MODELING OF PRECAST PRESTRESSED GIRDERS USING ADAPT ABI PROGRAM

By way of two numerical examples, this Technical Note explains how to model pre-tensioned precast members using ADAPT-ABI versions 4.xx and earlier. The examples cover the condition of de-bonding prestressing strands both at the ends of the beams and at the interior. One of the examples includes the removal of strands that are used for transportation and handling are covered.

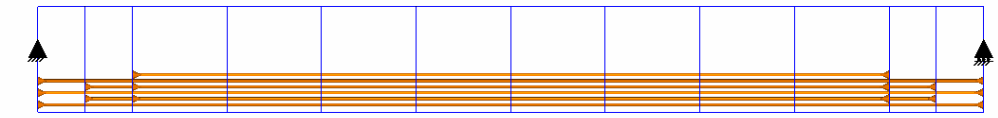

FIGURE 1 - Pre-tensioned beam with strands at several levels. Some of the strands are de-bonded at the end of the beam

Input data for Figure 1

```
;=====================================================================
;     ADAPT-BRIDGE-INCREMENTAL     ABI     SOFTWARE MANUAL EXAMPLES
;=====================================================================
;  name of this file: PCPS_1.INP    units are lb-in

START
TITLE N=4
      This example illustrates the modeling of a pre-tensioned precast
      girder. The model is a double-T section 100-ft span; 35.25 in. deep


UNITS U=USA

CONCRETE PARAMETERS N=1
         1  M=ACI

MESH INPUT
   NODES N=13
     1   X=0 Y=0
     3   X=10*12  Y=0  G=1,3,1
     11  X=90*12  Y=0  G=3,11,1
     13  X=100*12 Y=0  G=11,13,1

   CONCRETE PROPERTIES N=1
         1  Fpc=6000 Cr=2.0 Sh=0.0004   W=125/1728
   MILD STEEL PROPERTIES N=1
         1 Es=29000000.0 P=0.01
   SECTION PROPERTIES N=1
         1 Area=1446 I=157115.8  C=10.7241, 24.5259
   ELEMENTS N=12
```

```
      FRAME N=12
           1,1,2 C=1 X=1 St=1 Day=1 G=1,12,1,1,1

   PRESTRESSING STEEL  N=1
           1 Ep=28000000  Meu=0  K=0  Fpu=270000  R=45  Ap=1E-5
   TENDON GEOMETRY N=8
       1 Spans=1 M=1 Area=0.612*2
           1 N=13  G=1,13,1 B=0,0  E=10,0
                 R=0,0.5,0 S=-22.0259, -22.0259, -22.0259
       2 Spans=1 M=1 Area=0.306*2
           1 N=11  G=2,12,1
                 R=0,0.5,0 S=-20.0259, -20.0259, -20.0259
       3 Spans=1 M=1 Area=0.306*2
           1 N=9   G=3,11,1
                 R=0,0.5,0 S=-20.0259, -20.0259, -20.0259
       4 Spans=1 M=1 Area=0.612*2
           1 N=13  G=1,13,1
                 R=0,0.5,0 S=-18.0259, -18.0259, -18.0259
       5 Spans=1 M=1 Area=0.306*2
           1 N=11  G=2,12,1
                 R=0,0.5,0 S=-16.0259, -16.0259, -16.0259
       6 Spans=1 M=1 Area=0.306*2
           1 N=9   G=3,11,1
                 R=0,0.5,0 S=-16.0259, -16.0259, -16.0259
       7 Spans=1 M=1 Area=0.612*2
           1 N=13  G=1,13,1 B=0,0  E=10,0
                 R=0,0.5,0 S=-14.0259, -14.0259, -14.0259
       8 Spans=1 M=1 Area=0.153*2
           1 N=9  G=3,11,1
                 R=0,0.5,0 S=-12.0259, -12.0259, -12.0259

MESH COMPLETE
                           ; The forms are in place, there is no concrete
SET  G=0,0                 ; turn the gravity load off

CHANGE STRUCTURE

   BUILD N=1,12,1          ; Time is kept still at day=0 and concrete
                           ; assumed on forms,
   STRESS N=1,8,1  StressTo=202614  Anchor=0,0

                    ; strandes are stressed.
                    ; since this is a pretensioned member, there is no
                    ; friction. The entire force goes into strands.
                    ; Note that the ends of the strands are anchored in
                    ; the bulkhead at the stressing ends. Check the
                    ; solution and verify that all the prestressing
                    ; goes to the strands. There is no force
                    ; in concrete

                    ;The following restraints represent the bulkhead
                    ; of stressing ends in the prestressing beds
   RESTRAINTS
     1  R=1,1,1
     2  R=1,1,1
     3  R=1,1,1
     11 R=1,1,1
     12 R=1,1,1
     13 R=1,1,1

CHANGE COMPLETE
SOLVE DAY=1  ! OUTPUT
; ........................................... stage 1 ...........
                      ; at this moment tendons stressed. They are
                      ; anchored at the bulkhead.
                      ; selfweight of concrete is not active
                      ; concrete is cast. It is cured for 1 day
                      ; but not stressed


SOLVE DAY=2  ! OUTPUT  ; time is moved forward, allowing the concrete
```

```
                        ; to cure another day. Tendons are not cut

SOLVE DAY=3             ; a third day is passed, allowing the concrete
                        ; to cure, before cutting the strand.
                        ; in practice tendons are cut sooner,
                        ; in which case this this command will not
                        ; be used.

CHANGE STRUCTURE
    RESTRAINTS          ; The following instruction cuts the ends of
       1   R=1,1,0      ; the tendons at the bulkhead and allows the
       2   R=0,0,0      ; beam to camber off the form resting at its
       3   R=0,0,0      ; two ends. The solution will determine whether
       11  R=0,0,0      ; this will happen. The instructins provide the
       12  R=0,0,0      ; possibility.
       13  R=0,1,0

CHANGE COMPLETE

SET  G=0,-1             ; selfweight of concrete is activated
SOLVE     ! OUTPUT      ; a solution is obtained without lapse of time
                        ; it is still day=3 (see last day= command)

                        ; in this condition, the beam can be left as is
                        ; or it can be taken to a storage and supported
                        ; at its third points. For each of these
                        ; scenarios, the time is moved forward by a
                        ; Solve day=?? command, and the support
                        ; conditions are changed through "restraints"
                        ; command.
SOLVE DAY=5
SOLVE DAY=10  ! OUTPUT



; ..................................... stage 2 ..................
;                           The beam is placed in service on day 30
SOLVE DAY=30  ! OUTPUT
;                           Note that it is assumed that beam is supported
;                           at its ends
SOLVE DAY=35                ; time is allowed to lapse to day 35 when
                            ; superimposed load is added to the beam
;
LOADING
  L=1,12,1 F=0,-60/12

;
SOLVE  ! OUTPUT             ; a solution is obtained at day 35
                            ; right after superimposed load is added
SOLVE Day=38         ! OUTPUT
SOLVE DAY=45         ! OUTPUT
SOLVE DAY=60         ! OUTPUT
SOLVE DAY=80         ! OUTPUT
SOLVE Day=100        ! OUTPUT
SOLVE DAY=365        ! OUTPUT
SOLVE DAY=5*365      ! OUTPUT
SOLVE DAY=10*365     ! OUTPUT
SOLVE DAY=20*365     ! OUTPUT


STOP
```

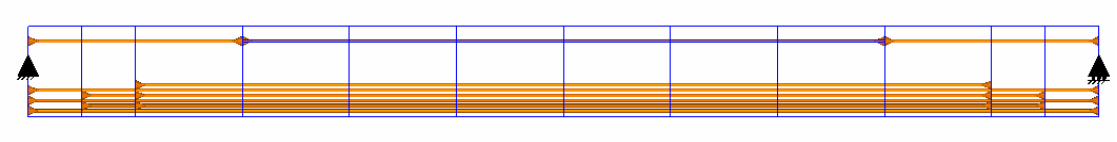

FIGURE 2 - Pre-tensioned beam with strands at several levels. Some of the strands are debonded at the end of the beam. In addition two strands at the top that are used for transportation and handling are debonded over the central portion of the beam and cut, when the beam is installed in its finial position.

Input data for example in Figure 2

```
;=============================================================================
;     ADAPT-BRIDGE-INCREMENTAL     ABI     SOFTWARE MANUAL EXAMPLES
;=============================================================================
;  name of this file: PCPS_2.INP    units are lb-in

START
TITLE N=8
      This example illustrates the modeling of a pre-tensioned precast
      girder with two specific features.
      First it illustrates how several of the strands can be debonded
      at the end of the beam.
      Second, it shows the modeling of strands that are debonded at the
      interior of a beam. These are used for handling and transportation.
      After installation, they can be removed as shown in this example.



UNITS U=USA

CONCRETE PARAMETERS N=1
         1  M=ACI

MESH INPUT
   NODES N=13
     1   X=0 Y=0
     3   X=10*12  Y=0  G=1,3,1
     11  X=90*12  Y=0  G=3,11,1
     13  X=100*12 Y=0  G=11,13,1

   CONCRETE PROPERTIES N=1
         1  Fpc=6000 Cr=2.0 Sh=0.0004   W=125/1728
   MILD STEEL PROPERTIES N=2
         1 Es=29000000    P=0.01
         2 Es=29000000    P=0.0

   SECTION PROPERTIES N=2
         1 Area=1446 I=157115.8  C=10.7241, 24.5259
         2 Area=1.0   I=4        C=0.5,0.5   ; Sheathing for wrapped
                                             ; strands

   OFFSET DATA N=1
         1 OI=0,5  OJ=0,5          ; OFFSET FOR debonding wrap
                                   ; this will be used with elemnet 13



   ELEMENTS N=13
      FRAME N=13
           1,1,2    C=1 X=1 St=1 Day=1 G=1,12,1,1,1
           13,4,10  C=1 X=2 St=2 Day=1 OFF=1   ; wrapping for debonding
```

```
   PRESTRESSING STEEL  N=1
           1 Ep=28000000  Meu=0  K=0  Fpu=270000  R=45  Ap=1E-5
   TENDON GEOMETRY N=11
       1 Spans=1 M=1 Area=0.612*2
           1 N=13  G=1,13,1 B=0,0  E=10,0
                 R=0,0.5,0 S=-22.0259, -22.0259, -22.0259
       2 Spans=1 M=1 Area=0.306*2
           1 N=11  G=2,12,1
                 R=0,0.5,0 S=-20.0259, -20.0259, -20.0259
       3 Spans=1 M=1 Area=0.306*2
           1 N=9   G=3,11,1
                 R=0,0.5,0 S=-20.0259, -20.0259, -20.0259
       4 Spans=1 M=1 Area=0.612*2
           1 N=13  G=1,13,1
                 R=0,0.5,0 S=-18.0259, -18.0259, -18.0259
       5 Spans=1 M=1 Area=0.306*2
           1 N=11  G=2,12,1
                 R=0,0.5,0 S=-16.0259, -16.0259, -16.0259
       6 Spans=1 M=1 Area=0.306*2
           1 N=9   G=3,11,1
                 R=0,0.5,0 S=-16.0259, -16.0259, -16.0259
       7 Spans=1 M=1 Area=0.612*2
           1 N=13  G=1,13,1 B=0,0  E=10,0
                 R=0,0.5,0 S=-14.0259, -14.0259, -14.0259
       8 Spans=1 M=1 Area=0.153*2
           1 N=9  G=3,11,1
                 R=0,0.5,0 S=-12.0259, -12.0259, -12.0259
       9 Spans=1 M=1 Area=0.153*2
           1 N=4  G=1,4,1
                 R=0,0.5,0 S=5,5,5
       10 Spans=1 M=1 Area=0.153*2
           1 N=2
             List=4,10
                 R=0,0.5,0 S=5,5,5
       11 Spans=1 M=1 Area=0.153*2
           1 N=4  G=10,13,1
                 R=0,0.5,0 S=5,5,5


MESH COMPLETE
                            ; The forms are in place, there is no concrete
SET  G=0,0                  ; turn the gravity load off

CHANGE STRUCTURE

   BUILD N=1,13,1           ; Time is kept still at day=0 and concrete
                            ; assumed on forms,
   STRESS N=1,11,1  StressTo=202614  Anchor=0,0

                    ; strandes are stressed.
                    ; since this is a pretensioned member, there is no
                    ; friction. The entire force goes into strands.
                    ; Note that the ends of the strands are anchored in
                    ; the bulkhead at the stressing ends. Check the
                    ; solution and verify that all the prestressing
                    ; goes to the strands. There is no force
                    ; in concrete

                    ;The following restraints represent the bulkhead
                    ; of stressing ends in the prestressing beds
   RESTRAINTS
     1  R=1,1,1
     2  R=1,1,1
     3  R=1,1,1
     4  R=1,1,1
     10 R=1,1,1
     11 R=1,1,1
     12 R=1,1,1
     13 R=1,1,1
```

```
CHANGE COMPLETE
SOLVE DAY=1  ! OUTPUT
; ..................................... stage 1 ...........
                     ; at this moment tendons stressed. They are
                     ; anchored at the bulkhead.
                     ; selfweight of concrete is not active
                     ; concrete is cast. It is cured for 1 day
                     ; but not stressed


SOLVE DAY=2  ! OUTPUT  ; time is moved forward, allowing the concrete
                       ; to cure another day. Tendons are not cut

SOLVE DAY=3            ; a third day is passed, allowing the concrete
                       ; to cure, before cutting the strand.
                       ; in practice tendons are cut sooner,
                       ; in which case this this command will not
                       ; be used.

CHANGE STRUCTURE
    RESTRAINTS         ; The following instruction cuts the ends of
       1   R=1,1,0     ; the tendons at the bulkhead and allows the
       2   R=0,0,0     ; beam to camber off the form resting at its
       3   R=0,0,0     ; two ends. The solution will determine whether
       4   R=0,0,0     ; this will happen. The instructins provide the
       10  R=0,0,0     ; possibility
       11  R=0,0,0     ;
       12  R=0,0,0     ;
       13  R=0,1,0

CHANGE COMPLETE

SET  G=0,-1            ; selfweight of concrete is activated
SOLVE     ! OUTPUT     ; a solution is obtained without lapse of time
                       ; it is still day=3 (see last day= command)

                       ; in this condition, the beam can be left as is
                       ; or it can be taken to a storage and supported
                       ; at its third points. For each of these
                       ; scenarios, the time is moved forward by a
                       ; Solve day=?? command, and the support
                       ; conditions are changed through "restraints"
                       ; command.
SOLVE DAY=5
SOLVE DAY=10  ! OUTPUT



; ..................................... stage 2 ...................
;                          The beam is placed in service on day 30
SOLVE DAY=30  ! OUTPUT
;                          Note that it is assumed that beam is supported
;                          at its ends
SOLVE DAY=32               ; time is brought to this date and beam is
                           ; installed

CHANGE STRUCTURE
   REMOVE N=13            ; At this stage, prior to the applictation of
     DE-STRESS  N=1       ; the load, the central portion of the top
       LIST=10            ; of the top strand that was debonded is
                          ; removed.


CHANGE COMPLETE
SOLVE  ! OUTPUT



SOLVE DAY=35               ; time is allowed to lapse to day 35 when
                           ; superimposed load is added to the beam
;
```

```
LOADING
  L=1,12,1 F=0,-400/12

;
SOLVE  ! OUTPUT             ; a solution is obtained at day 35
                            ; right after superimposed load is added
SOLVE Day=38          ! OUTPUT
SOLVE DAY=45          ! OUTPUT
SOLVE DAY=60          ! OUTPUT
SOLVE DAY=80          ! OUTPUT
SOLVE Day=100         ! OUTPUT
SOLVE DAY=365         ! OUTPUT
SOLVE DAY=5*365       ! OUTPUT
SOLVE DAY=10*365      ! OUTPUT
SOLVE DAY=20*365      ! OUTPUT


STOP
```