Natural Frequencies and Modeshapes of 20 Storey Building Using MATLAB

Ch. Raviteja, V.Ramesh, Dr. B. Panduranga Rao

1,2,3Dept. of Civil Engineering, VR Siddhartha College of Engineering, Vijayawada, AP, India

Abstract

MATLAB is generally programming software as C, unlike C and other programming languages MATLAB is problem-solution kind of software which is much useful to evaluate results instantly. In the present topic use of software is done for calculating Natural Frequencies and Modeshapes of a 20 storey building with basic functions by using MATLAB. The results obtained from the MATLAB are accurate comparatively this results obtained shows that the MATLAB can be furthur used to write programs which involve complicated iterations and cannot be done manually. The further work can be extended for writing the programs of much more complex equations in MATLAB and obtains exact solution. This analysis indicate that the MATLAB can also be used in Civil applications and to obtain Exact solution with our knowledge kept in use.

Keywords

MATLAB, Natural Frequencies, Modeshapes

I. Introduction

Matlab (Matrix laboratory) is an interactive software system for numerical computations and graphics. As the name suggests, Matlab is especially designed for matrix computations: solving systems of linear equations, computing eigenvalues and eigenvectors, factoring matrices, and so forth. In addition, it has a variety of graphical capabilities, and can be extended through programs written in its own programming language. Many such programs come with the system; a number of these extend Matlab's capabilities to nonlinear problems, such as the solution of initial value problems for ordinary differential equations. Matlab is designed to solve problems numerically, that is, in finite-precision arithmetic. Therefore it produces approximate rather than exact solutions, and should not be confused with a Symbolic Computation System (SCS) such as Mathematica or Maple. It should be understood that this does not make MATLAB better or worse than an SCS; it is a tool designed for different tasks and is therefore not directly comparable.

A. Traditional Method

There are many methods used to obtain Modeshapes and Natural frequencies such as STAAD Pro, ETABS etc., and can be obtained manually by calculating using

\[ [k]-[w]^2 [m]=0 \]

Where \( k \) = Stiffness of floor
\( m \) = Mass on Each floor
\( w \) = Natural frequency
And Modeshapes \( \Phi^{(1)}, \Phi^{(2)} \ldots \) can be obtained for Each Natural frequencies obtained

B. Current Method

This similar manual method is used in this process by using MATLAB just like C program a certain computer program is written to obtain the Natural frequencies and Modeshapes by using certain number of functions in MATLAB.

Advantages of MATLAB

MATLAB combine nicely calculation and graphic plotting MATLAB is optimized to be relatively fast when performing matrix operations MATLAB is interpreted (not compiled), errors are easy to fix

II. Methodology

An Example of multi-storeyed building (20 storey) is considered

This problem with a constant stiffness of \(-1.894\times106N/m\) and mass on all floors is 524.3 kg and Mass on roof is 400 kg.

Program

```matlab
% NATURAL FREQUENCIES AND MODE SHAPES FOR A 20 STOREY BUILDING
k = input('Enter the stiffness matrix 20*20')
m = input('Enter the mass matrix 20*20')
W = Naturalfreq(k,m) %Function 1
X = zeros(20,20);
for i = 1:20
    Y = Modeshape1(W(21-i),k,m); %Function 2
    X(:,i) = Y;
end
plot(X)
```

Function 1

```matlab
function [W] = Naturalfreq(k,m)
syms omega
a = k-(omega*m);
b = det(a);
c = sym2poly(b);
d = roots(c);
W = sqrt(d);
end
```

Function 2

```matlab
function [X] = Modeshape1(W,k,m)
omega = W^2;
a = k - (omega*m);
x1 = 1;
x2 = -a(1,1)/a(1,2);
x3 = -(a(2,1))/a(2,2)*x2/a(2,3);
x4 = -(a(3,2))/a(3,3)*x2+a(3,3)*x3/a(3,4);
x5 = -(a(4,3))/a(4,4)*x3+a(4,4)*x4/a(4,5);
x6 = -(a(5,4))/a(5,5)*x4+a(5,5)*x5/a(5,6);
x7 = -(a(6,5))/a(6,6)*x5+a(6,6)*x6/a(6,7);
x8 = -(a(7,6))/a(7,7)*x6+a(7,7)*x7/a(7,8);
x9 = -(a(8,7))/a(8,8)*x7+a(8,8)*x8/a(8,9);
x10 = -(a(9,8))/a(9,9)*x8+a(9,9)*x9/a(9,10);
x11 = -(a(10,9))/a(10,10)*x9+a(10,10)*x10/a(10,11);
x12 = -(a(11,10))/a(11,11)*x10+a(11,11)*x11/a(11,12);
x13 = -(a(12,11))/a(12,12)*x11+a(12,12)*x12/a(12,13);
x14 = -(a(13,12))/a(13,13)*x12+a(13,13)*x13/a(13,14);
x15 = -(a(14,13))/a(14,14)*x13+a(14,14)*x14/a(14,15);
x16 = -(a(15,14))/a(15,15)*x14+a(15,15)*x15/a(15,16);
x17 = -(a(16,15))/a(16,16)*x15+a(16,16)*x16/a(16,17);
end
```
x18 = -(a(17,16)*x16+a(17,17)*x17)/a(17,18);
x19 = -(a(18,17)*x17+a(18,18)*x18)/a(18,19);
x20 = -(a(19,18)*x18+a(19,19)*x19)/a(19,20);
X = [x1;x2;x3;x4;x5;x6;x7;x8;x9;x10;x11;x12;x13;x14;x15;
x16;x17;x18;x19;x20]
end

III. Results and Discussions

Sample Results

Table 1:

<table>
<thead>
<tr>
<th>Natural Frequencies (rad/sec)</th>
<th>Mode 1</th>
<th>Mode 10</th>
<th>Mode 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>119.8898</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>118.8954</td>
<td>1.994</td>
<td>0.2011</td>
<td>-1.9772</td>
</tr>
<tr>
<td>117.1715</td>
<td>2.976</td>
<td>-0.9596</td>
<td>2.9095</td>
</tr>
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<td>114.8534</td>
<td>3.9402</td>
<td>-0.3941</td>
<td>-3.7754</td>
</tr>
<tr>
<td>111.7930</td>
<td>4.8806</td>
<td>0.8803</td>
<td>-4.5555</td>
</tr>
<tr>
<td>108.1356</td>
<td>5.7918</td>
<td>0.5711</td>
<td>-5.2318</td>
</tr>
<tr>
<td>103.8052</td>
<td>6.6682</td>
<td>-0.7654</td>
<td>5.789</td>
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<tr>
<td>98.8724</td>
<td>7.5045</td>
<td>-0.7251</td>
<td>-6.2144</td>
</tr>
<tr>
<td>93.3411</td>
<td>8.2957</td>
<td>0.6196</td>
<td>6.4983</td>
</tr>
<tr>
<td>87.2493</td>
<td>9.0371</td>
<td>0.8497</td>
<td>-6.6343</td>
</tr>
<tr>
<td>80.6294</td>
<td>9.7243</td>
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<td>6.6193</td>
</tr>
<tr>
<td>73.5206</td>
<td>10.353</td>
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<td>-6.4536</td>
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<tr>
<td>65.9648</td>
<td>10.9196</td>
<td>0.2597</td>
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<tr>
<td>49.6960</td>
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<td>5.1065</td>
</tr>
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<td>41.0813</td>
<td>12.2141</td>
<td>-1.0043</td>
<td>-4.4082</td>
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<tr>
<td>32.2156</td>
<td>12.5019</td>
<td>-0.1418</td>
<td>3.6096</td>
</tr>
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<td>23.1530</td>
<td>12.7146</td>
<td>0.9757</td>
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</tr>
<tr>
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<td>0.3381</td>
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</tr>
<tr>
<td>4.6591</td>
<td>12.9101</td>
<td>-0.9077</td>
<td>-0.8024</td>
</tr>
</tbody>
</table>

Fig. 1: Modeshape 1

Fig. 2: Modeshape 10

Fig. 3: Modeshape 20

As per reviewing the current results the Natural frequencies and modeshapes obtained are accurate this states that MATLAB program can be used for complex civil problem solving.

IV. Conclusion

By observing this program we can state that MATLAB can be used as civil software to evaluate much harder problems by considering the empirical formulas to obtain results, and as observed in the above the MATLAB is slower than a compiled language and the commands used in MATLAB are not suitable for any other programming languages.

V. Acknowledgement

I express my deep gratitude to Mr. V. NAGA PRUDHVI RAJ Associate professor, Department of Electrical and Instrumentation Engineering, Velagapudi Ramakrishna Siddhartha Engineering College, for his suggestions and valuable help regarding MATLAB in giving shape and coherence to this endeavour.

References