Postprocessing of modal calculations with shock

Summary:

This document presents the principle of postprocessing of transitory calculations by modal recombination with non-linearities of shock available in the operator POST_DYNA_MODA_T.

Two options of postprocessing can be employed, the first usable one for problems of vibration-wear determines median values and RMS of displacements, forces of shock and power of wear dissipated on the level of the supports with games, second is applicable for the fine analysis of the impacts occurring at the time of transitory requests, the instantaneous maximum force, the duration of times of shock, the impulse exchanged, speed before impact are given for each shock.

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1 Introduction

Digital developments were carried out in *Code_Aster* to allow the transitory calculation of structures presenting of the vibrations with shock in certain points. In certain cases, forces of friction can also appear and lead to a phenomenon of localised wear.

That it is about damage by pure impact or impact-friction, the engineer wishes to reach the sizes associated with this damage, which requires a specific postprocessing behind non-linear transitory calculation.

This information of postprocessing is also invaluable when one wishes to validate the non-linear module of calculation by comparing his results with what can be measured on a specific test bench. Test routines (SOLID MASS and MULTICHOC) were implemented to this end and were the first users of these features of postprocessing.

The objective of this note consists in specifying the sizes to be analyzed in the vibrations with shock and their specificity. It is then a question of determining the suitable statistical treatments to apply to these signals to release from the instantaneous sizes or the most characteristic averages.

Initially one will in the case of see the treatment applied a problem with shock and friction (option 'WEAR'order POST_DYNA_MODA_T).

The following chapter will be devoted to the treatments applied in the case of a phenomenon of pure vibration-impact, where the sizes of each impact are more finely analyzed (option 'IMPACT'order POST_DYNA_MODA_T).

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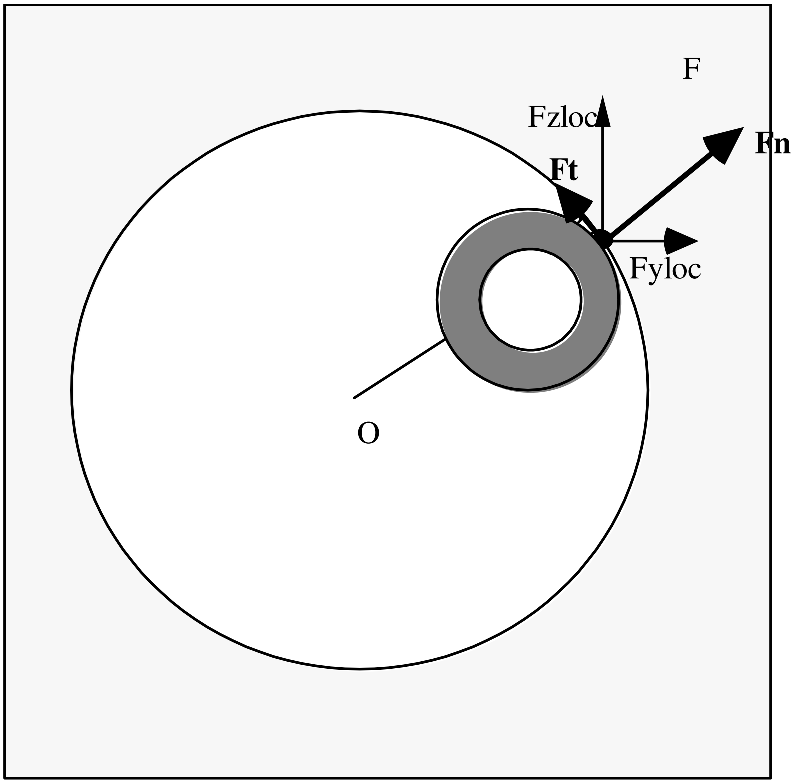
2 Sizes considered in the vibrations with shocks

The primary sizes considered in the vibrations with shock are identical that it is experimental measurements or digital calculation, they relate to the forces of shock and displacements on the level of the points of shock. The experimental results however present an additional difficulty of analysis due to the errors or skews introduced by the systems of measurement.

We will examine the two sizes quoted successively previously.

2.1 Forces of shock

The first concern concerning the structures vibrating with shocks is better to know the efforts received by the structure at the time of the shocks on its supports with games or between the structures. These data are calculated in a temporal way by the algorithm of `DYNA_TRAN_MODAL`, they are then filed with a step defined in this same operator. The data of shock having very important frequential contents one will take care to have a sufficient filing (not to exceed `PAS_ARCH` : 10). These forces expressed in a local reference mark with the obstacle $(Yloc, Zloc)$ are traditionally broken up into a normal part with the obstacle (Fn on the figure below) and a tangential part (Ft) so friction is taken into account between the structures. The conditions of shock make that the normal force of shock has a constant sign taken conventionally positive in *Code_Aster*.



2.2 Displacements of shock

Displacements of the structure on the level of its supports with game are another calculated important information. Its analysis poses however less problems because the spectral contents are less rich. In the case of circular or described obstacles in a polar way, a polar description of displacement can be interesting.

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2.3 Secondary sizes

2.3.1 Time of shock

The time of contact between the structure and the supports with games is an indirect size characteristic of the movement of vibration with shock. It can be deduced from various ways, on a criterion of displacement, force of positive reaction. A concept of time of total shock, broken up into elementary shock (or rebound) will be introduced in [§3.4].

2.3.2 Calculated sizes

Other secondary sizes can be important in the analysis of the conditions of shock, it acts of **the impulse** at the time of the impact (integral of the exchanged force), **power of wear**, **force maximum** at the time of an impact,… These sizes are specific to each postprocessing and they will be specified in the two chapters which follow for postprocessing option `'WEAR'` and `'IMPACT'`.

3 Modal transitory postprocessing – option `'WEAR'`

The characterization of transitional measures is the goal of the treatment of the signal. He teaches us that a signal is entirely determined by the data of all its statistical moments. In practice it is out of the question to calculate every statistical moment, one is limited in postprocessing to the sizes calculated classically in treatment of the signal (simple average, standard deviation and value RMS). They are characteristic of the signals which one wishes to analyze and compare. Similar signals must necessarily have these first close statistical moments (the reciprocal one being false). The statistical sizes selected here are well appropriate to the analysis, the comparison or classification of signals of vibrations under random excitation with non-linearities of shock.

We will thus examine the realised sizes and their calculation, by distinguishing the various sizes quoted in the preceding chapter:

- displacements,
- forces of shock,
- determination of the contact and the time of contact.

Other made up information could be calculated starting from the preceding ones in particular the power of wear.

3.1 Statistical processing per blocks

In order to analyze the stationnarity of the signals and the statistical treatments carried out on the signals, one carries out a cutting per blocks of the temporal signals. Thus duration of postprocessing defined between the initial moment (`INST_INIT`) and the final moment (`INST_FIN`) is cut out in a number of temporal blocks (`NB_BLOC`) from identical duration. The calculation of the statistics: average, standard deviation,… are carried out for each block, a general value for the signal for the whole of the blocks is also calculated.

In the case of a calculation of response of a structure to a random loading, this technique of calculation per blocks makes it possible to make sure that the transitional stage of calculation is finished and that the announced value is quite stationary over a time of observation associated with the duration with calculation.

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3.2 Statistical treatments applied to displacements of shock

Let us consider the temporal signal $Depl\_x(t)$, of which one carries out a filing at a certain frequency F_{acquis} on N points. The starting data is thus a vector $Depl\_x(i)$ with N components.

average displacement is defined in this case by:

$$\overline{Depl\_x}=\frac{\sum_{1}^{N} Depl\_x(i)}{N}$$

This median value characterizes the central value around which the signal of displacement evolves. For displacements, it will thus make it possible to determine if one observes a centered configuration (displacements with average worthless), or offset (average nonworthless).

variance of displacement is by definition:

$$var(Depl\_x)=\frac{\sum_{1}^{N}(Depl\_x(i)-\overline{Depl\_x})^2}{N}$$

L'**standard deviation of displacement** is worth then:

$$\sigma(Depl\_x)=\sqrt{var(Depl\_x)}$$

The standard deviation of a signal characterizes its dispersion around its median value. A weak standard deviation will rather relate to a signal with weak variations of amplitude, a strong standard deviation of the stronger variations.

For a centered variable i.e. with worthless average, the standard deviation is equal to average RMS of the signal (Root Mean Public garden).

For an unspecified variable one defines **average RMS** signal by:

$$RMS(Depl\_x)=\sqrt{\frac{\sum_{1}^{N} Depl\_x(i)^2}{N}}$$

minimum and absolutes maximum signal are also information interesting and very simple to obtain, which determines the extent of the signal.

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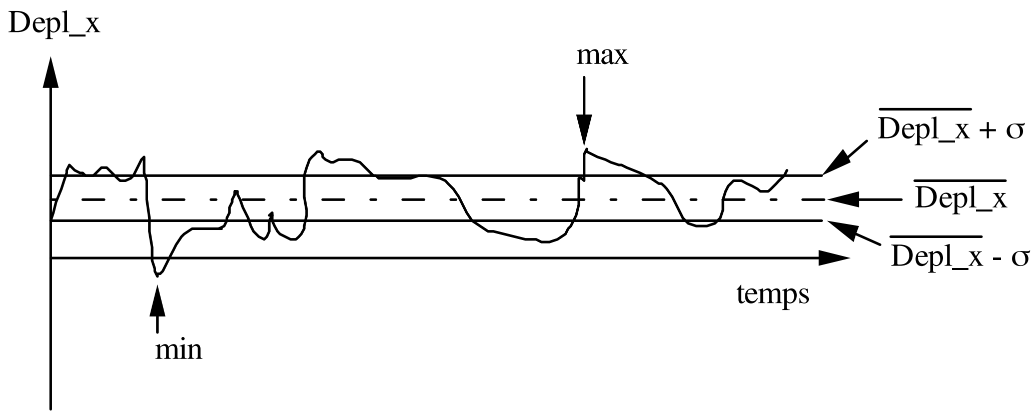

Figure 3.2-a: Example of signal of displacement and visualization statistical sizes

A polar representation of the whole of the signals $Depl\_x$ and $Depl\_y$ is also interesting to analyze an obstacle of circular or close geometry in the case of. Let us be appropriate to call R radial displacement and θ angular displacement, equivalents of $Depl\_x$ and $Depl\_y$ into polar.

By definition one a:

$$R(i)=\sqrt{Depl\_x(i)^2+Depl\_y(i)^2}$$
$$\theta(i)=Arctg\left(\frac{Depl\_y(i)}{Depl\_x(i)}\right)$$

This representation makes it possible inter alia things to distinguish:

- orbital movements with permanent contact (average radial displacement about the game and standard deviation of weak radial displacement),
- movements of pure impact (standard deviation of important radial displacement, variation of weak angular displacement),
- other configurations: orbital movement with impacts…

Note:

In the selected local reference mark for the obstacles of shock, the sizes called here $Depl\_x$ and $Depl\_y$ are in fact $DYloc$ and $DZloc$, the axis $Xloc$ having been chosen by convention perpendicular to the plan of the obstacle.

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In short, the option of postprocessing **'WEAR'** of the operator `POST_DYNA_MODA_T` will determine for local displacements $DYloc, DYloc, DZloc$ like for their polar decomposition R and θ statistical sizes per blocks with the principle stated above:

- median value,
- value RMS,
- standard deviation,
- minimal value,
- maximum value.

3.3 Statistics for the forces of shock

One supposes to lay out as for displacements of a discrete signal on N points: $Fx\_choc(i)$. The signal obtained should be made up of temporal beaches where the force of shock is worthless (not contact) and others where the force of shock is significant (effective contact), which is the case during calculations digital. In fact, for experimental signals, because of the dynamics of the system of measurement, a noise level can be observed except period of shock (cf [Figure 3.3-a]). It is thus necessary only to carry out the statistical processing when the signal leaves the sound level. That requires the introduction of a threshold of detection (**SEUIL_FORCE**) who, although superfluous in the digital field, was reproduced in the postprocessing of *Code_Aster*.

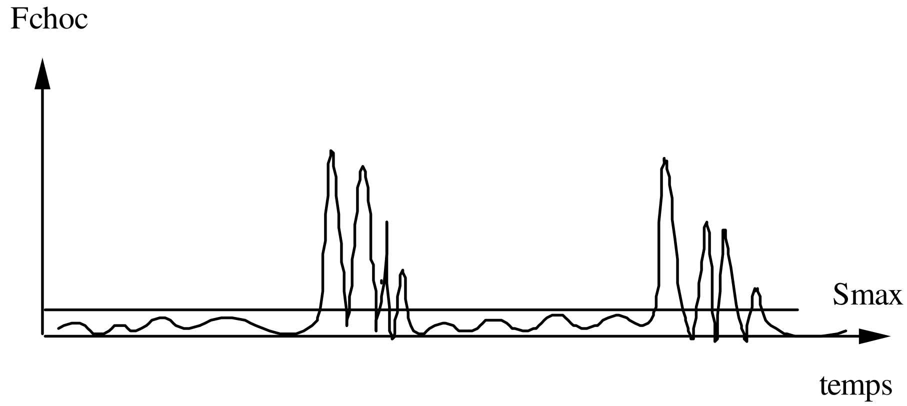

Figure 3.3-a: Example of signal of force of experimental shock

That is to say the value $S\,max$, determining the maximum level of the noise considered, one then will calculate:

- **many moments in shock** :

$$Nchoc = card\{i/|Fx\_choc(i)|>S\,max\}$$

- **average of force of shock** on **total time** :

$$\overline{Fx\_choc} = \frac{1}{N}\cdot\left(\sum_{i/|Fx\_choc(i)|>S\,max}^{N} |Fx\_choc(i)|\right)$$

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- **average of force of shock** brought back to **time of shock** is worth:

$$Fx\_choc = \overline{Fx\_choc} \cdot \frac{N}{Nchoc}$$

- **average RMS of force of shock** on **total time** is calculated in the following way:

$$RMS(Fx\_choc) = \left(\frac{1}{N} \sum_{i / |Fx\_choc(i)| > S\,max}^{N} Fx\_choc(i)^2 \right)^{1/2}$$

- **average RMS** brought back to **time of shock** is worth:

$$RMS(Fx\_choc) = RMS(Fx\_choc) \cdot \frac{N}{Nchoc}$$

As for the signals of displacements, one can also be interested in **maximum or absolute minimum** signal of force, thus determining its extent. For the normal force, the minimum is always equal to zero, whereas the tangential force is alternate.

In short, the option of postprocessing `'WEAR'` of the operator `POST_DYNA_MODA_T` will determine for the normal and tangential forces of shock the statistical sizes per blocks with the principle stated above:

- median value calculated over the time of shock or total time,
- value RMS calculated over the time of shock or total time,
- maximum value of the signal.

3.4 Statistics for times of shock

percentage of time of shock is defined by:

$$\%Tchoc = Nchoc / N$$

If one looks at information which one has on an experimental system, the signal of force of shock is adapted the most to determine in a precise way the occurrence of a contact. As one evoked with the top one tests the need to introduce a maximum noise level, and to count the phases of shock when the signal exceeds this threshold (`SEUIL_FORCE`).

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On the figure below, one can distinguish a concept of **elementary shock** determined like a successive passage to the top then with the lower part of the threshold, and a more general concept of **total shock**, gathering several elementary shocks separated by short moments from return under the threshold.

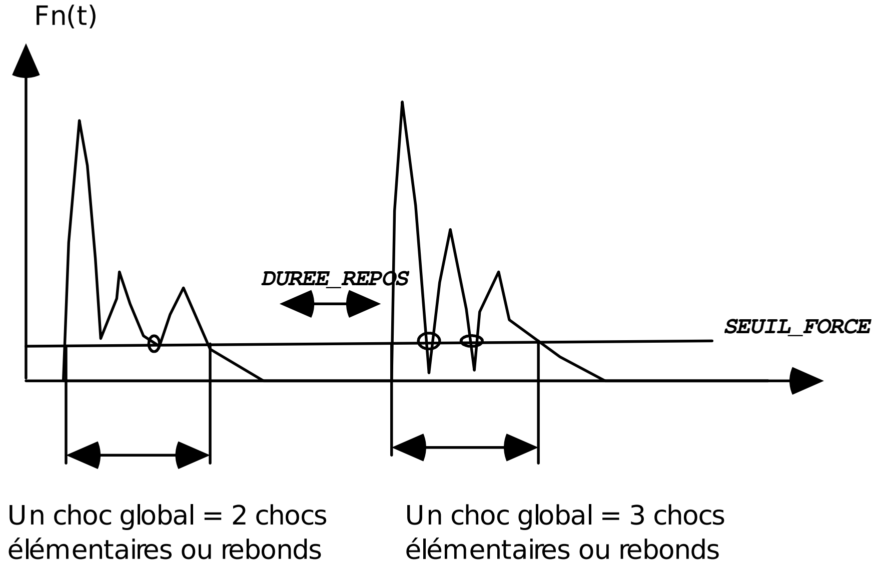

Figure 3.4-a

One thus introduces a time characteristic of rest Tr (**DUREE_REPOS**) ; end of an occurring time of total shock if the signal remains during a time at least higher than Tr at rest. This concept of time characteristic of rest Tr is well heard enough rooks and will have to be given by the user within sight of the transitory results. It is nevertheless essential because it only makes it possible to gather a train of constituting very brought closer impact makes only one phase of contact of it.

The concept of elementary time of shock being defined, the statistical processing over the time of shock will consist in determining following information:

- **many elementary shocks** : Nb_choc_elem
- **many total shocks** : Nb_choc_glob
- **many elementary shocks per total shock** : $\dfrac{Nb\_choc\_elem}{Nb\_choc\_glob}$
- **time of average elementary shock** :

$$\bar{T}_{choc\_elem}=\frac{Nchoc\cdot\Delta t}{Nb\_choc\_elem}$$

- **time of average total shock**

$$\bar{T}_{choc\_glob}=\frac{Nchoc\cdot\Delta t}{Nb\_choc\_glob}$$

- **time of maximum total shock** the greatest time of total shock noted on the analyzed block.

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In short, the option of postprocessing **'WEAR'** of the operator POST_DYNA_MODA_T will determine for times of shock the statistical sizes per blocks with the principle stated above:

- median value of the time of total shock, '
- maximum value of the time of total shock,
- median value of the elementary time of shock,
- the number of total shocks a second,
- the average number of shocks elementary per total shock.

3.5 Power of wear

The size generally calculated in the vibrations with shock and friction is the power of wear defined by ARCHARD [bib1], which translates the average power developed by the forces of friction at the time of the movement. These forces are the engine of wear by friction. The power of wear in the case of discrete signals is calculated as follows:

$$\overline{P_{usure}} = \frac{\sum_{i/|Fn|>S\,max}^{N} |Fn(i)\cdot Vt(i)|}{N}$$

This power can for example be correlated with a wear or removal of matter via a coefficient of wear K_T by a relation of the type: $V(T)=K_T * P_{usure} * T$ where $V(T)$ is the volume removed for the length of time T.

Other more sophisticated laws of wear can be used in another operator of post - treatment: POST_USURE described in [R7.01.10].

3.6 Structure of data counts POST_DYNA associated with the option 'WEAR'

A structure of the type counts for the option **WEAR** of the operator POST_DYNA_MODA_T gather the results previously described.

This table contains the names of the statistical under-tables of results associated with the various analyzed sizes: displacements, forces of shock, counting of the shocks and power of wear.

The variables of access of this table are 10:

- **for the variables displacement** : DEPL_X, DEPL_Y, DEPL_Z, DEPL_RADIAL, DEPL_ANGULAIRE, which corresponds respectively to displacements in X, Y and Z local and their cylindrical decomposition in the plan of the obstacle.
- **for the variable forces of shock** : FORCE_NORMALE, FORCE_TANG_1, FORCE_TANG_2, which corresponds respectively to the normal forces, tangential with the obstacle the first being in the plan of the obstacle, the second orthogonal one with the plan of the obstacle.
- **for the variables counting of shock** : STAT_CHOC.
- **for the variables power of wear** : PUIS_USURE.

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Under tables associated with the 10 sizes above, a certain number of variables of access for each connection of shock contain:

- **for the variables displacement** : MEANS, ECART_TYPE, RMS, MAXIMUM, MINIS, which corresponds respectively to the values average, standard deviations, value RMS or effective, maximum and minimal value of variable displacement corresponding.
- **for the variable forces of shock** : MOYEN_T_TOTAL, MOYEN_T_CHOC, RMS_T_TOTAL, RMS_T_CHOC, MAXIMUM, which corresponds respectively to the values average over time total, average over the time of shock, average value RMS or effective on time total, value RMS or effective over the time of shock, maximum value of the variable forces corresponding.
- **for the variables of counting of the shocks** : NB_CHOC_S, NB_REBON_CHOC, T_CHOC_MOYEN, T_CHOC_MAXI, T_CHOC_MINI, T_REBON_MOYEN, %_T_CHOC, which corresponds respectively to the values amongst shocks a second, amongst rebounds by shock, of the time of average shock, time of maximum shock, time of minimal shock, time of average rebound and percentage of time of shock.
- **for the variable power of wear** : PUIS_USURE who corresponds to the power of wear calculated according to ARCHARD.

4 Modal transitory postprocessing – option 'IMPACT'

4.1 Common practice of postprocessing of calculations of heart

The SEPTEN used, before development of postprocessing in *Code_Aster*, for its needs for checking of dimensioning, the code CLASH [bib2] developed by the BELGONUCLEAIRE. This software calculates the seismic answer of a file of assemblies. This code provides a set of detailed information for each point of shock and each impact.

Each result consists of a table by point of shock whose example is in Annexe 1. This table comprises following information:

- the moment of the peak of impact,
- the maximum force of impact reached,
- the exchanged impulse, defined as the integral of the force of shock over time,
- total duration of the shock,
- relative speed before impact.

These elements are particularly interesting for the SEPTEN because in addition to very limited contractual information, they make it possible to know the number and the composition of the impacts, as of the essential physical sizes which theirs are associated. Relative speed before impact, the impulse are for example very invaluable information in the specification of experimental tests of dynamic buckling of the grids of assemblies.

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4.2 Calculations for the postprocessing of the impacts

One regards as for preceding postprocessing that the conditions of impact are given like previously by going beyond a force threshold $Smax$ and one in the same way distinguishes total shock and elementary shock by the concept of rest period.

Calculation carries out a loop on all non-linearities of shock and an identical treatment for each one.

Then for each identified total shock, one will determine the following sizes:

- Time of beginning of shock: $T_{début}$ tel que $F_{choc}(T_{début}) > S_{max}$
- Time of end of total shock:

$$T_{fin} \text{ tel que } F_{choc}(T_{fin}) \le S_{max}, F_{choc}(T_{fin} - \Delta t) \ge S_{max}$$
$$\text{et } \forall t \in [T_{fin}, T_{fin} + T_{repos}] F_{choc}(t) \le S_{max}$$
$$\text{où } \Delta t \text{ est le pas de temps d'intégration}$$

- Total duration of the shock: $T_{choc} = T_{fin} - T_{début}$
- Maximum of force at the time of the shock: $F_{max} = max_{T \in [T_{début}, T_{fin}]}(F_{choc}(t))$
- The moment of maximum of force of shock,
- The impulse exchanged at the time of the shock: $I = \int_{t=T_{début}}^{T_{fin}} F_{choc}(t) \cdot dt$
- Relative normal speed before impact: $V_{choc} = V(T_{début} - \Delta t)$
- The number of elementary impacts cumulated in the total shock:

$$N_{impacts\, élémentaires} = card\left\{ t \in [t_{début}, T_{fin}] / F_{choc}(t) > S_{max} \text{ et } F_{choc}(t + \delta t) \le S_{max} \right\}$$

In order to synthesize information, one will moreover determine:

- the absolute maximum of force of shock, on a connection of shock given, for the duration of analysis,

  The maximum of force of shock to be more precisely given will not be obtained like the max in time on the whole of the shocks for each node of shock (to avoid the skew of the precision of filing) but given in transitory calculation on all the steps of calculation and will be filed in the concept result **`tran_gene`**. It is this information which will be used.

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- the median value of the extréma of force of shock like their standard deviation.
- a histogram of the density of probability of the maximum forces of impacts.

  This histogram will be relatively summary and will give for N_C classes density of probability of the maximum force of shock.

  The classes will be in the following way defined:

$$classe_{i=1..N_C}=\left\{F_{max}/\frac{i-1}{N_C}F_{max}^{absolu}\leq F_{max}\leq\frac{i}{N_C}F_{max}^{absolu}\right\}$$

4.3 Structure of data counts **POST_IMPACT** associated with the option '**IMPACT**'

4.3.1 Table **POST_IMPACT**

A structure of data of the type counts for the option **IMPACT** of the operator POST_DYNA_MODA_T of *Code_Aster* is produced.

The structure of result will be a subscripted table by the names of connections of shock, of type **POST_IMPACT,** containing names of tables which it contains.

The contents of each cell of this table are a name of table stored in CHARACTER*24. Three types of table are contained: a table known as IMPACT, a table known as TOTAL and a table known as PROBA.

It thus has 3 parameters: **IMPACT**, **TOTAL** and **PROBA**. The variable of access corresponds in the name of the connection of shock considered.

4.3.2 Table **IMPACT**

The table IMPACT is of type **TABL_IMPACT** and has 6 parameters of access: **INST**, **F_MAX**, **T_CHOC**, **IMPULS**, **V_IMPACT**, **NB_IMPACT**.
The contents of each cell of this table are one **REAL*8**.

4.3.3 Table **TOTAL**

The table TOTAL is of type **TABL_FMAX** and has 3 parameters of access:

- **F_MAX_ABS**, which gives access the absolute maximum of force of shock on all the noted shocks,
- **F_MAX_MOY**, which gives access the median value of maximum of force of shock noted,
- **F_MAX_ETYP**, which gives access the standard deviation of the extrema of forces of shock.

The contents of each cell of this table are one **REAL*8**.

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4.3.4 Table **PROBA**

The table PROBA is of type **TABL_HISTO** and has 3 parameters of access:

- **BEGINNING**, which gives access the value of minimal force of the class i,
- **END**, which makes it possible to reach the value of maximum force of the class i,
- **PROBA**, which gives access the density of probability of the variable forces maximum for the class i.

The contents of each cell of this table are one REAL*8.

5 Conclusion

One presented in this document the methods of postprocessing applicable to the transients with shock calculated by modal synthesis on structures with game. According to the concerns, one can carry out a postprocessing directed towards a diagnosis of the wear undergone by the components at the time of the shocks, a set of statistical sizes important are then determined. If the concern rather relates to the impacts and their level, another option allows a detailed analysis of each impact.

These two features make it possible to synthesize the transitory results got by integration temporal, to classify by level of severity of the different digital simulations or to compare at ends of validation of the calculated and measured sizes.

6 Bibliography

1) ARCHARD J.F and HIRST W.: The wear of metals under unlubrificated conditions - Proc. Roy. Ploughshare (1956).

2) J.P. FABRY, A. DECAUWERS: Code CLASH - Study Seismic of a line of assemblies REFERENCE MARK.

7 Description of the versions of the document

Version Aster	**Author (S) Organization (S)**	**Description of the modifications**
3	*G.JACQUART*-EDF-R&D/AMV	Initial text

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Annexe 1 : Example of table obtained with the option `'IMPACT'`

```
#-------------------------------------------------------------------------------
#
#ASTER 10.03.00 CONCEPT dynachoc CALCULATE 3/11/2011 A 17:47: 02 OF TYPE
#TABLE_SDASTER

 ENTITLE      NODE       CALCULATION  SHOCK           MOMENT          F_MAX
 CLOAS_2G     N1150      IMPACT                 1      4.99500E-02      3.89961E+03
 CLOAS_2G     N1150      IMPACT                 2      5.50500E-02      3.59805E+03
 CLOAS_2G     N1150      IMPACT                 3      1.19750E-01      6.22654E+03
 CLOAS_2G     N1150      IMPACT                 4      1.20900E-01      2.72275E+03
 CLOAS_2G     N1150      IMPACT                 5      1.29750E-01      3.99908E+03
 CLOAS_2G     N1150      IMPACT                 6      1.30900E-01      1.29756E+03
 CLOAS_2G     N1150      IMPACT                 7      1.39500E-01      4.01287E+03
 CLOAS_2G     N1150      IMPACT                 8      2.33900E-01      3.40404E+03
 CLOAS_2G     N1150      IMPACT                 9      2.58100E-01      5.35569E+03
 CLOAS_2G     N1150      IMPACT                10      3.64750E-01      5.97765E+03
 CLOAS_2G     N1150      IMPACT                11      4.36300E-01      1.43427E+03


 ENTITLE      NODE       IMPULSE         T_CHOC         V_IMPACT        NB_IMPACT
 CLOAS_2G     N1150       1.10221E+00     4.50000E-04    -4.91957E-01            1
 CLOAS_2G     N1150       1.99430E+01     8.00000E-03    -9.78335E-02            1
 CLOAS_2G     N1150       1.86814E+00     5.00000E-04    -7.36592E-01            1
 CLOAS_2G     N1150       8.43181E+00     4.30000E-03    -9.18914E-02            1
 CLOAS_2G     N1150       1.35933E+00     5.50000E-04    -4.88723E-01            1
 CLOAS_2G     N1150       1.00883E+00     1.70000E-03    -4.32639E-02            1
 CLOAS_2G     N1150       3.22593E+00     2.60000E-03    -4.30045E-01            1
 CLOAS_2G     N1150       1.48165E+01     6.65000E-03    -4.09494E-01            1
 CLOAS_2G     N1150       2.26770E+01     7.75000E-03    -5.64720E-01            1
 CLOAS_2G     N1150       2.27097E+01     6.80000E-03    -5.53400E-01            1
 CLOAS_2G     N1150       4.80676E+00     7.80000E-03    -1.68167E-01            1


 ENTITLE      NODE       CALCULATION     F_MAX_ABS       F_MAX_MOY       F_MAX_ETYPE
 CLOAS_2G     N1150      TOTAL            6.22654E+03     3.81165E+03     1.54804E+03


 ENTITLE      NODE       CALCULAT CLASS     BEGINNING     END           PROBA
 CLOAS_2G     N1150      ION           1  1.29756E+03   1.79046E+03   1.81818E-01
 CLOAS_2G     N1150      PROBA         2  1.79046E+03   2.28336E+03   0.00000E+00
 CLOAS_2G     N1150      PROBA         3  2.28336E+03   2.77626E+03   9.09091E-02
 CLOAS_2G     N1150      PROBA         4  2.77626E+03   3.26915E+03   0.00000E+00
 CLOAS_2G     N1150      PROBA         5  3.26915E+03   3.76205E+03   1.81818E-01
 CLOAS_2G     N1150      PROBA         6  3.76205E+03   4.25495E+03   2.72727E-01
 CLOAS_2G     N1150      PROBA         7  4.25495E+03   4.74785E+03   0.00000E+00
 CLOAS_2G     N1150      PROBA         8  4.74785E+03   5.24074E+03   0.00000E+00
 CLOAS_2G     N1150      PROBA         9  5.24074E+03   5.73364E+03   9.09091E-02
 CLOAS_2G     N1150      PROBA        10  5.73364E+03   6.22654E+03   1.81818E-01
                         PROBA
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