIF(2, 6) = 97 * S / 6006
ESTIF(2, 7) = 47 * S ^ 2 / 12012
ESTIF(2, 8) = -5 * S ^ 3 / 12012
ESTIF(3, 3) = 73 * S ^ 3 / 18018
ESTIF(3, 4) = 37 * S ^ 4 / 180180
ESTIF(3, 5) = -23 * S / 858
ESTIF(3, 6) = -47 * S ^ 2 / 12012
ESTIF(3, 7) = 7 * S ^ 3 / 5148
ESTIF(3, 8) = -73 * S ^ 4 / 720720
ESTIF(4, 4) = S ^ 5 / 90090
ESTIF(4, 5) = -5 * S ^ 2 / 5148
ESTIF(4, 6) = -5 * S ^ 3 / 12012
ESTIF(4, 7) = 73 * S ^ 4 / 720720
ESTIF(4, 8) = -S ^ 5 / 144144
ESTIF(5, 5) = ESTIF(1, 1)
ESTIF(5, 6) = -ESTIF(1, 2)
ESTIF(5, 7) = ESTIF(1, 3)
ESTIF(5, 8) = -ESTIF(1, 4)

```

$$\begin{aligned}
\text{ESTIF}(6, 6) &= \text{ESTIF}(2, 2) \\
\text{ESTIF}(6, 7) &= -\text{ESTIF}(2, 3) \\
\text{ESTIF}(6, 8) &= \text{ESTIF}(2, 4) \\
\text{ESTIF}(7, 7) &= \text{ESTIF}(3, 3) \\
\text{ESTIF}(7, 8) &= -\text{ESTIF}(3, 4) \\
\text{ESTIF}(8, 8) &= \text{ESTIF}(4, 4) \\
\text{ESTIF}(1, 9) &= EA / (2 * R) \\
\text{ESTIF}(1, 10) &= 127 * EA * S / (858 * R) - 50 * EI / (33 * S * R) \\
\text{ESTIF}(1, 11) &= 95 * EA * S^2 / (5148 * R) - 17 * EI / (66 * R) \\
\text{ESTIF}(1, 12) &= 5 * EA * S^3 / (5148 * R) - EI * S / (66 * R) \\
\text{ESTIF}(1, 13) &= \text{ESTIF}(1, 9) \\
\text{ESTIF}(1, 14) &= -\text{ESTIF}(1, 10) \\
\text{ESTIF}(1, 15) &= \text{ESTIF}(1, 11) \\
\text{ESTIF}(1, 16) &= -\text{ESTIF}(1, 12) \\
\text{ESTIF}(2, 9) &= -\text{ESTIF}(1, 10) \\
\text{ESTIF}(2, 10) &= -EI / (2 * R) \\
\text{ESTIF}(2, 11) &= EA * S^3 / (572 * R) - 25 * EI * S / (231 * R) \\
\text{ESTIF}(2, 12) &= 7 * EA * S^4 / (51480 * R) - 19 * EI * S^2 / (2772 * R) \\
\text{ESTIF}(2, 13) &= \text{ESTIF}(1, 10) \\
\text{ESTIF}(2, 14) &= -491 * EA * S^2 / (12012 * R) + 67 * EI / (66 * R) \\
\text{ESTIF}(2, 15) &= 173 * EA * S^3 / (36036 * R) - 23 * EI * S / (154 * R) \\
\text{ESTIF}(2, 16) &= -173 * EA * S^4 / (720720 * R) + 23 * EI * S^2 / (2772 * R) \\
\text{ESTIF}(3, 9) &= -\text{ESTIF}(1, 11) \\
\text{ESTIF}(3, 10) &= -\text{ESTIF}(2, 11) \\
\text{ESTIF}(3, 11) &= 0 \\
\text{ESTIF}(3, 12) &= EA * S^5 / (154440 * R) - EI * S^3 / (2772 * R) \\
\text{ESTIF}(3, 13) &= \text{ESTIF}(1, 11) \\
\text{ESTIF}(3, 14) &= -\text{ESTIF}(2, 15) \\
\text{ESTIF}(3, 15) &= EA * S^4 / (1872 * R) - 19 * EI * S^2 / (924 * R) \\
\text{ESTIF}(3, 16) &= -EA * S^5 / (39312 * R) + EI * S^3 / (924 * R) \\
\text{ESTIF}(4, 9) &= -\text{ESTIF}(1, 12) \\
\text{ESTIF}(4, 10) &= -\text{ESTIF}(2, 12) \\
\text{ESTIF}(4, 11) &= -\text{ESTIF}(3, 12) \\
\text{ESTIF}(4, 12) &= 0 \\
\text{ESTIF}(4, 13) &= -\text{ESTIF}(1, 16) \\
\text{ESTIF}(4, 14) &= \text{ESTIF}(2, 16) \\
\text{ESTIF}(4, 15) &= -\text{ESTIF}(3, 16) \\
\text{ESTIF}(4, 16) &= -EA * S^6 / (864864 * R) + EI * S^4 / (18480 * R) \\
\text{ESTIF}(5, 9) &= -\text{ESTIF}(1, 13) \\
\text{ESTIF}(5, 10) &= -\text{ESTIF}(2, 13) \\
\text{ESTIF}(5, 11) &= -\text{ESTIF}(3, 13) \\
\text{ESTIF}(5, 12) &= -\text{ESTIF}(4, 13)
\end{aligned}$$

$$\text{ESTIF}(5, 13) = \text{ESTIF}(5, 9)$$

$$\text{ESTIF}(5, 14) = -\text{ESTIF}(5, 10)$$

$$\text{ESTIF}(5, 15) = \text{ESTIF}(5, 11)$$

$$\text{ESTIF}(5, 16) = -\text{ESTIF}(5, 12)$$

$$\text{ESTIF}(6, 9) = -\text{ESTIF}(1, 14)$$

$$\text{ESTIF}(6, 10) = -\text{ESTIF}(2, 14)$$

$$\text{ESTIF}(6, 11) = -\text{ESTIF}(3, 14)$$

$$\text{ESTIF}(6, 12) = -\text{ESTIF}(4, 14)$$

$$\text{ESTIF}(6, 13) = -\text{ESTIF}(5, 14)$$

$$\text{ESTIF}(6, 14) = -\text{ESTIF}(2, 10)$$

$$\text{ESTIF}(6, 15) = \text{ESTIF}(2, 11)$$

$$\text{ESTIF}(6, 16) = -\text{ESTIF}(2, 12)$$

$$\text{ESTIF}(7, 9) = -\text{ESTIF}(1, 15)$$

$$\text{ESTIF}(7, 10) = -\text{ESTIF}(2, 15)$$

$$\text{ESTIF}(7, 11) = -\text{ESTIF}(3, 15)$$

$$\text{ESTIF}(7, 12) = -\text{ESTIF}(4, 15)$$

$$\text{ESTIF}(7, 13) = -\text{ESTIF}(5, 15)$$

$$\text{ESTIF}(7, 14) = -\text{ESTIF}(6, 15)$$

$$\text{ESTIF}(7, 15) = 0$$

$$\text{ESTIF}(7, 16) = \text{ESTIF}(3, 12)$$

$$\text{ESTIF}(8, 9) = -\text{ESTIF}(1, 16)$$

$$\text{ESTIF}(8, 10) = -\text{ESTIF}(2, 16)$$

$$\text{ESTIF}(8, 11) = -\text{ESTIF}(3, 16)$$

$$\text{ESTIF}(8, 12) = -\text{ESTIF}(4, 16)$$

$$\text{ESTIF}(8, 13) = -\text{ESTIF}(5, 16)$$

$$\text{ESTIF}(8, 14) = -\text{ESTIF}(6, 16)$$

$$\text{ESTIF}(8, 15) = -\text{ESTIF}(7, 16)$$

$$\text{ESTIF}(8, 16) = 0$$

$$\text{ESTIF}(9, 9) = 521 * \text{EA} * \text{S} / (1287 * \text{R}^2) + 280 * \text{EI} / (11 * \text{S}^3)$$

$$\text{ESTIF}(9, 10) = 151 * \text{EA} * \text{S}^2 / (2002 * \text{R}^2) + 140 * \text{EI} / (11 * \text{S}^2)$$

$$\text{ESTIF}(9, 11) = 137 * \text{EA} * \text{S}^3 / (18018 * \text{R}^2) + 40 * \text{EI} / (33 * \text{S})$$

$$\text{ESTIF}(9, 12) = 383 * \text{EA} * \text{S}^4 / (1081080 * \text{R}^2) + \text{EI} / 22$$

$$\text{ESTIF}(9, 13) = 245 * \text{EA} * \text{S} / (2574 * \text{R}^2) - 280 * \text{EI} / (11 * \text{S}^3)$$

$$\text{ESTIF}(9, 14) = -127 * \text{EA} * \text{S}^2 / (4004 * \text{R}^2) + 140 * \text{EI} / (11 * \text{S}^2)$$

$$\text{ESTIF}(9, 15) = 155 * \text{EA} * \text{S}^3 / (36036 * \text{R}^2) - 40 * \text{EI} / (33 * \text{S})$$

$$\text{ESTIF}(9, 16) = -521 * \text{EA} * \text{S}^4 / (2162160 * \text{R}^2) + \text{EI} / 22$$

$$\text{ESTIF}(10, 10) = 5 * \text{EA} * \text{S}^3 / (273 * \text{R}^2) + 600 * \text{EI} / (77 * \text{S})$$

$$\text{ESTIF}(10, 11) = 7 * \text{EA} * \text{S}^4 / (3432 * \text{R}^2) + 379 * \text{EI} / 462$$

$$\text{ESTIF}(10, 12) = \text{EA} * \text{S}^5 / (10010 * \text{R}^2) + 8 * \text{EI} * \text{S} / 231$$

$$\text{ESTIF}(10, 13) = -\text{ESTIF}(9, 14)$$

$$\text{ESTIF}(10, 14) = -373 * \text{EA} * \text{S}^3 / (36036 * \text{R}^2) + 380 * \text{EI} / (77 * \text{S})$$

$$\text{ESTIF}(10, 15) = 199 * \text{EA} * \text{S}^4 / (144144 * \text{R}^2) - 181 * \text{EI} / 462$$

```

ESTIF(10, 16) = -EA * S ^ 5 / (13104 * R ^ 2) + 5 * EI * S / 462
ESTIF(11, 11) = 43 * EA * S ^ 5 / (180180 * R ^ 2) + 50 * EI * S / 231
ESTIF(11, 12) = EA * S ^ 6 / (83160 * R ^ 2) + EI * S ^ 2 / 99
ESTIF(11, 13) = ESTIF(9, 15)
ESTIF(11, 14) = -ESTIF(10, 15)
ESTIF(11, 15) = 131 * EA * S ^ 5 / (720720 * R ^ 2) - EI * S / 462
ESTIF(11, 16) = -43 * EA * S ^ 6 / (4324320 * R ^ 2) - 5 * EI * S ^ 2 / 2772
ESTIF(12, 12) = EA * S ^ 7 / (1621620 * R ^ 2) + 2 * EI * S ^ 3 / 3465
ESTIF(12, 13) = -ESTIF(9, 16)
ESTIF(12, 14) = ESTIF(10, 16)
ESTIF(12, 15) = -ESTIF(11, 16)
ESTIF(12, 16) = -EA * S ^ 7 / (1853280 * R ^ 2) - EI * S ^ 3 / 4620
ESTIF(13, 13) = ESTIF(9, 9)
ESTIF(13, 14) = -ESTIF(9, 10)
ESTIF(13, 15) = ESTIF(9, 11)
ESTIF(13, 16) = -ESTIF(9, 12)
ESTIF(14, 14) = ESTIF(10, 10)
ESTIF(14, 15) = -ESTIF(10, 11)
ESTIF(14, 16) = ESTIF(10, 12)
ESTIF(15, 15) = ESTIF(11, 11)
ESTIF(15, 16) = -ESTIF(11, 12)
ESTIF(16, 16) = ESTIF(12, 12)
FOR I = 1 TO NEVAB
FOR J = I + 1 TO NEVAB
ESTIF(J, I) = ESTIF(I, J)
NEXT J
NEXT I
FOR I = 1 TO 8
FOR J = 1 TO 8
ESTIF(I, J) = ESTIF(I, J) * COST
NEXT J
NEXT I
REM
REM *****
REM *
REM *          Assembla la matrice elementare nella matrice globale
REM *
REM *****
REM
FOR IDOFN = 1 TO NDOFN / 2
MEMDIS(IDOFN) = NODFRE(IEND, IDOFN)
MEMDIS(IDOFN + NDOFN) = NODFRE(IEND, IDOFN + NDOFN / 2)

```

```
NEXT IDOFN
FOR IDOFN = 1 TO NDOFN / 2
MEMDIS(IDOFN + NDOFN / 2) = NODFRE(JEND, IDOFN)
MEMDIS(IDOFN + NDOFN / 2 + NDOFN) = NODFRE(JEND, IDOFN + NDOFN
/ 2)
NEXT IDOFN
FOR IEVAB = 1 TO NEVAB
NEWROW = MEMDIS(IEVAB)
IF NEWROW = 0 THEN 111
FOR JEVAB = 1 TO NEVAB
IF MEMDIS(JEVAB) = 0 THEN 121
NEWCOL = MEMDIS(JEVAB) - NEWROW + 1
IF NEWCOL > 0 THEN
GSTIF(NEWROW, NEWCOL) = GSTIF(NEWROW, NEWCOL) + ESTIF(IEVAB,
JEVAB)
END IF
121 NEXT JEVAB
111 NEXT IEVAB
NEXT IELEM
END SUB
```