TITLE OF THESIS WORK IN 16PT 1.5 LINE SPACING CENTERED

Ph.D. THESIS

by

STUDENT'NAME

DEPARTMENT OF <DEPARTMENT'S NAME> ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE–247667 (INDIA)
MONTH, YEAR

TITLE OF THESIS WORK IN 16PT IN 1.5 SPACING CENTERED

A THESIS

Submitted in partial fulfilment of the requirement for the award of the degree

of

DOCTOR OF PHILOSOPHY

in

DEPARTMENT

by

NAME OF STUDENT

DEPARTMENT OF <DEPARTMENT'S NAME> ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE–247667 (INDIA)
MONTH, YEAR

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE

STUDENT'S DECLARATION

I hereby certify that the work presented in the thesis entitled "**"Thesis title.....-.....**" is my own work carried out during a period from <month>, <year> to <month>, <year> under the supervision of <supervisor's name>, <designation>, <name of Department>, Indian Institute of Technology Roorkee, Roorkee.

The matter presented in this thesis has not been submitted for the award of any other degree of this or any other Institute.

Date: **(Student's name)**

SUPERVISOR'S DECLARATION

This is to certify that the above mentioned work is carried out under my supervision.

Date: **(supervisor's name)**

Acknowledgment

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(student's name)

Abstract

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

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Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

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eget erat in sapien mattis porttitor. Vestibulum porttitor. Nulla facilisi. Sed a turpis eu lacus commodo facilisis. Morbi fringilla, wisi in dignissim interdum, justo lectus sagittis dui, et vehicula libero dui cursus dui. Mauris tempor ligula sed lacus. Duis cursus enim ut augue. Cras ac magna. Cras nulla. Nulla egestas. Curabitur a leo. Quisque egestas wisi eget nunc. Nam feugiat lacus vel est. Curabitur consectetuer.

write your Dedication here . . .

Table of Contents

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List of Symbols

η	Viscosity	16
ν	Poisson's ratio	16
E	Young's modulus	16
V_p	P-wave Velocity	16
V_s	S-wave Velocity	16

List of Abbreviation

USGS United States Geological Survey . . . . . xiii, 3

1 Introduction

1.1 File sytem

There is main thesis.tex file which is the master file that is to be compiled by the text editor. all the secondary files are called with in this file. there are mainly two folders where different chapters are created first is '/prelim/' which contains the abstract, Acknowledgement, copyright, Declaration, Dedication, which could be modify bt the user of this template accordingly.

Nest is '/mainpage/' folder which contains chapters of the thesis, where 2 chapter files are created for reference namely chp1, chp2, user can add more chapter files as per requirement and add them to the main 'thesis.tex' file accordingly similar to chp1 and chp2.

1.2 Chapters

to add chapters in the file add a tex file in the 'mainpage' folder with file name starting with 'chp' such as for chapter 1 the file name should be chp1.tex.

the format of chp file should be as follows

```
\cleardoublepage
\chapter{\textbf{chapter_name}}\label{label_of chapter}
content
```

the `\chapter` will create the chapter number in grey colour as shown in this chapter mark as 1. the `\textbf{}` make the content in bold which is placed inside the curly brackets. `\label{}`

command create a label for the heading which can be called in any chapter or section for reference using `\ref{label_of_heading}`.

1.3 Section

to add section in the chapter following code shall be use.

```
\section{section_name}\label{section_label}

content of the section.
```

1.3.1 subsection

To add subsection following code shall be used.

```
\subsection{subsection_name}\label{subsection_label}

content
```

1.3.1.1 subsubsection

To add subsubsection following code shall be used.

```
\subsubsection{subsubsection_name}\label {subsubsection_label}
content
```

1.4 Figures

To add the figures in the section, first the file should add in the `/image/` folder. for including the image file in the section, figure environment can be used to add single image, the code are shown below.

```
\begin{figure}[]
\centering
\includegraphics[width=1\linewidth]{image/WORLD.jpg}
\caption{figure caption}\label{Fig 1.1}
\end{figure}
```

the command `\begin{figure} ...\end{figure}` creates a figure environment. `\centering` command will align the figure in the center. command `\includegraphics[width=1\linewidth` `{image/image_file_name}` add the figure in the section. further, size of figure can be modify changing the value of width, you could change the value from 1 to desirable value depending upon your requirements. command `\caption{}` create the caption of the figure below the image. command `\label{}` create the label of figure which can be used to cite the figure in the text.

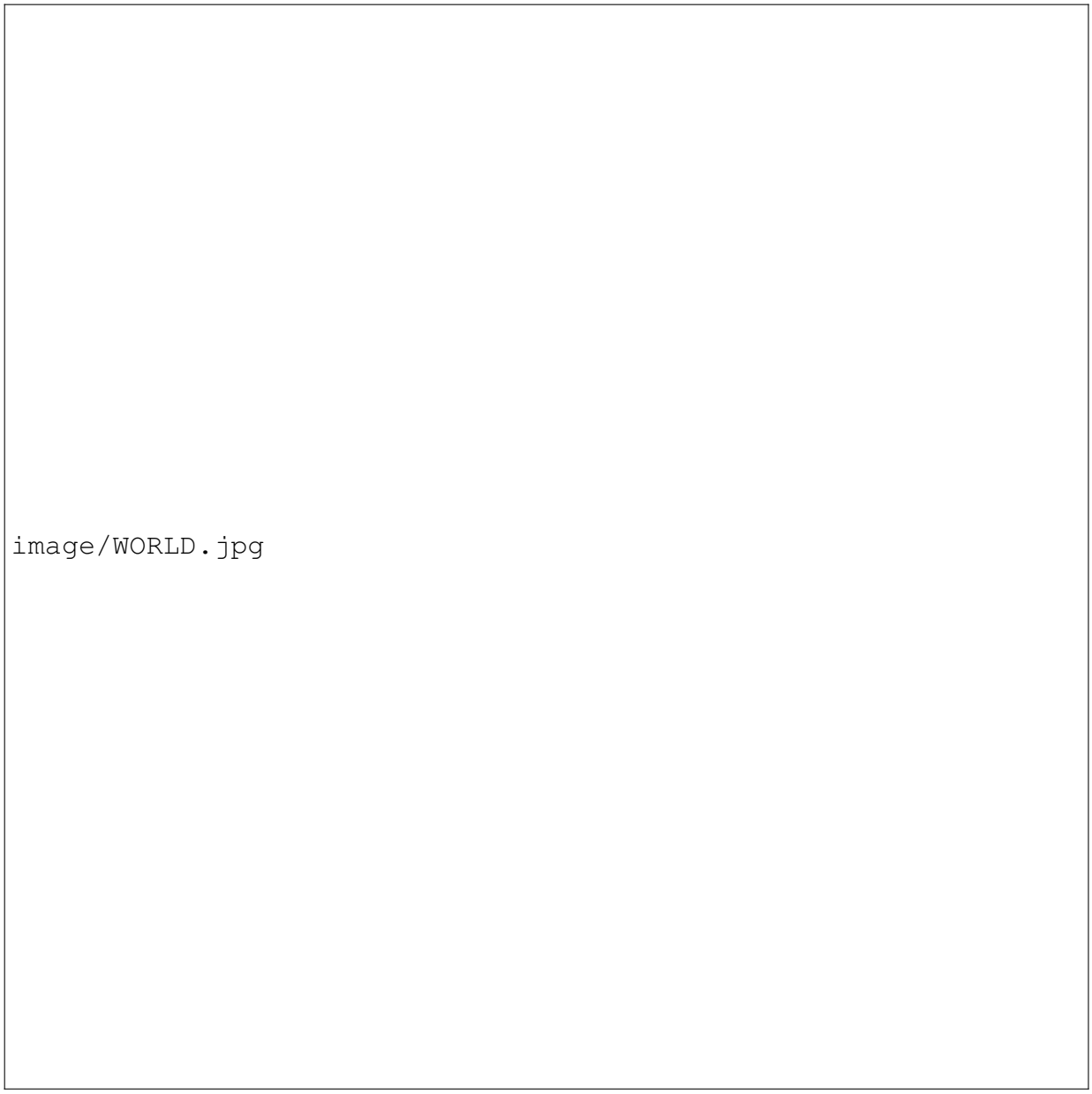

Figure 1.1: Great and Major earthquakes recorded worldwide (Earthquake data USGS and NDMA [2009]).

further if the requirement is to add multiple figure together with one common caption, the following command can be used.

```
 \begin{figure}[htb!]
\centering
```

Table 1.1: The elastic Properties used in the homogeneous model.

S. No.	H1	H2	H3	H4	H5	H6
1	11	xc	hj	hj	ij	jk
2	hg	jk	nm	jk	df	jk

```
    \begin{subfigure}[b]{0.4\textwidth}
        \includegraphics[width=\linewidth]{image/elastic_stress.png}
        \caption{}
        \label{Fig 3.5a}
    \end{subfigure}
\centering
    \begin{subfigure}[b]{0.4\textwidth}
        \includegraphics[width=\linewidth]{image/plastic_stress.png}
        \caption{}
        \label{Fig 3.5b}
    \end{subfigure}
    \begin{subfigure}[b]{0.4\textwidth}
        \includegraphics[width=\linewidth]{image/viscoelastic_stress.png}
        \caption{}
        \label{Fig 3.5c}
    \end{subfigure}
\caption{\centering Typical stress-strain relation of (a) elastic rheology (b)
\end{figure}
```

1.5 Tables

there could be to type two type of the table used in the thesis. (1) normal portrait table (small table width–wise) (2) landscape table (large table width–wise).

in portrait mode there are two type of tables. first is table 1.1 which could be add with following code.

```
\begin{table}[hbt!]
 \caption{\centering The elastic Properties used in the
  homogeneous model.}\label{Table 1.1}\\
 {\begin{tabular}{c l c c c c c}
\hline
\textbf{S. No.} & \textbf{H1} &
   \textbf{H2} & \multicolumn{1}{l}{\textbf{H3}} &
   \multicolumn{1}{l}{\textbf{H4}} & \multicolumn{1}{l}
   {\textbf{H5}} & \textbf{H6} \\
\hline
```

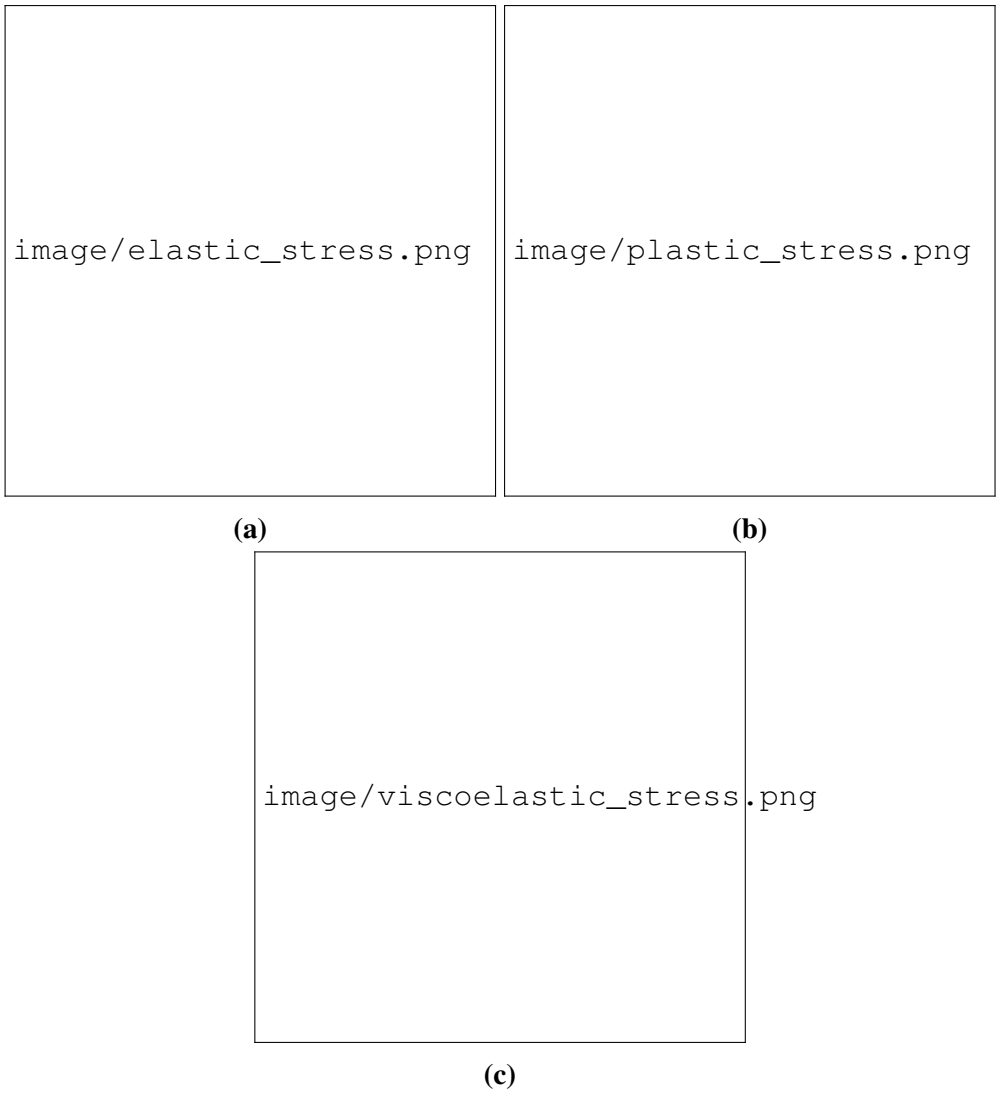

Figure 1.2: Typical stress-strain relation of (a) elastic rheology (b) linear elasto-plastic (c) linear viscoelastic.

```
1 & 11 & xc &  hj & hj & ij & jk \\
2&  hg & jk  &nm  &jk & df & jk \\
\hline
\end{tabular}}
\end{table}
```

if table overflow from the page in this example add a code `\resizebox{\columnwidth}{!}` before `{\begin{tabular}{c l c c c c c}` in above table enviroment.

another example is shown in table 1.2, which could be generated using following code.

```
\begin{table}[hbt!]
\centering
\caption{\centering Comparison of the Velocity (mm/yr.) estimated
 using the FEM models and Indian plate fixed GPS velocity data.}\\
 \label{Table 5.4}
\footnotesize
\begin{tabular}{l c c c c c c c c c c c c}
```

Table 1.2: Comparison of the Velocity (mm/yr.) estimated using the FEM models and Indian plate fixed GPS velocity data.

H1	**H2**	**H3**	**H4**				**H5**				H6	
			h1	h2	h3	h4	h5	h6	h7	h8	h9	h10
DELH	28.48	77.13	-1.38	0.46	-2.15	2.82	-0.60	0.32	0.72	0.05	-0.92	0.67
IITK	26.51	80.23	0.27	0.53	2.64	3.13	-1.67	1.41	0.06	0.55	-0.26	-0.49
LUCK	26.89	80.94	2.43	1.71	-3.02	2.82	-1.56	2.28	-1.59	1.39	0.72	-0.20
BHUP	25.27	82.99	0.08	0.07	0.17	0.44	-1.43	1.58	0.91	0.29	0.15	0.61
KHAV	23.92	69.77	1.18	2.57	2.46	3.54	-0.78	0.61	0.76	1.84	-1.39	-1.08
RADP	23.82	71.62	0.57	1.16	0.38	0.85	1.96	0.23	0.51	0.98	1.73	-0.47
BELP	23.87	70.8	0.19	1.82	0.66	1.55	0.39	2.02	0.50	1.39	-1.63	-0.89
MABU	24.65	72.78	-1.67	1.72	1.35	2.09	3.16	3.11	6.36	7.12	0.05	-0.75

Note: A note regarding table could be put here.

```
\hline
\multirow{2}{*}{\textbf{H1}} & \multirow{2}{*}{\textbf{H2}} &
   \multirow{2}{*}{\textbf{H3}} & \multicolumn{4}{l}{\textbf{H4}}
   & \multicolumn{4}{l}{\textbf{H5}}
   & \multicolumn{2}{l}{H6}\\ \cline{4-13}

   &   &   & h1& h2& h3& h4& h5& h6& h7& h8& h9& h10  \\ \hline
 DELH &  28.48 &  77.13 &  -1.38  &  0.46   &  -2.15 &  2.82 &  -0.60  & 0.32
 &  0.72  &  0.05 &  -0.92 &  0.67  \\
 IITK &  26.51 &  80.23 &  0.27 &  0.53   &  2.64  &  3.13 &  -1.67  & 1.41
 & 0.06 &  0.55 &  -0.26 &  -0.49 \\
 LUCK &  26.89 &  80.94 &  2.43   &  1.71   &  -3.02 &  2.82 &  -1.56 & 2.28
 &  -1.59 &  1.39 &  0.72  &  -0.20  \\
 BHUP &  25.27 &  82.99 &  0.08   &  0.07   &  0.17  &  0.44 &  -1.43  & 1.58
 &  0.91  &  0.29 &  0.15  &  0.61\\
 KHAV &  23.92 &  69.77 &  1.18   &  2.57   &  2.46  &  3.54 &  -0.78  & 0.61
 &  0.76  &  1.84 &  -1.39 &  -1.08 \\
 RADP &  23.82 &  71.62 &  0.57   &  1.16   &  0.38  &  0.85 &  1.96   & 0.23
 &  0.51  &  0.98 &  1.73  &  -0.47 \\
 BELP &  23.87 &  70.8  &  0.19   &  1.82   &  0.66  &  1.55 &  0.39   & 2.02
 &  0.50  &  1.39 &  -1.63 &  -0.89 \\
 MABU &  24.65 &  72.78 &  -1.67  &  1.72   &  1.35  &  2.09 &  3.16   & 3.11
 &  6.36  &  7.12 &  0.05  &  -0.75 \\

\hline
    \end{tabular}

    Note: A note regarding table could be put here.
\end{table}
```

another type of table could be large table width–wise can be created using `\begin{landscape} \begin{longtable} \captio` enviroment. which can be further used as follows for a table shown in the below.

Table 1.3: Example of Long landscape table.

S.No.	Author(s)	Analysis Method	3–D/2–D	Rheology	Inter/intra	Faults	Homogeneous	Geological
1.	2	-	-	-	-	-	-	-
2.	1	-	-	3	-	-	-	-
3.	-	-	-	-	-	-	-	-
4.	-	-	-	-	4	-	-	-
5.	-	-	-	-	-	-	-	-
6.	-	-	-	-	-	-	-	-
7.	-	-	-	-	-	-	-	-
8.	-	-	-	-	-	-	-	-
9.	-	-	-	-	-	-	-	-
10.	-	-	-	-	-	-	-	-
11.	-	-	-	-	-	-	-	-
12.	-	-	-	-	-	-	-	-
13.	-	-	-	-	-	-	-	-
14.	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-
16.	-	-	-	-	-	-	-	-
17.	-	-	-	-	-	-	-	-
18.	-	-	-	-	-	-	-	-
19.	-	-	-	-	-	-	-	-
21.	-	-	-	-	-	-	-	-
22.	-	-	-	-	-	-	-	-
23.	-	-	-	-	-	-	-	-
24.	-	-	-	-	-	-	-	-
25.	-	-	-	-	-	-	-	-
26.	-	-	-	-	-	-	-	-
27.	-	-	-	-	-	-	-	-

Continued...

Table 1.3–*Continued...*

S.No.	H1	H2	H3	H4	H5	H6	H7	H8
28.	-	-	-	-	-	-	-	-
29.	-	-	-	-	-	-	-	-
30.	-	-	-	-	-	-	-	-

Note: Could be here.

```
\begin{landscape}
  \centering

  \begin{longtable}{>\centering m{0.3cm} >\centering m{3cm}
   >\centering m{1.2cm} >\centering m{1.5cm} >\centering m{2.5cm}
   >\centering m{2.5cm} >\centering m{2.5cm} >\centering m{2.5cm} c }
  \caption{Comparison of the available numerical Study on
   tectonic plate modelling}
  \label{Table 2.1}
  \hline
  S.No. & H1 & H2 & H3 & H4 & H5 & H6 & H7 & H8 \\
  \hline
            \endhead
            \endlastfoot

   1.& 2&-&-&-&-&-&-&-\\
   2.& 1&-&-&3&-&-&-&-\\
   3.& -&-&-&-&-&-&-&-\\
   4.& -&-&-&-&4&-&-&-\\
   5.& -&-&-&-&-&-&-&-\\
   6.& -&-&-&-&-&-&-&-\\
   7.& -&-&-&-&-&-&-&-\\
   8.& -&-&-&-&-&-&-&-\\
   9.& -&-&-&-&-&-&-&-\\
   10.&-&-&-&-&-&-&-&-\\
   11.&-&-&-&-&-&-&-&-\\
   12.&-&-&-&-&-&-&-&-\\
   13.&-&-&-&-&-&-&-&-\\
   14.&-&-&-&-&-&-&-&-\\
   15& -&-&-&-&-&-&-&-\\
   16.&-&-&-&-&-&-&-&-\\
   17.&-&-&-&-&-&-&-&-\\
            18.&-&-&-&-&-&-&-&-\\
            19.&-&-&-&-&-&-&-&-\\
            21.&-&-&-&-&-&-&-&-\\
            22.&-&-&-&-&-&-&-&-\\
            23.&-&-&-&-&-&-&-&-\\
            24.&-&-&-&-&-&-&-&-\\
            25.&-&-&-&-&-&-&-&-\\
            26.&-&-&-&-&-&-&-&-\\
            27.&-&-&-&-&-&-&-&-\\
            28.&-&-&-&-&-&-&-&-\\
            29.&-&-&-&-&-&-&-&-\\
            30.&-&-&-&-&-&-&-&-\\
  \hline
  \end{longtable}
   Note: Could be here.
\end{landscape}
```

1.6 Itemize/enumerate

To itemize `\begin{itemize}...\end{itemize}` environment is used as follows.

- first item
- second item
- third item
  - first item
  - second item
  - third item

which can be cretaed using the following code

```
\begin{itemize}
    \item first item
    \item second item
    \item third item
    \begin{itemize}
        \item first item
        \item second item
        \item third item
    \end{itemize}
\end{itemize}
```

whereas enumeration can be incorporated using `\begin{enumerate} ... \end{enumerate}` environment.

1. first
2. second
3. third
   (a) first
   (b) second
   (c) third

```
\begin{enumerate}
    \item first
    \item second
    \item third
     \begin{enumerate}
        \item first
        \item second
        \item third
    \end{enumerate}
\end{enumerate}
```

1.7 Equations

simplest of equation can be written using `\begin{equation}....\end{equation}` command as :

$$x+y=z$$

which can be generated using the following command

```
\begin{equation*}\label{}
   x+y=z
\end{equation*}
```

the * create equation without the equation number. to create the equation with the number * should be removed such as

$$x+y=z \tag{1.1}$$

which could be generated using the following code.

```
\begin{equation}\label{}
   x+y=z
\end{equation}
```

further combined equation such as:

$$\begin{cases} U(x,y) = \alpha_1 + \alpha_2 x + \alpha_3 y + \alpha_4 xy \\ V(x,y) = \alpha_5 + \alpha_6 x + \alpha_7 y + \alpha_8 xy \end{cases} \tag{1.2}$$

which could be generated using code as follows.

```
\begin{equation}\label{eq1.2}
\centering
\begin{cases}
    \begin{aligned}
        U(x,y) = \alpha_1 + \alpha_2x + \alpha_3y + \alpha_4xy \\
    V(x,y) = \alpha_5 + \alpha_6x + \alpha_7y + \alpha_8xy
    \end{aligned}
    \end{cases}
\end{equation}
```

the matrix equationis written in `\begin{gather}...\end{gather}` environment as:

$$\begin{Bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{Bmatrix} = \begin{bmatrix} 1 & x_1 & y_1 & x_1y_1 \\ 1 & x_2 & y_2 & x_2y_2 \\ 1 & x_3 & y_3 & x_3y_3 \\ 1 & x_4 & y_4 & x_4y_4 \end{bmatrix} \begin{Bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{Bmatrix} \tag{1.3}$$

which could be generated using following code

```
\begin{gather}\label{eq3.4}
        \begin{Bmatrix}
u_1\\ u_2 \\u_3 \\u_4
\end{Bmatrix}
=
```

```
\begin{bmatrix}
1& x_1     & y_1 & x_1y_1 \\
1& x_2     & y_2 & x_2y_2 \\
1& x_3     & y_3 & x_3y_3 \\
1& x_4     & y_4 & x_4y_4 \\
\end{bmatrix}
\begin{Bmatrix}
    \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4
    \end{Bmatrix}
\end{gather}
```

Partial differential equation can be written as

$$\frac{\partial U}{\partial Y} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \tag{1.4}$$

which can be generated using code

```
    \begin{equation}
     \frac{\partial U}{\partial Y} = \frac{\partial u}{\partial y}
     + \frac{\partial v}{\partial x}
\end{equation}
```

Integral with summation equation can be written as:

$$\sigma(t) = \int_0^t E_\circ \frac{\partial \varepsilon(s)}{\partial s} ds + \int_0^t \sum_{i=1}^{N} E_i \exp(-\frac{t-s}{\tau_{t,i}}) \frac{\partial \varepsilon(s)}{\partial s} ds \tag{1.5}$$

2

Creating References, List of Abbreviation, List of Symbols

2.1 References and citation

To create a reference/bibliography first you need to create a *.bib file in the main directory as mybib.bib file the content of this file should be in the form as shown below:

```
@article{Hashimoto1984,
author = {Hashimoto, Manabu},
doi = {10.4294/jpe1952.32.373},
issn = {00223743},
journal = {J. Phys. Earth},
number = {4},
pages = {373--398},
title = {{Finite Element Modeling of Deformations of The
 Lithosphere At An Arc-Arc Junction: The Hokkaido Corner, Japan}},
volume = {32},
year = {1984}
```

To add the reference paper to the list the same should be in the bib file. after adding the particular citable paper in the bib file the paper can be cited in the text. such as for the above article by Hashimoto can be cited using the label given to the paper as 'Hashimoto1984' which is provided in the first line `@article{Hashimoto1984`. To cite this paper in text `\citet{Hashimoto1984}` is used which results as Hashimoto [1984], whereas to cite in parentheses `\citep{Hashimoto1984}` is used which results as [Hashimoto, 1984], as the paper cited in the text it should also reflect in the reference/bibliography list also.

2.2 List of Abbreviation

To create an abbreviation list and use it in the text `\newacronym{acr:usgs}{USGS}{United States`Geological Survey| is used, where in the first curly bracket label of the Abbreviation is written, in the second curly bracket display name is written, and in the third curly bracket full form of the abbreviation. it also creates a hyperlink. to cite the abbreviation in the text `\acrshort{acr:ctf}` command is used which uses the label of the abbreviation. which results as . Once the abbreviation is cited in the text it will reflect in the List of Abbreviations.

2.3 List of Symbols

to create list of symbols `\nomenclature{}{}` command is used. where in the first bracket symbol is written, and in the second bracket description of the symbol is written. Such as

```
\nomenclature{$\nu$}{Poisson's ratio}
\nomenclature{$E$}{Young's modulus}
```

will show the symbol in the list of symbols.

References

Hashimoto, M. (1984). Finite Element Modeling of Deformations of The Lithosphere At An Arc-Arc Junction: The Hokkaido Corner, Japan. *J. Phys. Earth*, *32*(4), 373–398.

NDMA (2009). Development of Probabilistic Seismic Hazard Map of India. *Govt. of India*, (pp80).