4. START OF THE PROGRAMS OF THE CALCULATION OF THE OUTPUT VARIABLES IN THE LIBRARIES OF THE COMPLEX

4.1. Functions of the programs of the calculation of the output variables and the structure of operator SUBROUTINE.

There are two reasons, for which variables, the directly obtained as a result solutions of the initial systems of equations in the complex PRADIS, are inaccessible for the mapping:

1) usually a quantity of variables, which require for the analysis of the results of calculation, it is considerably less than the general quantity of results, obtained at each step integration.

2) frequently for obtaining the requiring results internal variables must be subjected by the certain to conversions.

Fig. 4.1. shows the place of the programs of the calculation of the output variables ([PRVP]) in this process. On the completion of each step integration occurs turning to required [PRVP], which and they calculate the current state of the vector of output variables. Initial data for this are:

- the value of internal variables at this step integration. To the internal variables in the complex PRADIS relate the values of all potential the variables of this step, value of all flow variables for each model of element, and also the variables of the working vector of all models of elements;

- the value of constant parameters, assigned by user in the description of the call of the program of the calculation by output variable (subsection # OF OUTPUT the corresponding division of $FRAGMENT).

Each program of calculation by output variable can to calculate one or several output variables. In this case it is assumed that several output variables, calculated by one [PRVP], this one multicomponent output variable. Access to each component of this variable is effected on it to ordinal number.

For example, this record of the call of the program of the mapping DISP:

```
Conclusion of results 'DISP (FROM=1;
                    Variable (2), variable (1))
```

it means that it is necessary to build the graph of the dependence of the first the component of multicomponent output variable “variable” from the second component of the same variable.

The values of all output variables remain in the file the results of integration with the given one for this program integration with the step OF OUT.

Operator OF SUBROUTINE for the program of calculation by the output by variable it has two forms of record depending on the value the key parameter VPS in the passport [PRVP].

If the key parameter VPS speaks, that given [PRVP] expects on the entrance the fixed quantity of the internal variables (VPS=0), then is the operator OF SUBROUTINE in this case it appears as follows:

```
SUBROUTINE OUTPUT (OUT, SYS1,… SYSN, PAR, WRK)
REAL * OF 8 OUT (1), OF SYS1,… SYSN, PAR (1), WRK (1)
```

In this call:

OUTPUT - name of the program of calculation by the output by variable, formed according to the rules language FORTRAN.

OUT - calculated output variable or the vector of the calculated output variables. Quantity of those calculated by this [PRVP] of the output variables it is determined by passport [PRVP]. It is necessary to note that in PRADIS it is not guaranteed the retention of the values of the elements of massif OUT upon transfer to the following step integration. Therefore for the retention the required values of this massif (for example, if it is necessary to accumulate some value), it is used working vector [PRVP]. If the parameter OUT it is equal to zero, this vector is absent from the list of the formal parameters of program;

SYS1… OF SYSN - the value of internal variables on the data the step of integration. It is necessary to note, that if J -[aja] internal variable in this list it has to be potential, and in text in the language PRADIS it is described as indicator to the number of unit, then inside [PRVP] it is always described as massif of three variables. In this case the first element massif - displacement according to the assigned degree the freedom, the second - speed, the third - acceleration. For example:

```
         SUBROUTINE OF THE V (OUT, THE X, PAR)
         REAL * OF 8 OUT, THE X (1), PAR (1)
C PAR (1) - the assigned scale of the conclusion
C the calculation of the current speed
         OUT = OF PAR (1) * OF THE X (2)
         RETURN
         END
```

If indicator to the number of the unit is used with the symbol ', then in [PRVP] it is transferred massif of two variables, by the first of which is the speed, the second - acceleration. If is used indicator on

the number of unit with the symbol ", then in [PRVP]
the acceleration of appropriate is transferred
unit. Quantity of those transferred in [PRVP]
internal variables it is determined
by passport [PRVP]. As it follows from the description
language, for the transfer in [PRVP] of the value of
force,

acting on the specific branch
element, is used the indicator of the I:, for
the transfer of the potential variable
the number of the unit, to which this, is used
variable corresponds, for the transfer
the element of working vector - indicator W:.
If the value of the key parameter SYS
it is equal to 0, internal variables be absent
in the list of the formal parameters of program.

ATTENTION! [PRVP] on no account
it must change the values of the internal
variables.

PAR - vector of the parameters for the program of the calculation
by output variable. Quantity
the parameters [PRVP] it is determined by the passport
program. [PRVP] cannot change the values
the elements of this vector. If this massif
in the program, which realizes [PRVP], it is described
by the usual method (for example, PAR (1)), then
storage cell PAR (0) contains the quantity
the parameters for this [PRVP]. This can
to be required in the case of realization [PRVP]
with a variable quantity of parameters. In
this case storage cell PAR (0)
the actual quantity contains
the parameters, transferred in [PRVP] with
this call. Combination of the zero
the values of the key parameters VPR and
PAR leads to the fact that this vector
it is absent from the list of the formal parameters
program.

WRK - working vector [PRVP]. It is used in those
purposes, as the vector WRK of the model
element. Pravda is one finesse.
Rotation in [PRVP] occurs only one
once at the step of integration, its in the case
successful completion. Therefore [PRVP] not
it needs state vector. Let us say,
the accumulation of any value is possible
to make with the use of the following group
the operators:

```
          .....
          IF (NSTEP .EQ.  0)
  , THEN
                  WRK (1) = of 0.D0
          END IF
          .....
          WRK (1) = OF WRK (1) + OF STEP * X1 (1)
          .....
```

Working vector [PRVP] has constant
part and the variable part, which depends on
quantity of parameters in the vector
the parameters [PRVP]. The overall length of accessible
in
[PRVP] of working vector is determined
by the combination of the key parameters of the passport
WRK and WRP. If the length of working vector,
that determined by these parameters, is equal to 0,
vector is absent from the list of the formal
the parameters of program.

Second variety of operator SUBROUTINE for [PRVP]
it appears as follows:

```
SUBROUTINE OUTPUT (OUT, SYS, NVAR, PAR, WRK)
REAL * OF 8 OUT (1), OF SYS (1), OF PAR (1), OF WRK (1)
INTEGER * OF 4 NVAR
```

This record of title [PRVP] corresponds to the program
the calculation of output variables with the variable quantity
the transferred to it indicators to the internal variables. In this case
This is SYS- the vector of those transferred in [PRVP] of internal variables,
NVAR - quantity of elements in this vector. Let us assume that in
to the basic library of complex is a program of the calculation of the sum
several internal variables:

```
                SUBROUTINE SUM (OUT, SYS, NVAR, PAR)
C
                REAL * OF 8 OUT, SYS (1), PAR (1)
                INTEGER * OF 4 NVAR, THE I
C
C PAR (1) - the scale
                OUT = of 0.D0
                DO OF 100 I = 1, NVAR
                     OUT = OF OUT + OF SYS (THE I)
100 CONTINUE
                OUT = OF OUT * OF PAR (1)
C
                RETURN
                END
```

Let us assume also that in the text of the description of the object
the following subsection of the description of the conclusion is present:

```
        # OUTPUT
    Sum of forces 'SUM (the I:Element (1),
                            The I:Element (2), the I:Drive (e);1)
    Sum of displacements 'SUM (1,2,33,56,78;1)
```

Then output variable “sum of forces” is equal
to the algebraic sum of the forces, which act on the first and the second
to the branches of element “element” and on thirds of branch of element “drive”.
Output variable “sum of displacements” will be equal
to the algebraic sum of displacements according to the degrees of freedom 1, 2,
33,
56 and 78. It is necessary to note that with the second form of the record
operator SUBROUTINE for [PRVP] (and with that corresponding to this
to the case the determination of its passport) for the manipulation with the
speeds

(by accelerations) it is necessary to use indicators to the number of unit
by the corresponding symbols ('or "). For example,
the algebraic summing up of speeds can be executed
by this call of program SUM:

    Sum of speeds "SUM (1", 2 ', 33 ', 56 ', 78 ';1)

4.2. Passport of the program of the calculation of output variables.

Passport [PRVP] begins with the keyword OUTPUT. Afterward
this goes the name of the subprogram, which realizes [PRVP] and, after the
symbol
":" - the names of the key parameters of passport and their value -
positive integers.

In the passport [PRVP] of user, included in the composition
the libraries of complex, can be assigned the following key
the parameters:

OUT - determines a quantity of components in
by the calculated this by program output
by variable (length of the vector of the output
variables, calculated by this [PRVP]).
On silence OUT = 1;

SYS - determines a quantity of the internal
variable, transferred [PRVP]. IN [PRVP],
intended for treating the variable
quantity of internal variables, this
the key parameter is determined minimally
a possible quantity of the internal
the variables, transmitted data [PRVP].
On silence SYS = 1. If SYS=0 and
VPS=0, internal variables be absent
in the list of the formal parameters [PRVP];

VPS - sign of a variable quantity of the internal
variables. If VPS is not assigned or equal to 0,
it is considered that [PRVP] is intended for
working the constant quantity
internal variables (this quantity
it is determined by the key parameter SYS).
If VPS=1, then [PRVP] processes
a variable quantity of the internal
variables, but not less than this
it is determined by the key parameter SYS. This
the case corresponds to the second type
operator SUBROUTINE for [PRVP].
Developer can require from
the translator of the additional control
quantity of internal variables on
parity and odd parity. If the quantity
internal variables must be
odd, then is the key parameter VPS
it [eadaetsja] equal to 11, if even - that of 21;

PAR - determines a quantity of parameters for
[PRVP] with a constant quantity of parameters.
For [PRVP] with the variable quantity
the parameters is assigned smallest possible
a quantity of parameters for this [PRVP].
If the key parameter PAR is not assigned,
a quantity of parameters [PRVP] starts
equal to 1. If PAR=0 and VPR=0, the vector
the parameters it is absent from the list of the formal
the parameters [PRVP];

VPR - sign of the fact that [PRVP] has variable
a quantity of parameters. If VPR is not assigned
or it is equal to 0, it is considered that [PRVP] has
a constant quantity of parameters. If
VPR=1, the [PRVP] have the variable quantity
the parameters. In this case in the stage
syntactic analysis it is controlled,
in order to the given quantity of the parameters
[PRVP] was not less than the key parameter
PAR. Developer can require from
the translator of the additional control
quantity of parameters to the parity and
odd parity. If a quantity of the parameters
[PRVP] must be odd, then of the key
the parameter VPR is assigned [ravynm] 11, if
even - that of 21;

WRK - determines the length of a constant part of the worker
vector [PRVP];

WRS - determine, how many elements of the worker
vector must correspond to each
by internal [perememennoj] in the variable part
the vector of the internal variables, transferred
in [PRVP]. This key parameter is useful in [PRVP]
with a variable quantity of those transferred
internal variables, when it is required for
by each variable or the group of the variables
to preserve the results of any single
calculations;

WRP - determine, how many elements of the worker
vector must correspond to each
to the parameter in the variable part of the vector
the parameters. This key parameter is useful in
[PRVP] with a variable quantity of parameters,
when it is required for each parameter or
the group of the parameters to preserve the results
any single calculations.
NOTE.
The overall length of the working vector, transferred
of the model of element, it is calculated from the formula
WRK +
(<[fakticheskoe] quantity [vn].[peremennykh] -
- SYS) * WRS +
(<[fakticheskoe] quantity of parameters # OF PAR) * WRP

4.3. Reference information on [PRVP].

Following contents of the reference is recommended information on [PRVP]:

1) the first line of reference information, which contains the brief designation of the program of calculation by output variable;

2) complete designation [PRVP];

e) the type of the transferred in [PRVP] indicators to the the internal variables;

4) the description of the vector of the parameters [PRVP];

shch) the description of output variable or the description of each of the component of multicomponent output variable.

4.4. Examples of the programs of the calculation of the output the variables of complex PRADIS.

4.4.1. PROGRAM of the X. the calculation of displacement, force and the element of working vector.

Examples of the call of the program of X in the subsection # OUTPUT the description of the object:

```
# OUTPUT:
1)
Speed along the y axis of point A “X (13”; 1)
Acceleration along the y axis of point A 'X (13 "; 1)
Force of compression of spring 'the X (the I: Spring (1);  1)
Elastic energy of spring 'the X (W: Spring (12); 1)
```

Text of the program:

```
C OUTPUT OF THE X: OUT=1, SYS=1, PAR=1
C the date of the creation:                08/22/90 10:21 am
C the date of the last correction: 01/24/92 05:24 pm
C
C HELP calculation by the assigned output variable.
C HELP THE NAME:      Program of calculation by the output variable
C HELP (displacement, force or the component
C HELP of the working vector of the model of element).
C HELP THE TYPE OF THE TRANSFERRED TO THE PROGRAM INTERNAL VARIABLES:
C HELP 1- displacement, force, or the component of the worker
C HELP of the vector of the model of element.
C HELP THE CONSTANT PARAMETERS:
C HELP 1- scale.
```

```
C HELP THE OUTPUT VARIABLES:
C HELP 1- transmitted internal variable, multiplied by
C HELP scale.
         SUBROUTINE OF THE X (XOUT, XSYS, PAR)
         REAL * OF 8 XOUT, XSYS, PAR
         XOUT = OF PAR * OF XSYS
         RETURN
         END
```

4.4.2. PROGRAM MAXI. Calculation of the maximum value from N of internal variables.

Program MAXI is given here as the example [PRVP] with a variable quantity of the transferred to the program internal variables, that calculates the multicomponent output variable.

Text of the program:

```
C OUTPUT MAXI:SYS=0, VPS=1, OUT=2, PAR=1
C
C the date of the creation:                07/21/92 11:47 am
C the date of the last correction: 05/31/93 12:09 pm
C HELP the calculation of maximum value from N of the internal variables
C HELP THE NAME:       Program of the calculation of the maximum value
C HELP from N of internal variables.
C
C HELP THE TYPE OF THE TRANSFERRED TO THE PROGRAM INTERNAL VARIABLES:
C HELP 1… N - displacement, force, the component of the working vector
C HELP or the component of the state vector of the model of element;
C
C HELP THE CONSTANT PARAMETERS:
C HELP 1- scale.
C
C HELP THE OUTPUT VARIABLES:
C HELP 1- current maximum value of those transmitted
C HELP of internal variables, multiplied by the scale;
C HELP is 2nd the ordinal number of internal variable, that flows
C HELP value of which is maximal.
C
        SUBROUTINE MAXI (XOUT, XSYS, NVAR, PAR)
C
         INTEGER * OF 4 NVAR
         REAL * OF 8 XOUT (1), PAR
         REAL * OF 8 XSYS (1)
C
         INTEGER * OF 4 I
C
         XOUT (1) = OF XSYS (1)
         XOUT (2) = 1
         DO OF 10 I = 2, NVAR
                IF (XSYS (I) .GT. XOUT (1))
     , THEN
```

```
                    XOUT (1) = OF XSYS (THE I)
                    XOUT (2) = OF THE I
                END IF
10 CONTINUE
         XOUT (1) = OF PAR * OF XOUT (1)
         RETURN
         END
```