Comparison of *FEAP* and *FEAPpv* Features

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Abstract

This document contains a short summary of the main differences between *FEAP* and *FEAPpv*.

1 Introduction

This short document describes some of the basic differences between the book program system *FEAPpv* and the full program *FEAP*. Supplementary information may be obtained by using the lists and tables in conjunction with the user manuals.

Generally, *FEAPpv* is not extended or modified on a regular basis. Corrections to errors found by users will be incorporated into the program. On the other hand, *FEAP* is continuously developed and extended on a regular basis.

New users are encouraged to try the free version, *FEAPpv*, to learn about the structure and general format of use. Once this is known, the migration to *FEAP* is straight forward since both programs share the same input format (which can consist of constants, variables, paramaters, and expressions as described in the user manuals). Charges to ship a CD-ROM containing the full source program and user manuals for *FEAP* may be obtained by sending e-mail to: feap-help@vulture.ce.berkeley.edu.

2 Mesh Input

FEAP and *FEAPpv* have the same basic input style; however, the number of input commands is different. Currently, *FEAP* has the following possible command set: [1]

```
'coor','elem','mate','boun','forc','temp','end ','prin',
'nopr','titl','bloc','pola','ebou','angl','sloa','cons',
'sphe','btem','icon','pars','nopa','trib','para','efor',
'eang','cbou','cfor','cang','foll','slav','rese','sblo',
'esse','rota','setn','setr','btra','fpro','cpro','regi',
'tran','damp','mass','stif','csur','ereg','reac','manu',
'body','glob','shif','disp','edis','cdis','debu','side',
'face','snod','blen','move','rigi','moda','flex','base',
'epro','mpro','loop','next','file','*nod','*ele',
'mes1','mes2','mes3','mes4','mes5','mes6','mes7','mes8',
'mes9','mes0'
```

FEAPpv contains only the command subset:

[1] See *FEAP* User Manual for details on commands.

```
'coor','elem','mate','boun','forc','disp','temp','angl',
'eang','ebou','edis','efor','epro','fpro','mpro','ereg',
'cang','cbou','cdis','cfor','cpro','csur','regi','rese',
'bloc','btem','pola','shif','blen','snod','side','tran',
'para','prin','nopr','pars','nopa','debu','glob','titl',
'manu','end',
'mes1','mes2','mes3','mes4','mes5'
```

In particular, *FEAPpv* does not have the ability to solve problems which contain rigid body parts in the finite deformation solution option. The `*nod` and `*ele` options are also not available in *FEAPpv*. Finally, only 5 user mesh functions are provided in *FEAPpv* whereas 10 exist in *FEAP*.

The loop feature in mesh input for *FEAP* permits generation of problems with sub-structure forms or repetative patterns. For example see the wheel problem in the *FEAP* User Manual.

3 Mesh Manipulation

The user manuipulation options available in each program are similar except for the following which are included in *FEAP* but not in *FEAPpv*:

- Master/Slave options in small deformation which permit, for example, rigid floor diaphrams or beams in in-plane or axial deformations.
- Multi-body dynamics with joint connections in large displacement analysis. This feature currently works only with the energy-momentum conserving elements and time integration methods.
- Profile optimization for use with variable-band linear equation solvers.
- Real and complex arithmetic solution options (N.B. No elements are included with complex moduli, etc.).
- Two and three-dimensional contact interaction capability.
- Partitioned solution option.
- Setting of order of ODE for each degree of freedom (e.g., in coupled transient thermo-mechanical solutions heat equation is a first order ODE and the mechanical part is a second order ODE or static.)

4 Solution Commands

Both programs use a command language to construct solution to problems. The commands also permit output of quantities and graphical display of results. Options for graphical output are compared in Section 5.

The current list of command options in *FEAP* are:

```
'stre','utan','tang','form','mass','reac','chec','erro',
'damp','augm','geom','dire','iter','expo','impo','ntan',
'base','jint','zzhu',
'tol ','dt  ','loop','next','prop','data','time','prin',
'nopr','beta','init','iden','newf','back','debu','line',
'nonl','auto','meth','if  ','else','endi','tran','step',
'disp','solv','mesh','plot','subs','writ','read','cont',
'rest','velo','acce','bfgs','arcl','save','paus','eige',
'expl','memo','acti','deac','zero','epri','moda','opti',
'eigv','rayl','cxso','broy',
'mac1','mac2','mac3','mac4','mac5','mac6','mac7','mac8',
'mac9','mac0',
'outm','renu','show','scre','comm','smoo','set ','assi',
'list','tplo','para','func','dync','part','mate','capt',
'manu'
```

whereas those contained in *FEAPpv* are the subset:

```
'stre','utan','tang','form','mass','reac','chec','damp',
'augm','geom','dire','iter',
'tol ','dt  ','loop','next','prop','data','time','prin',
'nopr','tran','init','iden','newf','back','debu',
'disp','solv','mesh','plot','subs','writ','read','rest',
'velo','acce','bfgs','arcl','save','eige','epri','eigv',
'show','tplo',
'mac1','mac2','mac3','mac4','mac5',
'manu'
```

Generally, the command subset in *FEAPpv* are sufficient to solve most academic problems; however, in a complex research environment the added features in *FEAP* do permit additional solution options. Noted previously in Section was the partitioned solution option available in *FEAP* but not

FEAPpv. In addition *FEAP* has the added linear equation solvers: (1) Out of core profile solver for symmetric and unsymmetric equations; (2) In-core complex arithmetic profile solver; (3) In-core sparse solver for symmetric equations; (4) User interfaces on-line for other solvers. For the profile solvers *FEAP* also has a minimizer to create more efficient solution to linear equations. Finally, a simple conjugate gradient solver with diagonal preconditioning is provided in *FEAP*. This has proved effective in solution of linear elastic (or viscoelastic) problems in three dimensions.

Both programs permiit users to save the time history for solution parameters such as displacement, velocity, acceleration, stress, and reactions. These can be converted to plots using readily available programs (e.g., Matlab).

Both programs also permit users to add their own solution options as external modules (requires recompilation of program).

5 Plots and Graphical Outputs

Both program permit display of graphical results for mesh, solution variables (e.g., displacement, stress, flux, etc.) on the terminal screen. In a Windows environment use of the Compaq Fortran compiler (or previous versions distributed by Digital Equipment and MicroSoft) for graphics to work. In a UNIX environment (including Linux) graphics is provided through X-windows. Generally, *FEAP* permits display for 1,2 or 3 dimensional meshes, whereas *FEAPpv* permits only 1 and 2 dimensional plots.

The list of commands currently available in *FEAP* are:

```
'fram','wipe','fact','cent','cart','line','symm','cont',
'outl','load','mesh','stre','node','boun','elem','zoom',
'colo','fill','text','size','cvar','eigv','bord','scal',
'axis','pers','disp','show','hide','prin','nopr','defo',
'unde','velo','acce','post','reac','eige','mate','back',
'clip','titl','mark','refr','pick','capt','pbou','pfor',
'pnod','quad','real','imag','eyes','dofs','estr','prof',
'prax','pair','clea','pstr','dplo','splo','manu','prom',
'defa','scre','pdis','pele','proj','labe','nola','snod',
'psno','exno','xypl','wind','logo','time','bplo','rang',
'nora','rect','cyli','sphe','full','nofu','uplo','jint',
'regi'
```

and those in *FEAPpv* are:

```
'fram','wipe','fact','cent','cart','line','mesh','outl',
'load','disp','stre','node','boun','elem','zoom','colo',
'fill','eigv','scal','axis','pers','hide','defo','unde',
'cont','velo','acce','post','reac','mate','dofs','estr',
'pstr','prom','defa','uplo'
```

In addition to screen display both programs permit the generation of encapsulated PostScript output files which may be included in reports of other documents or printed as hard copy output.

6 Element Library

Each program is delivered with a library of basic elements as indicated in Table 1. In the table the notation "D" implies a displacement formulation, "M" a mixed formulation (see Chapter 10, Vol 2, The Finite Element Method, 5th ed., by O.C. Zienkiwicz and R.L. Taylor published by Butterworth-Heinemann, London, 2000); and "E" enhanced formulation (see Chapter 11, Volume 1, 5th ed.). The notation "L" means linear deformations and "N" non-linear deformation. Each element is complemented by a material library.

Details for adding user developed elements are given in the *FEAP* Programmers Manual.

6.1 Material Library

The material library for each element is established by calling a material module for either small or finite deformation. The basic models available are indicated in Table 2. The notation "I" denotes an isotropic model, "O" an orthotropic model, "D" damage model, and "G" a generalized plasticity model. The "X" denotes ability to add any model through a user interface. Details for adding models are given in the *FEAP* Programmers Manual.

Element	*FEAP*			*FEAPpv*		
Dimension	1	2	3	1	2	3
Solid (D)		LN	LN		LN	L
Solid (M)		LN	LN		LN	
Solid (E)		LN	LN		L	
Truss	LN	LN	LN	LN	LN	LN
Frame		LN	LN		LN	L
Plate		L			L	
Shell		LN	LN		LN	L
Membrane		LN	LN			
Thermal		L	L		L	L
Convection		L	L		L	L
Gap	LN	LN	LN			
Point	L	L	L			
Pressure		LN	LN			

Table 1: Element Library List

Model	*FEAP*		*FEAPpv*	
Type	Linear	Nonlinear	Linear	Nonlinear
Elastic	IO	I	IO	X
Viscoelastic	I	ID	I	
Plastic	IG	I	I	
User	X	X	X	X

Table 2: Material Library List